Department of Conservation
Te Papa Atawhai

Department of Conservation

Whakapapa Waste Water Treatment Plant

Resource Consent Renewal

Application (20 March 2017)

Department of Conservation (DOC)

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Prepared by:

Department of Conservation
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Veolia
Nicholas Singers Ecological Solutions Ltd
NIWA
Morphum Environmental Ltd
Lattey Group Ltd

Reviewed and Approved for Release by:

Allan Munn
Director of Operations
Department of Conservation

Date: 20 March 2017

Ref: Whakapapa AEE WWTP Final

EXECUTIVE SUMMARY

The Whakapapa Village Wastewater Treatment Plant (WWTP) collects and treats wastewater from the Iwikau and Whakapapa Villages. This application seeks replacement consents to enable the continuation of wastewater services for the Whakapapa and Iwikau Villages.

The WWTP is located within the dual world heritage Tongariro National Park and has a long history of development dating back to the 1940s. The WWTP is owned by DOC, and is currently operated under contract by Ruapehu District Council, which provides specialist operational experience and expertise.

Wastewater is collected from the lodges on the mountain, Ruapehu Alpine Lifts (RAL) and ski field infrastructure, accommodation facilities such as the Chateau and the Skotel, the Visitor Centre, DOC offices, cafes and staff accommodation, and piped to the WWTP for treatment. The current system discharges treated effluent to land disposal sites, however has faced operations challenges in recent times.

The management philosophy for the Tongariro National Park, developed under the National Parks Act 1980 and written into the Tongariro National Park Management Plan (2006 – 2016), focuses on the need to protect its special natural features and cultural values which give the park its high significance, while providing for public access and enjoyment subject to certain constraints.

The Tongariro National Park Management Plan states: *"There are inherent challenges in managing a sensitive protected site and providing for the varied expectations of hundreds of thousands of visitors per annum. Visitor demands have led to the development of three ski areas and a multimillion dollar recreation and tourism infrastructure. There is an obvious tension between the perceived requirement for infrastructure development and maintenance, in order to meet visitor requirements, and the preservation ethic which is at the heart of the National Parks Act 1980 (Page 4)."*

The WWTP currently operates under the following resource consent:

- Discharge Permit 105684 – Discharge to land – Treated wastewater up to 700 cubic metres per day.

To provide for the ongoing operation of the WWTP, the following replacement consents are sought under the Horizons Regional Council One Plan:

- A Discharge Permit for the discharge of treated wastewater onto land (Rule 14-30
- A Discharge Permit for the discharge of treated wastewater into water as an emergency measure during extreme weather events (Rule 14-25).
- A Discharge Permit for the discharge of treated wastewater to land attributed to seepage from the treatment facilities (Rule 14-30).
- A Discharge Permit for the discharge of contaminants to air (odour) (Rule 15-17).

In support of these applications, a range of technical assessments have been undertaken (see Appendices), including:

- An engineering report by Veolia – Conceptual Upgrade Options assessment relating to Resource Consent Application Whakapapa WWTP (**Appendix 3**);
- A fresh water quality and ecological monitoring report by Aquanet Consulting Ltd (**Appendix 9**);

- An ecological assessment – terrestrial by Nicholas Singers Ecological Solutions Ltd (**Appendix 2**);
- A design report (+ plans) on the Whakapapa Wastewater Treatment Wetland by Morphum Environmental Ltd (**Appendix 7**);
- A Hydrogeological Investigation Area G by Lattey Group Ltd (**Appendix 17**);
- A survey of whio (blue duck) (**Appendix 13**);
- A wetland treatment conceptual design report by NIWA (**Appendix 6**);
- A landscape Plan by Nicholas Singers Ecological Solutions Ltd (**Appendix 14**);
- A photo montage of proposed wetland by DC Urban (**Appendix 15**);
- An alternative options assessment by MWH (**Appendix 16**); and
- A gap analysis and recommended programme of investigations by Aquanet Consulting Ltd (**Appendix 10**).

In response to the matters identified in these assessments, and through consultation with Ngāti Hikairo, Uenuku, Tongariro National Park stakeholders and other parties, replacement consents are being sought based on the following approach to managing the environmental effects of the ongoing discharge of treated effluent from the WWTP:

- Approximately 1.1 hectares of constructed wetland area will be developed as a core component of the treatment process. This places a high degree of reliance on natural treatment processes, in response to direction provided through consultation with Ngāti Hikairo and Uenuku, and in recognition of the surrounding environment and its significance.
- A series of comprehensive improvements to the WWTP and the underground pipe network are proposed to improve treatment performance, noting that many of these improvements have already been implemented in the period following the June 2016 application.
- A staged approach to implementing future engineering improvements at the WWTP and to the development of the constructed wetland is proposed to allow sufficient time for detailed design and commissioning of works.
- Effluent quality standards are proposed such that effluent leaving the WWTP and entering the constructed wetland will be managed to a high degree, and to a known and predictable quality.
- Environmental Outcomes are proposed for the Northern and Southern tributaries which establish an adaptive management approach, to respond to the uncertainties associated with developing a treatment system dominated by natural processes, the difficulties associated with predicting in-stream ecological responses to changes in the wastewater treatment process, and to account for some current data limitations.
- Environmental standards are proposed for the Wairere Stream, to provide certainty that effects beyond the immediate vicinity of the WWTP are carefully managed.

CONTENTS

APPENDICES

Ref	Report Descriptions	Reference/Date
1	Topographical Plans of the Existing Whakapapa Wastewater Treatment (WWTP) Plant including: • Topographical map showing location. • Aerial Plan showing WWTP in relation to proposed Wetland, existing disposal fields and tributaries • Gazette Notice and SO Plans for Tongariro National Park • Survey Plan for area G – proposed wetland site. • Copy of the existing consent permit 105684	16/11/2016 16/11/2016 SO37523 2014-145-TP001 (22/07/14) January 2012
2	Ecological Assessment - Terrestrial – Whakapapa WWTP – Nicholas Singers Ecological Solutions Ltd	NES Ltd Report 1: 2016/17, March 2017
3	Engineering Report by Veolia – Conceptual Upgrade options assessment relating to Resource Consent Application Whakapapa WWTP	March 2017
4	DBCON – Permeability Test and Report Whakapapa WWTP	December 2010
5	Proposed Conditions	March 2017
6	NIWA Wetland Specialist Report, Modelling and Recommendations	February 2017
7	Morphum Environmental Wetland Design Report and Plans	February 2017
8	List of Ingression and Infiltration (I&I) works completed and list of works proposed.	June 2016
9	Ecological Monitoring Water Quality Report – Whakapapa WWTP – Aquanet Consulting Ltd + a memo providing updated monitoring results	March – September 2016
10	Gap analysis and recommended programme of investigations (2015-2016) - Aquanet Consulting Ltd	February 2016
11	Operational Management Plan – Whakapapa WWTP	September 2016

12	Consultation and Affected Parties Written Approval	As attached
13	Whio Survey – Whakapapa WWTP and Memorandum from Technical Advisor Ecology for the DOC (Jess Scrimgeour)	March 2016
14	Landscape Plan - Nicholas Singers Ecological Solutions Ltd	June 2016
15	DCM Urban Design Limited – Photo Montage of Wetland	February 2017
16	Options Assessment - MWH	July 2014
17	Lattey Group Ltd – Hydrogeological Investigation Area G - wetland	February 2017

APPLICATION FOR RESOURCE CONSENT

Under Section 88 and 4th Schedule of the Resource Management Act 1991

To Horizons Regional Council:

1. The Department of Conservation applies for the following types of resource consent:

   - A Discharge Permit for the discharge of treated wastewater onto land (**Rule 14-30**).
   - A Discharge Permit for the discharge of treated wastewater into water as an emergency measure during extreme weather events (**Rule 14-25**).
   - A Discharge Permit for the discharge of treated wastewater to land attributed to seepage from the treatment facilities (**Rule 14-30).**
   - A Discharge Permit for the discharge of contaminants to air (odour) (**Rule 15-17**).

   Discharge permits are sought for a duration of 28 years (expiring 1 July 2045).

2. The activity to which the application relates (the proposed activity) is as follows:

   The operation of the Whakapapa Village wastewater treatment plant (WWTP) and the discharge of treated effluent from the WWTP to land and draining by sub-surface and/or overland flow where it may enter an un-named tributary of the Wairere Stream as an emergency measure during extreme weather events, and any ancillary emission of odour.

3. The site at which the proposed activity is to occur is as follows:

Address for Activity:	Whakapapa Village, State Highway 48, Mount Ruapehu
Legal Description:	Tongariro National Park (Lot 7 DP69559)
Valuation Number:	06090/176/00
Map Reference:	NZMS260 S19:296-201; NZTopo50 BH34:196-585

4. The full name and address of each owner and occupier of the site to which the application relates is as follows:

   Public Conservation Land forming part of the Tongariro National Park managed by the Department of Conservation on behalf of the Crown. DOC manages and operates the Whakapapa Village Waste Water Treatment Plant within the Amenity Area of the village.

   Postal Address:
   Department of Conservation
   P.O. Box 528
   TAUPO

5. In order to construct the proposed wetland area, earth disturbance is required on land used for wastewater treatment. This land qualifies as potentially contaminated under the Hazardous Activities and Industries List (HAIL) prepared by the Ministry for the Environment (2011), and the provisions of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) therefore apply. A resource consent application under the NESCS is required and will be prepared and lodged with the Ruapehu District Council.

6. In accordance with section 88 of, and the Fourth Schedule to, the Resource Management Act 1991, an assessment of environmental effects in the detail that corresponds with the scale and significance of the effects that the proposed activity may have on the environment has been prepared and lodged with the applications.

7. There is no further information required to be included in this application by the district plan, the regional plan, the Resource Management Act 1991, or any regulations made under the Act.

8. The Applicant requests, under s.95A(2)(b) of the RMA, that the application be publicly notified.

Date: 20 March 2017

Signature: ....

Allan Munn
Director of Operations
Department of Conservation
Authorised to sign on behalf of the Director General

Contact Details:

Address for service of Applicant:

Department of Conservation
P.O. Box 528
37 Motutaiko Street
TAUPO 3330
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Contact person: Tamzin Moore: Project Manager – Planning

1 INTRODUCTION

The Whakapapa Wastewater Treatment Plant ('WWTP') has existed at Whakapapa Village since the 1940's. The first WWTP developed included an aeration basin (1940's), with the sedimentation basin, sludge pumps, operations building and oxidation pond added to the plant in 1964. Sewage from Whakapapa Village was reticulated, treated and discharged to the Wairere Stream. Sewage generated from the Iwikau Village, including from the ski accommodation facilities, cafes and ski field base facilities was originally discharged into land via septic tanks.

In 2002, resource consent was approved by Horizons (consent number 101961) to connect Iwikau Village to the WWTP. This included upgrades to the treatment system and a change to land-based treatment. In 2004, Iwikau Village was connected to the WWTP along with improvements that included the addition of sedimentation tanks, sand filters and UV treatment, and the construction of a dripper irrigation system.

The current discharge permit for the WWTP (No. 105684) was issued in January 2012. This was granted for a term of three years, expiring on 1 December 2014. This consent is attached in **Appendix 1**. To meet s.124 of the RMA, an application for replacement consents was lodged by DOC before expiry and was accepted by Horizons Regional Council on 1 September 2014.

Since then, the WWTP has continued to operate under s.124 (RMA) while the current consent application is processed. Horizons have issued a s.92 (RMA) requests for additional information, and DOC has continued to investigate and improve WWTP performance.

As WWTP improvements have continued and more data has been gathered, it has been possible for DOC to further refine the basis for which replacement consents are being sought. In considering this refined approach, and the further information requests form Horizons, DOC has decided to integrate these matters into an updated application and assessment of effects ('AEE'). That is the basis for the current application, including a revised upgrade strategy and associated new AEE.

2 DESCRIPTION OF THE ENVIRONMENT

2.1 Tongariro National Park

Whakapapa Wastewater Treatment Plant is located on the northern slopes of Mount Ruapehu and within the Tongariro National Park (the 'Park'). The Park is a dual world heritage site due to its natural and cultural properties. The Park was the first national park in New Zealand following the tuku of the mountain peaks by Te Heuheu Tūkino IV (Horonuku) the paramount chief of Ngāti Tūwharetoa in 1887.

In New Zealand, national parks are areas of land preserved in perpetuity for their intrinsic worth and for the benefit, use and enjoyment of the public. The Park consists of areas that contain distinctive scenery, ecological systems and natural features so significant that its preservation is of national and international interest. The Park has values not found elsewhere in New Zealand - the distinctive volcanic landforms of Mount Ruapehu, Ngauruhoe and Tongariro and the landscape formed by volcanic processes surrounded by forests and hinterland.

The Tongariro National Park Management Plan states: *"There are inherent challenges in managing a sensitive protected site and providing for the varied expectations of hundreds of thousands of visitors per annum. Visitor demands have led to the development of three ski areas and a multimillion dollar recreation and tourism infrastructure. There is an obvious tension between the perceived requirement for infrastructure development and maintenance, in order to meet visitor requirements, and the preservation ethic which is at the heart of the National Parks Act 1980 (Page 4)."*

The Horizons Regional Council One Plan identifies the Park as a 'Regionally Outstanding Natural Feature and Landscape' (Schedule F). The listed characteristics and values are:

a. *Visual and scenic characteristics, particularly the park's visual prominence in the Region and contrast of the Rangipo desert with adjacent landscapes.*
b. *Geological features including the Rangataua Lava flow.*
c. *Recreational Values, particularly tramping and snow sports.*
d. *Scientific value, particularly the volcanic landscape.*
e. *Ecological value, particularly the mountains ecology and the extensive tussock grasslands and wetland supporting rare indigenous flora.*
f. *Importance to Tangata Whenua.*

The Park is also recognised as an 'outstanding natural feature and landscape' in the Ruapehu District Plan.

The Park has a long history of recreational use. The Park history identifies that ski facilities and huts on the mountain were introduced in the early 1900s. The Chateau was built in 1929 following the extension of the road up the Whakapapa Valley. The Bruce Road was constructed in the 1930s, giving improved access to the then new ski area.

Post-war development in the 1950s and 1960s saw the construction of numerous huts on the mountain – something which the Park Board of the day encouraged with a view to assisting development and interest in the ski field and promoting recreational use of the Park.

Situated in the centre of the North Island, approximately 350 km from Wellington and Auckland and much closer to several towns and cities within 1-2 hour's drive, it is accessible to large numbers of New Zealanders. The main North Island rail link, providing a freight and passenger service, passes through and adjoins the Park on its western boundaries. The location of the Park provides accessibility for a huge number of visitors for a variety of recreational pursuits. Most notable is the winter snow sports activity. Other recreational uses include tramping, sightseeing, mountain climbing, photography, walking and picnicking. Increasing day visitor use is expected to continue.

The Park environment is nationally and internationally significant for resource-based recreation and is a major tourist attraction. Increasing numbers of tourists visit the park with the highest numbers during the winter ski season in July and August. This requires ongoing management to provide essential services and continued investment of the Whakapapa WWTP is required to better manage discharge and treatment of waste generated by visitors to the Park.

The issue of protection versus use in the Park are addressed in the Tongariro National Park Management Plan through limitation of the comfortable carrying capacity of the Park's Amenity Areas. This management approach gives confidence in design for facility development and goes some way to establishing infrastructure design criteria. The comfortable carrying capacity for Iwikau village is 1,600 beds and a ski area that caters for up to 6,000[1] visitors per day. Whakapapa village has a design capacity of 1,200 population equivalents and is currently at capacity.

The management philosophy for the Park, developed under the National Parks Act 1980 and written into the Tongariro National Park Management Plan (2006 – 2016), focuses on the need to protect those natural features/values which give the Park its high significance. The National Parks Act 1980 establishes a number of principles to be applied. These are primarily oriented towards preservation of natural features and ecosystems in perpetuity, and public access and enjoyment subject to certain constraints to protect those natural features and values.

The Park is unique in having dual world heritage status[2]. The culture considerations of mana whenua are equally as important in status as the landscape and activities undertaken in the Park. Part of the respect for the mountain has been to ensure waste is removed from the tapu top of the maunga down onto the lower slopes for treatment. Treatment must include the passage of wastewater such it has contact with mother earth (Papatūānuku) for cleansing and restoring the mauri to the receiving water.

[1] Peak at approximately 6,000 visitors may occur on a clear sunny day following snowfall in winter (a 'bluebird day'). Anecdotally, from personal coms RAL staff, the actual number of blue bird days are very rare and it is estimated to be approximately 5 in any winter season.
[2] As listed by United Nations Educational, Scientific and Cultural Organization (UNESCO).

2.2 The Whakapapa Wastewater Treatment Plant – Site Description

The Whakapapa Village is located approximately 6 km along State Highway 48 (Bruce Road) from the intersection with State Highway 47 (**Figure 1**). The WWTP is located at the end of Sewage Treatment Plant Road, about 600 m north east of the Chateau Tongariro and east of State Highway 48 and the golf course.

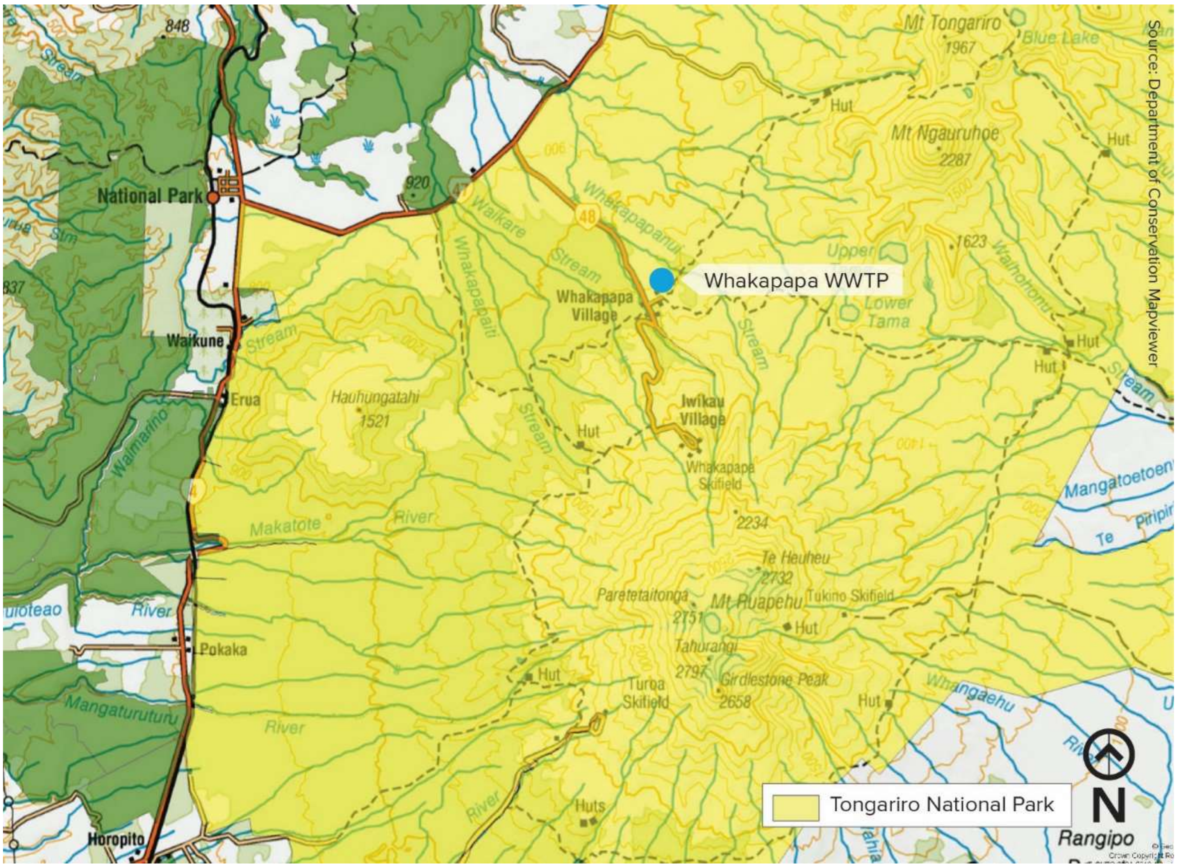

Figure 1: Location Plan

The WWTP's existing disposal fields A – D and G are located within the 'Amenity Area'[3] of Tongariro National Park (**Figure 2**).

[3] Amenity areas are set aside in Tongariro National Park for the development and operation of recreational and public amenities and related services at a scale and intensity which is not generally appropriate elsewhere in the Park (Section 4.2.4 of the Tongariro National Park Management Plan refers).

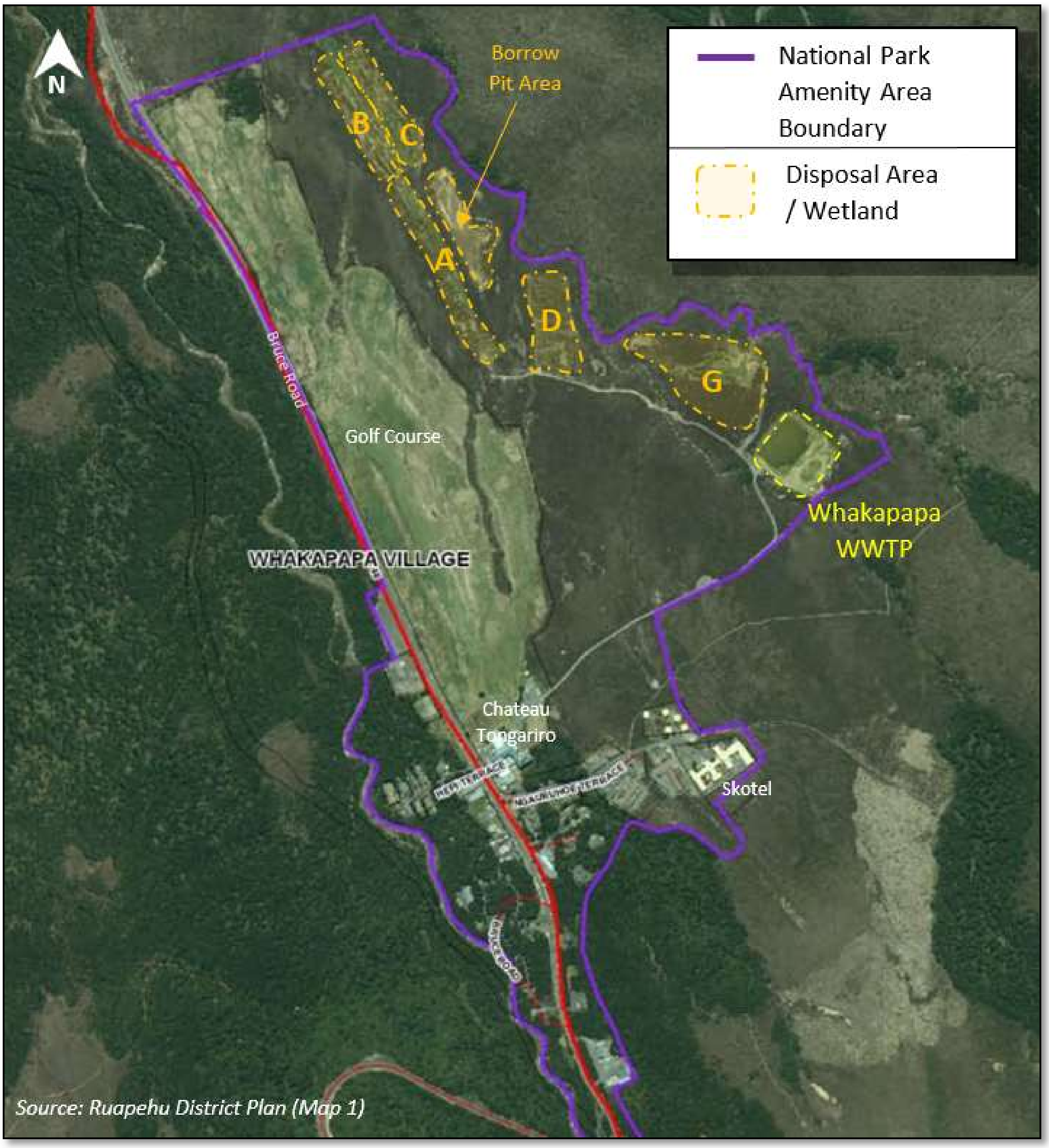

Figure 2: Location of WWTP and Disposal Fields in Whakapapa Amenity Area

The current wastewater disposal fields (installed from 2004 – 2007) are located in areas identified as A, B, C and D with area G northwest of the tertiary treatment pond (**Figure 2**). The area was naturally covered in beech forest but following fires has regenerated into scrub land.

During the 1950s, area G was used as a piggery for food supply to the Chateau Tongariro and areas A to C accommodated the old airstrip. All areas A to D contain the existing subsurface dripper irrigation system with areas A to C being more modified by human activities than area D. Area G currently accommodates discharge trenches.

The WWTP sits between a northern and southern unnamed tributary to the Wairere Stream (hereinafter referred to as the 'Northern Tributary' and 'Southern Tributary') with a flow to the north east away from Whakapapa Village, parallel to State Highway 48 and eventually converging with the Whakapapanui Stream (**Figure 3**). The ultimate point of drainage for all treated wastewater applied to land within this area, whether by surface or sub-surface flow, is therefore toward this tributary.

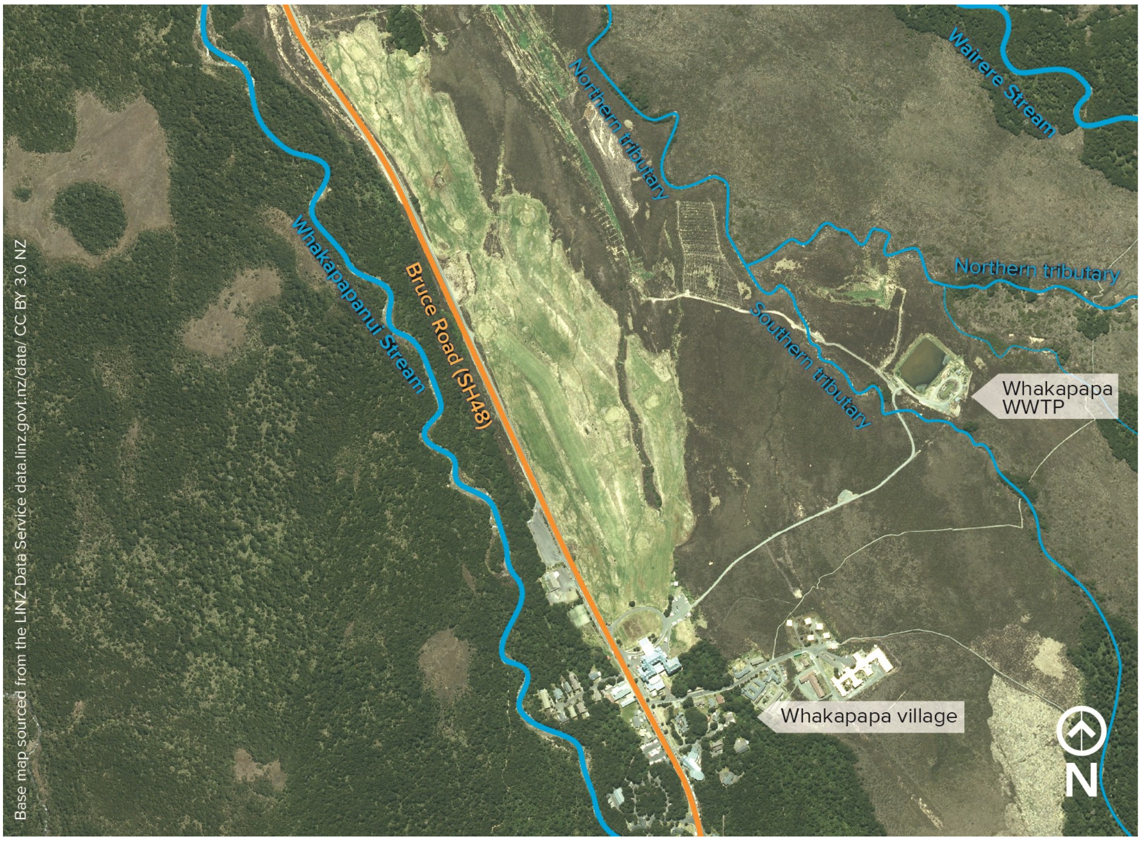

Figure 3: Location of WWTP and surrounding waterways (including tributaries)

The treatment plant and tertiary treatment pond has an area of 1,240 m². The disposal fields (A, B, C, D & G) occupy an area of up to approximately 5.0 hectares to the north of the plant, which was formerly used for farming and an airstrip.

The land below the WWTP within the current disposal field area has a high water table with a number of ephemeral water courses passing through it. Vegetation comprises of shrubs and grasses including heather, tussock and toetoe. More detail around the terrestrial vegetation type is provided in the report titled Ecological Assessment Terrestrial – Nicholas Singers Ecological Solutions Ltd (See **Appendix 2**).

2.3 Climate

Whakapapa Village is located at approximately 1,100 m above sea level and receives snow fall during the winter months. Average annual rainfall is approximately 2,825 mm (1971 to 2000). Temperature varies as follows:

- Average daily maximum air temperature.. 12.33°C
- July average daily maximum air temperature.. 3.16°C
- Minimum ground temperature at 100 mm... 0.7°C
- Minimum ground temperature at 200 mm... 0.2°C

Snow falls at the Whakapapa WWTP, on average, occur 16 days per year but will melt shortly after a big snow fall event. There are a number of days that the tertiary treatment pond will freeze over, but this does not affect the pond's primary function of tertiary treated effluent storage, before discharge. The prevailing wind is from the west but the site also receives strong southerly winds off the mountain.

3 DESCRIPTION OF EXISTING WASTEWATER TREATMENT SYSTEM

3.1 Background to the Existing Wastewater Scheme

There has been significant investment in the WWTP over the years. The development of the WWTP demonstrates a commitment to the ongoing use of the plant to treat wastewater from the Whakapapa and Iwikau Villages starting back in 1943 to the current application. Table 2 below provides a brief history of the investment in wastewater treatment in the Park.

Table 1: History of Investment of wastewater Treatment in the Park

Date	Description
1943	Whakapapa Village wastewater treated in a combination aeration basin and oxidation pond and discharge directly to a tributary of the Wairere Stream
From 1950	Iwikau Village wastewater from 48 lodges and ski area facilities is treated by individual septic tanks and discharge to soakage pits.
1992 - 1995	DOC in consultation with stakeholders and Iwi investigate issues with wastewater and options for a new scheme including a wetland concept at the existing site and an alternative to treat wastewater outside the Tongariro National Park.
2001	Resource consent for discharge is lodged with the Manawatu Wanganui Regional Council for the current Whakapapa Wastewater Treatment Plant plus improvements.
2001	Closed-circuit television ('CCTV') inspection of the Whakapapa sewers identifies infiltration and ingression issues with the existing pipe network.
2002	Resource Consent granted: • To discharge wastewater to water for a 3-year period (Permit Number 101960) • To discharge tertiary treated wastewater to land for a 20-year term expiring 2022 (Permit number 101961)
2003	DOC applies for a variation to consent (101961) to make changes to the wastewater treatment system design and increase the rate of discharge to land.
2004	Land disposal fields upgraded by $4.3 million investment with Iwikau Village decommissioning septic tanks and connecting to the Whakapapa WWTP.
2005	Resource consent to discharge treated wastewater to water expires (Permit Number 101960)
2006	Operational upgrades at the plant occur including a new pumping station and additional land for disposal trenches built. There were some ongoing compliance issues with the consent (variation) granted in 2003.

2011	DOC applies for short term consent to discharge treated wastewater to land. This application was to replace resource consent permit number 101961 and is granted for a 3-year period (Permit Number 105684). This application approved: • Discharge up to 700 m^3/day of treated wastewater to land during storm events and peak flow (winter); • Discharge an annual average of 170 m^3/day of treated wastewater to land; • Discharge to land via drip-line irrigation at a rate of 3.5 l/hr to a 2.96 ha disposal field • Discharge tertiary treated wastewater to the 'emergency overflow pond' and then to ground soakage via three existing ground soakage trenches.
2012	New consent permit number 105684 granted January 2012 for a period of 3 years. Expired on 1 December 2014
2014	A new application for resource consent is lodged on 1 September 2014. At Horizons' discretion, the existing Wastewater Treatment Plant operates under s.124 (2) of the RMA until such time as a new consent has been granted or declined and all appeals are determined. Consent was sought for: • The continued wastewater treatment and storage at the plant and pond. • Continued discharge to existing land base disposal methods prior to operation of the wetlands. • Construction of the wetland. • Discharge of treated wastewater from the plant and pond to the wetland.
2015	Following discussions with the Horizon's Regional Council - additional monitoring, consultation and information gathering are undertaken in support of this resource consent application and the application is revised and lodged in June 2016.
2016-2017	The following works were completed in the period to March 2017: • CCTV camera inspections of <100 mm and >100 mm pipes; • Smoke testing; • Upgrading of Iwikau horizontal infrastructure has with sealed manholes and the main pipes being replaced with High Density Polyethylene (HDPE) pipes; • Further initial repairs and storm water re-diversions; • Design and improvements to the Iwikau Buffer Tank; and • Collection and propagation of seeds for the development and planting of the first wetland area 2016/17. • Replacement of flow instrument in clarifier outlet; • Trial improved nitrification in Pasveer ditch;

	• Improved sampling regime during peak and shoulder periods; • Further measures aimed at reducing inflow & infiltration, with this work continuing; • Installed a thickened waste activated sludge tank; • Recommissioned re-aeration tank for its original purpose; • Overhauled the tertiary filters; and • Fitting out the Iwikau buffer tank for flow buffering.

3.2 Existing Whakapapa sewerage scheme

This section describes the principal components of the existing Whakapapa sewerage scheme, notwithstanding that a range of improvements have been, and continue to be, implemented (as discussed in Table 1). Section 5 below outlines how the WWTP will be improved in a staged manner as part of this consent application, and how it will operate in future.

The existing Whakapapa sewerage scheme comprises of four main areas:

- Iwikau Village Sewerage
- Whakapapa Village Sewerage
- Wastewater Treatment Plant located at Whakapapa Village
- Land application and disposal areas

3.2.1 Iwikau Village including Whakapapa Ski Area

Iwikau Village was connected to the system in 2004. This was largely driven by tāngata whenua concerns around the adverse effects of having human effluent disposed of on the maunga (mountain) by way of septic tanks.

Within Iwikau Village are 48 ski club lodges and the Ruapehu Alpine Lifts Ltd (RAL) facilities such as cafes, public toilets, equipment rental, and administration buildings. Club lodges are supplied by roof collected rainwater and so have water saving controls and practices in place.

3.2.2 Whakapapa Village

Whakapapa Village has a reticulated water supply managed by DOC. Whakapapa Village contains the Chateau Tongariro, Skotel and Whakapapa Holiday Park visitor accommodation, the Visitor Centre, DOC workshop, cafes, staff accommodation for DOC and RAL, and a few club lodges. Except for commercial kitchens and the few necessary workshops, there are no industrial activities connected to the wastewater system. All commercial café and kitchens have grease traps. Laundry services for the Chateau Tongariro and the Skotel are undertaken outside of the Park, therefore the phosphorus component of the wastewater is minimised.

Given a large ratio of visitors to residents and the ratio of visitors that do not stay overnight in the Park during winter, the influent is expected to be high in nitrogen species compared to other wastewater systems that primarily service resident populations.

3.2.3 Land Application Area

There are four existing irrigation fields notated as areas A – D which provide drip irrigation for treated wastewater which were installed from 2004 to 2007 (Table 2). Soakage trenches were also installed in 2006.

Table 2: Wetland Areas

Component	Design Area (m^2)	Drip Line Length (m)	Design Capacity (m^3/d)
Area A (2005)	6000	1000	84
Area B (2005)	8800	2400	202
Area C (2005)	5800	2400	202
Area D (2007)	9000	1800	151
Area G Soakage Trenches (2006)	between 20 – 40m in length		
Total	29600 (+ trenches)	7600	639

<u>Existing Design Volume</u>

The current wastewater treatment plant and land disposal area was designed for a dry weather average design flow rate at maximum population of approximately 700 m^3/day and an average of 170 m^3/day receiving influent volumes from Whakapapa and Iwikau Villages.

3.2.4 Treatment Plant Components

The existing wastewater treatment plant comprises the following components as outlined in **Figure 4**, which are described in further detail below (also refer to **Appendix 3** Engineering Report by Veolia):

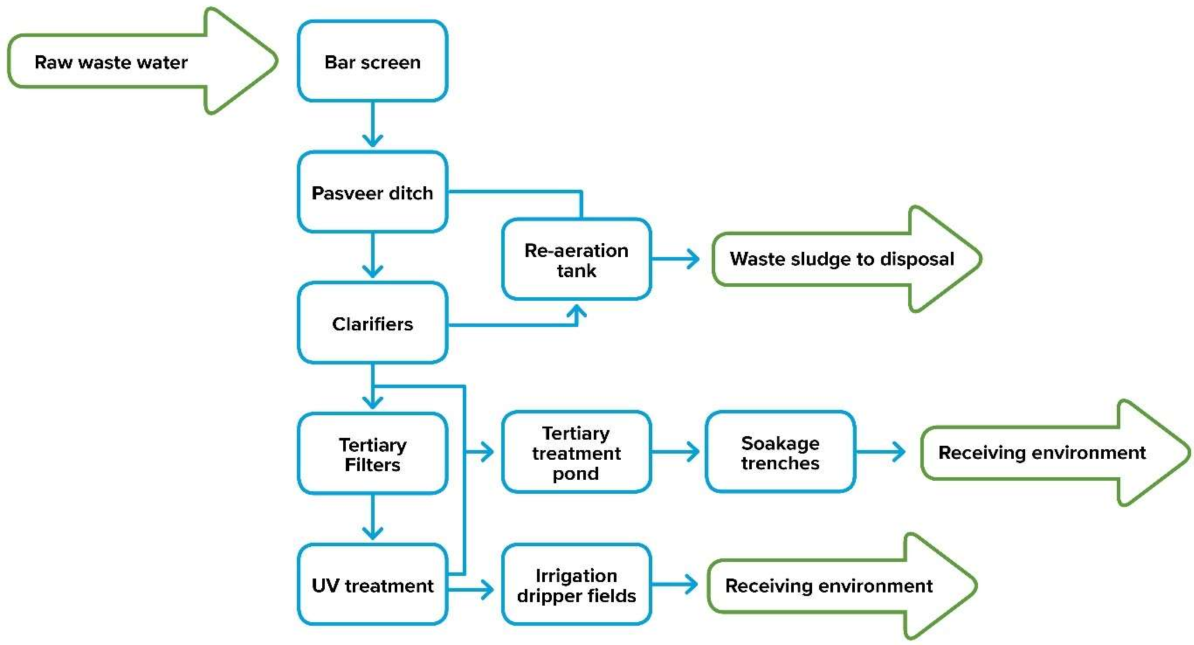

Figure 4: Simplified flow diagram of Existing Treatment System Flow system

3.2.5 Coarse Screen

The raw wastewater discharges into a small concrete chamber in which there is a coarse bar screen and rakes within the Pasveer Ditch. Downstream of the screen, the return activated sludge discharge mixes with raw wastewater before both discharges reach the Pasveer Ditch. Material held by the screen and rakes (termed screenings) is removed daily by the Operator.

3.2.6 Pasveer Ditch

Built in 1961, the Ditch is a doughnut shaped basin around which mixed activated sludge flows, propelled by two paddle aerators. Mixed activated sludge is a mixture of wastewater and microorganisms. The microorganisms metabolise the carbonaceous material in the wastewater (e.g. sugars, carbohydrates) and multiply.

3.2.7 Sedimentation Tanks

Mixed activated sludge overflows the Ditch and is discharged equally to two sedimentation tanks. In a quiescent environment, microorganisms in the sludge coagulate and settle and clear treated wastewater spills over a weir and to a pumping station. The liquid in which the micro-organisms settle is withdrawn from the base of the sedimentation tanks and returned to the ditch (activated sludge). The treated wastewater is typically of a secondary standard.

3.2.8 Sand Filters

The pump station discharges the treated wastewater to three sand filters in parallel, which provide further treatment by removing fine particulate matter.

3.2.9 Ultraviolet Disinfection

Treated wastewater from the filters passes through a channel in which it is irradiated with ultraviolet light. The light deactivates micro-organisms including pathogenic micro-organisms. The sand filters have a hydraulic capacity of 470 m^3/d. Flows up to this maximum can treated to a tertiary standard by the filters and after disinfection, discharged to a second pumping station. Any daily flow that exceeds the capacity of the sand filters (720 m^3/day) is diverted to the tertiary treatment pond, which effectively also produce tertiary treated wastewater and can be used to store (buffer) flows before the discharge to the dripper fields system.

3.2.10 Tertiary Treatment (Oxidation) Pond

The pond currently provides a storage and discharge facility for excessive inflows which can at times overwhelm the treatment capacity of the plant. From plant flow monitoring data, it has shown that storm water infiltration and cross connections exist within the Whakapapa and Iwikau Villages, which during rain events can provide excessive flows through the plant. The existing pond is not artificially lined; however, a pond lining of ash and pumice has created a non-permeable layer as supported by the testing undertaken by DBCon in January 2011. This report is provided as **Appendix 4**.

4 REVIEW OF THE EXISTING WASTE WATER TREATMENT PLANT SYSTEM

To understand the state and performance of the wastewater collection network, the treatment plant and the dripper irrigation fields, options for maintenance, repairs and upgrades, DOC has reviewed past reports and commissioned a number of studies and reports, which together provide a comprehensive review of the current Whakapapa WWTP system and have contributed to this application. These reports, investigations and applications are outlined in Table 3.

Table 3: Investigations into Whakapapa WWTP

Discipline	Report Title	Date
Engineering	Whakapapa Sewage Scheme Feasibility Study, and Iwikau Sewage Scheme Feasibility Study by Royds Consulting	September 1994
	An Environmental Assessment of Further Options for Sewage Treatment for Iwikau and Whakapapa by K Hackwell	September 1994
	Resource consent application Whakapapa Wastewater Treatment Plant – summary and history of Consideration of Alternatives by Beca	1998
	Operating and Maintenance Manual for Whakapapa WWTP prepared by AWT	2010
	Tertiary Treatment Pond floor sampling and permeability Test by DBCon Engineering	2011
	Whakapapa Wastewater Flow Report by MWH	2014
	MWH Issues and Options Investigation and Reporting	July 2014
	Storm water Ingression and Infiltration by MWH	July 2014
	Whakapapa Wastewater Treatment Plant Process Modelling Nitrogen Reduction Options by MWH	2015
	Whakapapa CCTC Footage Investigation	April 2015
	Whakapapa Smokescreen testing by Veolia	April 2015
	Veolia Monthly Operation Report for the Provision of Facilities Management for the 3 waters (water, storm water and wastewater)	July – October 2015
	Disposal Fields Performance Investigation by Veolia	February 2016
	Iwikau Buffer Tank - Assessment of physical integrity and storage capacity of the buffer storage tank located at Iwikau Village prepared by Veolia	March 2016
	Assessment of accuracy of wastewater flow meter by Veolia	April 2016
	Conceptual upgrade options assessment relating to Resource Consent Application for Whakapapa WWTP by Veolia	May 2016

Discipline	Report Title	Date
Ecology	Whakapapa Village Wastewater Treatment Plan Assessment of Environmental Effects by the Catalyst Group	August 2014
	Gap Analysis Whakapapa WWTP resource consent application prepared by Aquanet	December 2015
	Freshwater Ecological Water Quality Report by Aquanet	March 2015
	Terrestrial Ecology Report by Nick Singers	Revised June 2016
	Whio Survey and Assessment	February 2016
	Memo from Aquanet providing updated results of freshwater quality and ecology monitoring.	September 2016
Geology	Hydrogeological Investigation – Area G BY Lattey Group	January 2017
Landscape	Landscape Visual Assessment and Plan by Nick Singers	May 2016
	Photo montage by DC Urban	February 2017
Wetland	Wetland Assessment by NIWA	June 2016
	Wetland Concept and Modelling by NIWA	February 2017
	Constructed Wetland Design Summary by Morphum Environmental	February 2017
Monitoring	Monitoring Report 2012/2013 Whakapapa Wastewater Treatment Plant by DOC	February 2014
	Aquanet Monitoring and Reporting in-stream Values	From October 2015
Planning	Whakapapa Village WWTP – Resource Consent Application	February 2011
	Application for resource consent - Cheal on behalf of DOC	August 2014
	Application for resource consent – Mitchell Daysh on behalf of DOC	June 2016
	S.92 Further Information Request from Horizons	July 2016
	S.92 Further Information Request from Horizons	August 2016
	First response to further information	September 2016
	Second response to further information	November 2016
	Third response to further information	February 2017
	Updated application for resource consent following additional technical work, monitoring and further information request from Horizons – Mitchell Daysh on behalf of DOC	March 2017

The following sections outline the key issues identified from these reports and assessments:

4.1 Wastewater Material

Typical domestic wastewater is a balance of urine and faecal material as the feedstock for the bugs at a treatment plant. The Whakapapa WWTP is not typical in that it receives approximately half of the wastewater from the ski field at Iwikau Village, which has a dominant urine (ammonia) feedstock entering the collection system making it more of a challenge to process and to treat. It has been

identified that additional buffering of effluent volumes being received by the WWTP is required to balance loading on the plant.
There is an existing holding tank in Iwikau Village located underground within a lower car park area off Bruce Road. In 2005, the tank was originally installed as a holding tank for emergencies on the pipe line or at the WWTP to hold effluent for a period of up to 48 hours.

Through an upgrade to electronic valves, the addition of a mixing system and sensors, it was proposed to change the use of the emergency holding tank into a flow buffering tank. This will manage the higher loadings from the ski field at Iwikau by slowly releasing the influent into the collection line to the WWTP over a 24-hour period. Through a local communications link and a Supervisory Control and Data Acquisition system ('SCADA') at the WWTP, an optimisation of the buffering capacity will be achieved

These works were completed in the period following the June 2016 application, and the buffer tank is now operational, pending final commissioning aspects.

4.2 Clogging of the Dripper Irrigation Field

A key issue is the condition and operation of the dripper irrigation fields, installed in between 2004 and 2007. Each of the lines in Areas A – D has a length between 1000 m up to 2400 m. The colder alpine environment compounded with the biofilm growth and the build-up of fine debris in the pipes and dripper lines in the soakage field have caused the lines over time to clog up.

The lines and drippers are now severely clogged, with the remaining un-blocked drippers and line-breaks flowing excessively. The condition of the system is such that now, even in dry weather conditions, the dripper fields are unable to take all of the effluent from the plant (it can take around 300 m^3/day), with the balance going to the tertiary treatment pond then the soakage trenches.

A significant amount of time has been invested into the dripper fields to attempt to improve their functionality. The effectiveness of the dripper field has been alleviated to some extent by recent work on dosing and venting of the lines but there is little prospect of the system ever becoming fully functional again and will only be used in the interim until stage 1, as proposed as part of this application and improvements, is completed.

4.3 Storm water and Groundwater Inflow & Infiltration (I&I)

Measured discharge volumes for the years 2005 to 2013 have averaged between 370 and 570 m^3/day. Discharge volumes have however peaked between 1,400 and 2,200 m^3/day over this period. The high flows have been attributed to high storm water inflow and infiltration during periods of heavy rain within a steep catchment. However, investigations have also indicated that at high volumes, the flow measuring instrument has been inaccurate, and it appears that this has been the case for some time. Actual flow rates at high volumes are therefore uncertain.

While peak wet-weather flows cannot be quantified, their effects are well understood and have been documented in assessing the plant performance issues and solutions. The effects of peak wet-weather inflows are:

- Residence times in each of the stages of treatment are reduced, including less time for adequate biological decomposition to occur in the Pasveer ditch;
- Dilution and, in winter, chilling of process microbes in the Pasveer ditch, meaning reduced biological decomposition in this stage of treatment. Chilling is particularly a problem where inflow of snow melt-water occurs;
- Less time and ability to 'still' and dose the effluent for the removal of solids in the clarifiers, meaning effluent is not fully clarified before it exits the tanks;
- Overloading and bypassing of the sand filters. If the clarifiers are not working properly in the preceding stage due to high flows, the amount of sediment flowing through to the sand filters can exceed the rate at which the filters can self-clean. The problem is further compounded by a back-wash system in the filters that re-uses water from the clarifiers (rather than fresh water). On these occasions the operator has in the past had no option but to by-pass the filters;
- Less effective UV treatment due to higher flows, reduced effluent clarity;
- By-passing of the dripper soakage field. The soakage fields were never originally designed to cope with large storm flows.
- Areas A – D have a total design capacity of approximately 639 m^3/d. Furthermore, when the sand filters are overloaded and by-passed during storm flows, no effluent can be put through the dripper system since unfiltered effluent will substantially worsen the already clogged-up condition of the lines. Just as the sand filters are bypassed at times of high in-flow, the dripper soakage field must also be by-passed at these times, with the finished effluent instead running to the previously termed 'emergency overflow pond' (the former oxidation pond now known as the Tertiary Treatment Pond) and from there to the overflow trenches (three between 20 - 40 m in length) located with Area G. This has in the past, flowed overland to the southern tributary of the Wairere Stream. The overflow trenches have since been re-designed (in 2015) to spread the flow into a number of run-out areas. While an improvement, this not a long-term solution, given continued potential for overflow from the trenches to form a channelised overland flow directly to the southern tributary of the Wairere Stream.

4.4 Effluent Discharge Volumes

The discharge volumes applied for in the June 2016 application were based on data available at the time (2015-2016), from the wet well flow meter.

However, as noted above, in addition to storm water inflow and infiltration affecting discharge volumes, the accuracy of the data recorded by the flow meter was discovered to be questionable.

Significant asset management inventory, assessment and repairs have been undertaken since the June 2016. These priority repairs have already delivered control of the inflow and infiltration and are achieving a steadier flow of wastewater to the treatment plant. There is an ongoing programme of works identified in the Whakapapa Asset Management Plan which will further improve this.

To improve accuracy in data recording, a new flow meter was installed on the line post-clarifiers and calibrated by Veolia in June 2016. Flow data, available for the period 15 June to 3 November 2016 are summarised in the Table 4 below.

Table 4: WWTP Discharge Flow data - 15 June to 3 November 2016

Statistic	*Flow from WWTP (m^3/day)*
N.	*131*
Mean	*168*
5^{th} %ile	*55*
10^{th} %ile	*84*
LQ (25^{th} %ile)	*130*
Median (50^{th} %ile)	*167*
Upper Quartile (75^{th} %ile)	*195*
90th %ile	*242*
95th %ile	*305*
99th %ile	*352*
MAX	*373*

The dataset covers the whole of the 2016 ski season, and therefore provides a reasonably robust representation of normal winter/ski season conditions. It is however important to note that the dataset only covers a 4-and-a-half-month period, which did not include any significant or major storm events. (The highest precipitation in this period was 50 mm on 23 July as reported by NIWA. The forecast once in 30 year 24 hrs depth would be 195 mm as forecast by HIRDS.) It is therefore likely that the above numbers will evolve over time, and, whilst they are useful information for the upgrade and constructed wetland design, they should not be used to define compliance limits without incorporating a significant margin to provide for peak flows during significant rainfall events. Conditions of consent limiting maximum discharge volumes have been specified accordingly in the Proposed Conditions of Consent (**Appendix 5**).

4.5 Tertiary Treatment Pond (formerly Oxidation Pond)

Earlier investigations undertaken by DBCon Consulting in 2011 (see report provided in **Appendix 4**) provided a permeability test and pond floor sampling of the then emergency overflow pond (now tertiary treatment pond). The laboratory test result confirmed the site observation that the floor lining would have a higher permeability rate than the desired rate of 1×10^{-9}. Summary of the test results (from sample of pond floor lining set to Opus laboratory in Auckland) show that the soil has a permeability rate of 2.23×10^{-7} m/s.

The report states that site observations indicated no passage of moisture from the pond into the underlying soils. The colour of the pond sludge can be described as a dark charcoal. The contamination of the first 15-20 mm of pond layer was a light grey. The remaining pond lining was a natural pumice/grey ash colour (dark creamy colour).

It is concluded that the soil properties of the accumulated sludge are providing a barrier preventing leakage from the pond. Given the relative thin layer of contamination in the floor lining, it could be also concluded that this sealing occurred early in the life of the pond. The field plasticity test tends to help the conclusion that the material can provide such a barrier. Only chemical testing of the surrounding water and the inflow/outflow recordings and evaporation measurement would confirm this.

In recent times, the use of the tertiary treatment pond has been reinstated to hold tertiary treated wastewater before it is released to the dripper fields or trenches. It will be used in future as a tertiary holding pond for bonus treatment of nitrogen and settling of solids from stormwater bypasses of the filters. Constructed wetlands also need to be maintained from time to time which means the flow must be restricted to perform the maintenance. The tertiary treatment pond provides the ideal buffer for flows and the settling of any total solids from the plant.

5 DESCRIPTION OF THE PROPOSAL

On the basis of a comprehensive review of the existing WWTP (refer to Section 4), a consideration of possible alterative options (refer to Section 7.2.2), and consultation undertaken (Refer to Section 8), replacement consents are being sought based on the following approach to managing the environmental effects of the ongoing discharge of treated effluent from the WWTP:

a. Approximately 1.1 hectares of constructed wetland area will be developed as a core component of the treatment process. This places a high degree of reliance on natural treatment processes, in response to direction provided through consultation with Ngāti Hikairo and Uenuku, and in recognition of the surrounding environment and its significance.

b. A series of comprehensive improvements to the WWTP and the underground pipe network are proposed to improve treatment performance, noting that many of these improvements have already been implemented in the period following the June 2016 application.

c. A staged approach to implementing future engineering improvements at the WWTP and to the development of the constructed wetland is proposed to allow sufficient time for detailed design and commissioning of works.

d. Effluent quality standards are proposed such that effluent leaving the WWTP and entering the constructed wetland will be managed to a high degree, and to a known and predictable quality.

e. Environmental Outcomes are proposed for the Northern and Southern tributaries which establish an adaptive management approach, to respond to the uncertainties associated with developing a treatment system dominated by natural processes, the difficulties associated with predicting in-stream ecological responses to changes in the wastewater treatment process, and to account for some current data limitations.

f. Environmental standards are proposed for the Wairere Stream, to provide certainty that effects beyond the immediate vicinity of the WWTP are carefully managed.

This approach is described in more detail in the following sections.

5.1 Improving Wastewater Treatment Outcomes

There are a number of design options available to improve wastewater treatment outcomes from the WWTP and these have been documented in the engineering report contained in **Appendix 3**.

To determine the preferred option, DOC has sought to incorporate the views and aspirations of Ngāti Hikairo and Uenuku and park stakeholders, and to recognise the location of the WWTP within the Tongariro National Park. This has resulted in a design objective which seeks to keep the WWTP footprint to a minimum, incorporate it in to the landscape, and, as far as practicable, utilise natural treatment processes which minimise the use of added chemicals and hard engineering processes.

This has resulted in a design that relies on the development of approximately 1.1 hectares of constructed wetland area to process tertiary treated effluent, and improvements at the WWTP to improve treatment outcomes and ensure that the effluent entering the constructed wetland is treated (nitrification) in such a way that wetland treatment performance is optimised. This approach is outlined below.

5.1.1 Wetland Development

DOC engaged NIWA to undertake a conceptual design of the constructed wetland. This report is attached in **Appendix 6.**

Following the conceptual design, which was submitted with the June 2016 application, Morphum Environmental Ltd produced a working report and design for the constructed wetland. This report is provided as **Appendix 7**.

The design has been developed to optimise the water quality treatment performance within the constraints of the site whilst balancing the cut fill balance as much as practical and integrating the constructed wetland into the landscape. The design has also considered a range of operational conditions including infrequent storm events and climatic extremes.

Based on this, a constructed wetland system comprising a series of four terraced cells connected by spillways is proposed. These will have variable water depths and will support dense plantings of emergent macrophyte plant species. Treated effluent from the constructed wetland shall discharge to land via a dedicated infiltration area, which will penetrate the identified low permeability volcanic ash layer. This report should be read in conjunction with other supporting technical reports and the Technical Drawing set issued by Morphum. Key design dimensions and parameters are presented below.

Parameter	Measure
Total wetland area at PWL (m^2)	11,100
Total volume at PWL (m^3)	3,811
Direct infiltration area - trench base (m^2)	600
Total site area (m^2)	29,720
Total cut volume (m^3)	12,400
Total fill volume (m^3)	11,400
Excess soil volume (m^3)	1,000

Wetland cell	Area at PWL (m^2)	Volume at PWL (m^3)	Depth range (mm)	PWL (m)
1	3,436	1,745	500 to 1000	60.80
2	2,617	893	250 - 500	59.05
3	3,174	672	150 - 250	57.30
4	1,868	501	150 - 500	55.55

It is noted that this detailed design work has enabled a constructed wetland area to be specified with more accuracy than the concept design submitted with the June 2016 application. In that concept plan, a constructed wetland area of up to 5 hectares was identified, essentially in line with the land area available. With the benefit of improved data relating to WWTP performance, and detailed design work from Morphum, the constructed wetland area required has been identified as 1.1 hectares.

The work by Morphum Environmental Ltd has also enabled NIWA to update its performance modelling. This report is provided in **Appendix 7**.

The modelling indicates that the proposed constructed wetland will likely have an average hydraulic retention time (HRT) of 15.7 days (summer: 16.2 d; winter: 15.3 d) based on the current flow conditions. NIWA have predicted an annual TN removal of 65-75% (average effluent TN <12 mg/L) under current flow conditions, and 50-60% (average effluent TN <16 mg/L) under predicted future flow conditions. It is important to note that these are modelling previsions meaning that actual performance may differ. It is proposed that this is tested/confirmed through monitoring (see proposed conditions).

The proposed constructed wetland has highest removal of Total Nitrogen when the nitrogen is in the form of nitrate (as opposed to ammoniacal-nitrogen). Removal will thus be denitrification (plus some plant uptake, other microbial transformations, and adsorption to cation exchange surfaces). Where the incoming TN includes ammoniacal-N, some of this will be taken up by plants and microbes. Plant uptake is very low, but not completely absent, in the winter, particularly when the plants are not fully senescent. Also, microbes will continue to transform the ammonium into nitrate (but at a low level due to low temperatures). Adsorption to cation exchange surfaces will not be greatly affected, unless the surfaces are fully frozen.

Thus, the current predictions are based on inputs of Total Nitrogen both in the form of nitrate as well as ammoniacal-N at the temperatures predicted for the site based on 5 years' historical temperature data (2011-2015).

As identified above, to ensure optimal wetland performance, reliable and improved nitrification at the WWTP is essential. This is to be achieved through WWTP improvements and proposed conditions which set treated effluent quality parameters (refer to discussion below).

The final design of the constructed wetland will be confirmed through consultation with Ngāti Hikairo and Uenuku and will be presented for certification by Horizons prior to construction commencing. Conditions are proposed to achieve this and are included as a proposed condition of consent (See **Appendix 5** Proposed Conditions).

5.1.2 WWTP Repairs and Upgrades

A package of improvements to the existing WWTP have been designed to respond to the issues identified through the comprehensive review process (discussed in Section 4) and to the design requirements of the constructed wetland system. These improvements are identified and recommended in the report prepared by Veolia and attached as **Appendix 3.** The key components of these improvements are outlined in the following excerpt from the executive summary of that report:

- *Combating inflow and infiltration plus generating more buffer capacity in the network;*
- *Installation of automated data collection and communication between various sites plus additional measures for improved collection of data on flows and loads;*
- *Construction of a new switchboard and control centre at the WWTP in order to accommodate the future motors and instruments;*
- *The tertiary filters will be overhauled as part of stage 1 as well as the internal sludge management and disposal system;*
- *Installation of a semi-natural wetland system. This is a commitment made by the Department of Conservation. The system will be installed mainly for social-cultural reasons, but is understood to be designed for denitrification duties.*
- *The wetlands being aimed at denitrification raises the need for improved nitrification at the WWTP site. If the initial stage 1 improvements do not generate the desired nitrification level, a dedicated fixed film nitrification process will be installed at the WWTP. This will then also entail influent screening and a grit trap at the plant's inlet.*
- *During and after stage 1 the combination of the nitrification capacity of the WWTP and the denitrification capacity of the wetlands will be assessed in practice. After this stage the upgrade approach will be partially adaptive.*
- *After upgrade stage 1 it will become clear whether additional denitrification capacity and/or alkalinity supply is required for meeting effluent standards. This may then lead to denitrification capacity installed at the plant at stage 2, as well as some chemical storage and dosing facilities. If chemical phosphorous removal is considered required, this will be installed as part of stage 2. Lastly at this point the composition and quantity of waste sludge is finally certain for which a sludge dewatering facility can be built.*

It is also noted that the existing tertiary treatment pond will be used for storage of tertiary treated wastewater to enable management and maintenance of the constructed wetland system to be achieved. This will be important during each stage of the constructed wetland development but also as an ongoing option to allow maintenance within the system. The pond provides a buffer capacity after the plant treatment to reduce flushing of material through the system.

5.1.3 Works Already Completed

Prior to the June 2016 application, and in the period leading up to this application, DOC have commenced and completed a series of investigations and work based on the recommendations it had received from the technical review of the WWTP including:

- CCTV camera inspections of <100 mm and >100 mm pipes;
- Smoke testing;
- Upgrading of Iwikau horizontal infrastructure has with sealed manholes and the main pipes being replaced with High Density Polyethylene (HDPE) pipes;
- Further initial repairs and storm water re-diversions;
- Design and improvements to the Iwikau Buffer Tank;
- Collection and propagation of seeds for the development and planting of the first wetland area 2016/17;

- Replacement of flow instrument in clarifier outlet;
- Trial improved nitrification in Pasveer ditch;
- Improved sampling regime during peak and shoulder periods;
- Further measures aimed at reducing inflow & infiltration, with this work continuing;
- Installed a thickened waste activated sludge tank;
- Recommissioned re-aeration tank for its original purpose;
- Overhauled the tertiary filters; and
- Fitting out the Iwikau buffer tank for flow buffering.

The results of the survey work have been fed into the horizontal infrastructure renewal programme in the Whakapapa Village as part of the Asset Management Plan (discussed below).

The CCTV footage and smoke screen testing completed in March 2016 and is documented in a report prepared by Veolia. The information shows the first round of I&I (infiltration and inflow) quick wins have been reasonably effective at removing inflow points. These priority repairs, which are required to get control of the infiltration and inflow to achieve a steadier designable flow to the treatment plant, are listed in **Appendix 8**.

An appraisal of the existing 350 m^3 Iwikau underground holding tank was completed (March 2016), with this tank deemed suitable for immediate modification and utilisation as a buffering tank for all the inflows from Iwikau Village, allowing a more even spread of hydraulic and ammoniacal nitrogen loadings originating from this source. The flows from the ski field and Iwikau Village can at times represent more than half of the total flow to the treatment plant. This work has been substantially completed, pending the installation of a permanent control panel.

5.2 Management of Effects

The upgrades above must have clear objectives in terms of improvements in environmental outcomes. However, a heavy reliance on natural treatment processes introduces some uncertainty in outcome, and a lag time in improved treatment and optimal constructed wetland performance as wetland plants take time to establish, the following approach is proposed

5.2.1 Effluent Quality Standards

Effluent quality standards are proposed to manage the quality of effluent leaving the WWTP and entering the constructed wetland. A key component of these standards is the Total Ammoniacal Nitrogen (nitrification) standard that must be met to ensure that the constructed wetland can function optimally.

5.2.2 Environmental Outcomes – Northern and Southern Tributary

Currently, the adverse effects of the WWTP appear to be restricted to the unnamed Northern and Southern tributaries (refer to the Water Quality and Ecology Assessment in **Appendix 9**). These tributaries will improve in quality over time, as improvements in the WWTP are commissioned and the constructed wetland system reaches its full treatment potential.

An adaptive management approach is proposed for these streams, to respond to the uncertainties associated with developing a treatment system dominated by natural processes, the difficulties associated with predicting in-stream ecological responses to changes in the wastewater treatment process, and to some current data limitations.

Clear, measurable in-stream water quality and ecological outcomes (Environmental Outcomes) that are to be achieved and maintained through the term of this consent are proposed. These will be used to assess the success of the various improvements, and whether further works will be required at the WWTP. It is proposed that these Environmental Outcomes become in-stream standards at a set time within the term of the consent.

In setting appropriate Environmental Outcomes, Schedule D of the One Plan is a logical starting point. It defines a number of water quality and ecological targets for the relevant Water Management Sub-zone. These targets are summarised in Table 2 of the Water quality and ecology report (Aquanet 2016) and are not repeated here. Also relevant is the National Policy Statement for Freshwater Management 2014 (NPSFM 2014), and, importantly, the uniqueness and high conservation and cultural values of the Tongariro National Park. Matters considered in developing the Environmental Outcomes are outlined below.

The overall approach taken for the definition of environmental outcomes for the Whakapapa WWTP is to align with the requirements of the highest classification under the NPSFM ("Band A"). This classification is generally suitable for "high conservation value systems" and corresponds to a very low risk of effects, and is considered suitable for the area surrounding the Whakapapa WWTP.

5.2.3 Escherichia coli (E. coli)

The concentration of *E.coli* in water is used as an indicator of health risks to recreational users of the water bodies.

The One Plan defines two *E. coli* concentration targets: 260 *E. coli*/100mL at flows below median flow during the main bathing season (November to April inclusive), and 550 *E. coli*/100mL at flows below the 20th Flow Exceedance Percentile (FEP). The technical report underpinning the definition of these targets recommends a compliance level of 95% for both these targets.

The NPSFM 2014 defines 4 "bands" based on annual median and 95th percentile *E. coli* concentrations, with Band "A" being the "best" and Band "D" being the worst quality. Given the location of the WWTP and the receiving streams within the Park, DOC is proposing that the receiving waters should remain in Band "A" downstream of the discharge for both median and 95th percentile concentrations, i.e. the highest standard under the NPSFM. Band "A" means that people are exposed to a low risk (up to 1% risk) of infection from water when undertaking activities likely to involve full immersion and a very low (less than 0.1%) risk of infection from contact with water during activities with occasional immersion and some ingestion.

The NPSFM Band "A" is proposed to be used in this case, as it is more stringent than the One Plan target; the 260 *E. coli*/100mL threshold applies year-round and at all river flows instead of only at certain river flows and for part of the year under the One Plan target.

On this basis, the proposed environmental outcome is:

> *"The discharge does not cause the 95th percentile of the E. coli concentration to exceed 260 E.coli/100mL, on the basis of monthly measurements taken over a period of 36 months".*

To enable a robust calculation of a 95th percentile concentration, it is proposed that an assessment be conducted on the basis of monthly measurements, taken over a period of 36 months in the tributaries. It is noted that, after the initial 36-month period, the assessment can be conducted on a "rolling" basis at any time, by using the latest 36 samples.

5.2.4 Total Ammoniacal Nitrogen

The One Plan defines two total ammoniacal nitrogen concentration targets: an average concentration of 0.320 mg/L (chronic exposure); and a maximum concentration of 1.7 mg/L (acute exposure). These targets are based on the application of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality ('ANZECC') Guidelines (2000) at the 99% species protection level.

The 99% species protection level is the highest level of protection prescribed by the ANZECC Guidelines, and is generally applicable to "*High conservation/ecological value systems – effectively unmodified or other highly-valued ecosystems, typically (but not always) occurring in national Parks, conservation reserves or in remote and/or inaccessible locations*". The ANZECC Guidelines also prescribe lower protection levels: 95% species protection for "*slightly to moderately disturbed systems*"; and 90% and 80% for "*highly disturbed systems*".

The NPSFM (2014) defines 4 "bands" for ammonia (toxicity). Band A corresponds to a 99% species protection level, i.e. no observed effect on any species tested. However, although the stated level of protection is the same in the One Plan target and Band A of the NPSFM, the actual numbers are quite different, with the One Plan targets corresponding to Band C. i.e. above the defined national bottom line (Band D) but a departure from the highest water quality standard in Band A. This difference is primarily due to the NPSFM incorporating more recent data on particularly sensitive species, such as freshwater bivalves.

In keeping with the general principle expressed above, DOC is proposing that the receiving waters should remain in Band "A" downstream of the discharge for both median and maximum concentrations, following pH and temperature adjustment of the data. This outcome is significantly more stringent than the One Plan targets.

To enable a robust calculation of the median concentration, it is proposed that an assessment be conducted on the basis of monthly measurements, taken over a period of 36 months in the tributaries. It is noted that, after the initial 36-month period, the assessment can be conducted on a "rolling" basis at any time, by using the latest 36 samples. The proposed environmental outcome is:

"The discharge does not cause the total ammonia (TNH4-N) concentration to exceed

i. *a rolling median concentration of 0.03 grams per cubic metre; or*

ii. *a maximum concentration of 0.05 grams per cubic metre"*

Note: the above numbers are based on pH 8 and temperature of 20°C. Compliance with this outcome shall be undertaken after pH and temperature adjustment of the data."

5.2.5 Periphyton Biomass

The One Plan defines a target of 50 mg chlorophyll *a*/m^2 for the Wairere Stream and its tributaries. The technical report underpinning the definition of these targets recommends a compliance level of 80% for this target.

The NPSFM (2014) defines 4 "bands" for periphyton biomass, with Band "A" being the "best" and Band "D" being the "worst" quality. The numerical threshold for the NPSFM Band "A" is the same as the One Plan target (50 mg/m^2), but the compliance level is different: the NPSFM prescribes that the threshold must not be exceeded by more than 8% of samples, "*based on a monthly monitoring regime. The minimum record length for grading a site on periphyton (Chl-a) is 3 years*".

The NPSFM (2014) Band "A" is therefore more stringent than the One Plan target applied at the recommended 80% compliance level.

The NPSFM "Narrative Attribute State" for Band "A" is "*Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat*".

Given the location of the WWTP and the receiving streams within the Tongariro National Park, DOC is proposing that compliance over time with the requirements for the receiving waters in Band "A" downstream of the discharge for periphyton biomass, i.e. the highest standard under the NPSFM, be required.

To ensure consistency with the monitoring and assessment regime prescribed in the NPSFM, it is proposed that assessments be conducted based on monthly measurements in the tributaries taken over a period of 36 months. It is noted that, after the initial 36-month period, the assessment can be conducted on a "rolling" basis at any time, by using the latest 36 samples.

The proposed environmental outcome is:

"The discharge does not cause the periphyton biomass to exceed 50 mg chl-a/m^2 on more than 8% of samples, on the basis of monthly measurements taken over a period of 36 months."

5.2.6 Visual Clarity

The One Plan defines a target of no more than 20% reduction in visual water clarity. This target is based on the "Water Quality Guidelines for the Management of water colour and clarity" (MfE, 1994) which recommends two levels of protection for changes in water clarity: a maximum change of 20% in “Class A” waters where visual clarity is an important characteristic; and 33% to 50% change in other waters. The 20% change threshold corresponds to a degree of change in clarity that is able to be detected by some but not all people, whilst a 30% change can be detected by almost all people. The NPSFM does not define Attribute States relative to water clarity or colour.

It is considered that the One Plan target corresponds to a high standard of protection for waters where visual clarity is an important characteristic, such as the Wairere Stream and its tributaries.

The proposed environmental outcome is:

“The discharge does not cause the water clarity to be reduced by more than 20%.”

It is noted however that, whilst the outcome may be met, water clarity measurement is likely to be challenging in the unnamed northern and southern tributaries due to the small size of the streams.

5.2.7 Change in Qualitative Macro Invertebrate Community Index (QMCI)

The One Plan defines a target of no more than a 20% reduction in the Quantitative Macro Invertebrate Community Index. This target corresponds to a degree of change that is at the same time likely to be able to be detected statistically with reasonable sampling effort and ecologically relevant (Stark, 2010). The NPSFM does not define Attribute States relative to macroinvertebrate communities.

The proposed environmental outcome is:

“The discharge does not cause a reduction in QMCI of more than 20%.”

5.2.8 Environmental Standards – Wairere Stream

The data available to date indicates that the above proposed environmental outcomes for the Northern and Southern Tributaries are currently met in the Wairere Stream at Site S6 (**Appendix 9**).

To provide certainty that it will remain the case, and to ensure that effects further beyond the immediate vicinity of the WWTP are carefully managed, the Environmental Outcomes expressed above are proposed as standards to be met in the Wairere Stream from the commencement of consents.

5.2.9 Emergency Discharge

The Morphum Environmental Ltd design for the constructed wetland specifies a system of lined wetland cells, leading to an infiltration area as the final discharge point. The constructed wetland is designed to treat all flows from the WWTP, with no overflow to surface water.

This design has been assisted with input from Lattey Group (see **Appendix 17**), which has undertaken an investigation into site soils and hydrogeology for the constructed wetland location (Area G).

The Morphum Environmental Ltd have identified, however, that:

"flood flows resulting from direct rainfall within the constructed wetlands immediate catchment are able to be detained above the permanent water level (PWL) in cell 4. Based on the 500 mm depth between the crest of the outlet manhole and the lower bund a total volume of 950 m3 will be achieved. This will provide buffering storage for up to the 1 hour, 100 year ARI rainfall event".

This means that, while high flows have been significantly mitigated through the work completed on I&I and the buffer tank provided at Iwikau Village, during an extreme weather event exceeding a 1 hour, 100 year ARI rainfall event, there may be an overland flow to surface water as the capacity of the constructed wetland and infiltration area is exceeded.

With the benefit of these design details, DOC is seeking an additional discharge permit for the discharge of treated wastewater into water as an emergency measure during extreme weather events (Rule 14-25).

It is noted that should such an event occur, the wastewater will be low in contaminant load as there will not be many visitors during such weather. The streams will also be in a state of flood, so any effects on in-stream values will be significantly reduced.

5.3 Proposed Consent Conditions

A set of proposed conditions has been prepared to provide the framework for the above approach. These are provided as **Appendix 5**.

As discussed above, effluent quality standards are proposed, along with environmental standards in the Wairere Stream that must be complied with. Conditions are proposed to deal with any growth in visitor numbers to the area serviced by the WWTP, and any resulting impacts on WWTP treatment performance, should this occur. Conditions are also proposed for the emergency discharge and discharge to air (odour) components to the ongoing operation of the WWTP.

The conditions also set out a series of staged upgrades and improvements to the WWTP, in-stream and effluent quality monitoring requirements, and Environmental Outcomes for the Northern and Southern Tributaries. In combination, these elements form the basis for an adaptive management approach whereby:

(a) Stage 1 additions and modifications to the WWTP are specified in the proposed conditions to be completed in a staged manner within a specified timeframe. Effluent quality standards become more stringent following the commissioning of WWTP improvements.

(b) Monitoring is undertaken throughout this time. A post-upgrade review is required to determine whether or not the WWTP and constructed wetland are on track to meet the Environmental Outcomes set for the Northern and Southern Tributaries.

(c) There is a trigger point at this time for Horizons Regional Council to initiate a review under s.128 of the RMA should the Stage 1 upgrades not produced the expected improvements in wastewater quality.

(d) Three full years (36 months) of monitoring is then required to confirm that environmental outcomes in the Northern and Southern Tributaries are being consistently achieved following the completion of Stage 1 upgrades. This is consistent with NPSFM (2014) standards for compliance monitoring.

(e) If the monitoring phase confirms that the Environmental Outcomes for the Northern and Southern Tributaries are being met, then these outcomes become standards that must continue to be met for the remaining term of the consent.

(f) If, however, the monitoring phase identifies that one or more of the Environmental Outcomes are not being met, then an adaptive phase is required. A Best Practicable Option Assessment will be conducted to determine:

- The causes of the non-compliance with the Environmental Outcomes;
- The range of options available to address those causes;
- The best practicable option to address those causes, having regard to, among other things:

    i. the nature of the non-compliance and the sensitivity of the receiving environment;
    ii. the financial implications, and the effects on the environment, of that option when compared with other options;
    iii. the current state of technical knowledge and the likelihood that the option can be successfully applied

(g) The Best Practicable Option is then presented for certification by Horizon Regional Council, and must be implemented as part of the adaptive Stage 2 works within a specified timeframe.

(h) Following the completion of the adaptive Stage 2 works, the Environmental Outcomes set for the Northern and Southern Tributaries become standards that must be met for the remaining term of the consent.

This process is illustrated in the conditions flow chart in **Figure 5** below.

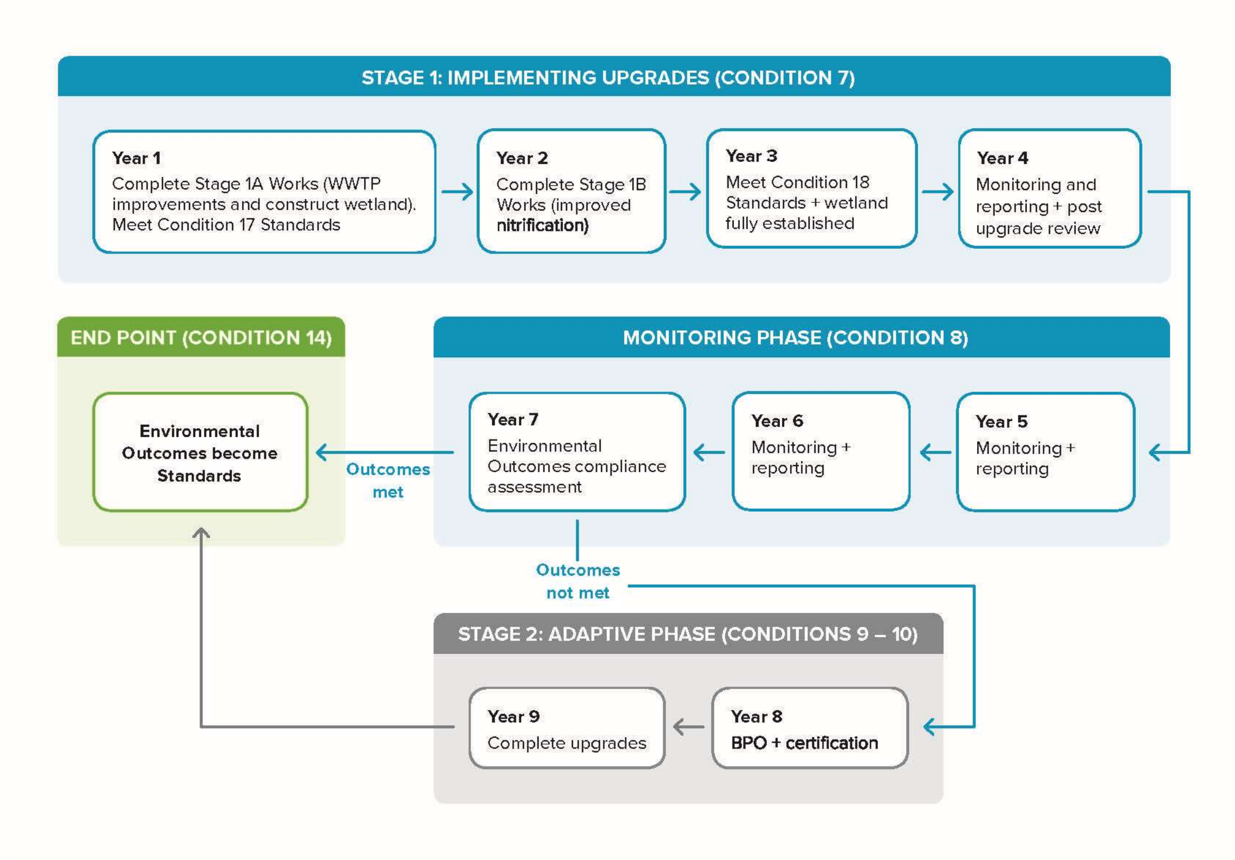

Figure 5: Conditions Flow Chart (See **Appendix 5**)

It is noted that the conditions (as illustrated in **Figure 5**) setting out the timeframe of monitoring and improvements have been refined over time with input from various parties including Horizons Regional Council. A key requirement responded to is to reduce timeframes as far as practicable, to ensure that works are completed as early as possible, and that environmental standards are applicable as early as possible. This requirement must be balanced by wetland plant establishment time, and sufficient monitoring duration following the completion of works to confirm results with a reasonable degree of certainty. The timeframe outlined in **Figure 5** and imposed by the proposed conditions represents the shortest practicable timeframe, in consideration of these factors.

5.4 Proposed Monitoring Approach

A Gap Analysis has been conducted by Aquanet Consulting Ltd (**Appendix 10**). This analysis looks at the past monitoring and makes recommendations for a wastewater and in-stream monitoring programme in order to assess the water quality and ecological effects of the discharges from the Whakapapa WWTP.

This includes water quality and in-stream ecological monitoring at key paired upstream and downstream monitoring sites on the Southern and Northern Tributaries and on the Wairere Stream, as well as an additional water quality monitoring site on the Whakapapanui Stream just above the Tawhai Falls to measure the downstream extent of any measurable effects of the WWTP on key water quality parameters.

This monitoring programme has been implemented since October 2015, and DOC proposes that it continues in conjunction with the initial stages of the consent supported by way of conditions of consent.

Environmental monitoring of the actual effects of the Whakapapa WWTP will be an important component of the overall plant upgrade strategy outlined in this application and will be used to establish whether each of the successive improvements to the WWTP treatment process (including reticulation network) is having a sufficiently positive effect on the Environmental Outcomes defined in the proposed conditions and discussed earlier in this section. It will therefore be essential that the resource consent allows for sufficient time to monitor effects throughout the Stage 1 upgrade phase.

It is important to note that the monitoring programme as currently implemented is very intensive and costly. This is considered necessary for the initial stages of the consent given the sensitivity of the receiving environment. However, as further information is gathered and more certainty is gained as to the nature of the environmental effects, monitoring for some indicators and/or at some sites may be able to be decreased in frequency or stopped. It is proposed that the consent conditions should allow for a degree of flexibility and adaptability with regards to monitoring requirements.

5.5 Duration of Consent Sought

A duration of 28 years (expiring 1 July 2045) is proposed for these permits.

Under One Plan Policy 12-5(b), consent durations are generally set to coincide with the next common catchment expiry date. For the Whakapapa Water Management Sub-Zone that expiry date is 2025 (i.e. in nine years' time). However, expiry dates:

> *... May also be extended in 10 year increments where a term longer than 10 years can be granted after considering the following criteria:*
>
> *(i) the extent to which an activity is carried out in accordance with a recognised code of practice, environmental standard or good practice guideline;*
> *(ii) the most appropriate balance between environmental protection and investment by the applicant;*
> *(iii) the provision of s128 review opportunities to enable matters of contention to be periodically reviewed in light of monitoring and compliance information; and*
> *(iv) whether the activity is infrastructure; water, sewage or storm water treatment plants and facilities; or publicly accessible solid waste facilities including landfills, transfer stations and resource recovery facilities.*

The Whakapapa Village WWTP qualifies under '(iv)' as an infrastructure facility for sewage treatment.

The proposed duration is also consistent with clause '(ii)' – i.e. where additional 10 year increments provide "*the most appropriate balance between environmental protection and investment by the applicant*". In this case the investment by the Applicant has been considerable, when considering both past investment (in the previous upgrade alone, over $4M was spent on the plant and irrigation fields) and the investment associated with the current proposal. All major private and public investment at Whakapapa Village and Iwikau Village is also ultimately dependent on the continued operation of a viable and economically sustainable wastewater treatment system.

As for the balancing of environmental protection considerations, these protections will be assured by the proposed consent conditions requiring the achievement of specific Environmental Outcomes. The Permit Holder will be required to meet these targets, on completion of the upgrade, which will then become standards within the term of the consent for the purpose of consent compliance.

Policy 12-5 also sets out considerations for determining whether there should be a shorter duration than requested. These considerations are:

(i) whether it is necessary for an activity to cease at a specified time;
(ii) whether the activity has effects that are unpredictable and potentially serious for the locality where it is undertaken and a precautionary approach is needed;
(iii) the risks of long-term allocation of a resource whose availability changes over time in an unpredictable manner, requiring a precautionary approach; and
(iv) in the case of existing activities, whether the consent holder has a good or poor compliance history in relation to environmental effects for the same activity.

In the case of the Whakapapa WWTP, the activity will not cease at a specified time. The service provided by the wastewater treatment plant will be required in perpetuity.

As regards to item (ii): the effects of the discharge are known (within a certain variance) and the proposed upgrade will result in better, more consistent treatment and reduced effects on downstream waterways. The worst potential outcome, even in the event of a temporary failure of the upgraded treatment plant, would be a reduced quality of effluent, and increased effect on stream values, that would be comparable to the existing (pre-upgrade) situation. This would not be a satisfactory situation.

But equally, as a temporary situation, given the absence of a significant trout fishery; the lack of good natural whio habitat in the un-named tributary; and very low potential for recreational access in this area, it would not be accurate to describe such a scenario as 'potentially serious' in a broader environmental sense – at least not to an extent that would justify an overly precautionary approach in setting the duration of consent.

Clause (iii) concerns the long-term allocation of resources. This presumably applies more to issues of water allocation than to discharges and is therefore assumed to be less relevant here. However, to the extent that it is potentially relevant to the WWTP in terms of assimilative capacity (and the allocation of a right to discharge contaminants), it is noted that the WWTP provides an essential service that has been in operation at this site since the 1940's. The proposals contained within this application will ensure that a higher level of treatment is achieved, meaning that any allocation of a right to discharge contaminants will de facto be reduced as a result of the proposal. Under the proposal, extensive monitoring data will be collected in support of the improvements going forward.

Further, the adaptive management approach, as proposed, represents a precautionary approach to the extent that measures are in place to respond to unanticipated environmental outcomes which have previously been masked by other parameters or lack of environmental monitoring.

With regard to Clause (iv): It is acknowledged that more recently there have been compliance and operational problems with the operation of the WWTP, and these issues are explained in further detail in Section 4. DOC has recognised this problem and now accepts that wastewater treatment is currently not a core competency for the organisation. Accordingly, the day-to-day management of the plant has been contracted to Ruapehu District Council (supported 'on the ground' by Veolia – specialist wastewater consultants). This arrangement will be on-going through the existing contract. Ruapehu District Council has the necessary skills, systems and in-house experience to ensure an appropriate standard of care in the future running of the plant. The District Council has a sound track record in respect of consent compliance on each of the Council's other existing plants.

On examining the adaptive management approach and length of term, guidance can be taken from the recent decision of the Environment Court on the application by Manawatu District Council to discharge wastewater from the Fielding township to the Oroua River[4]. In its decision, the Court discussed other factors which influenced the granting of a shorter (10 year) term of consent for discharge to water in that case. These were (page 46):

- Uncertainties relating to the ability of the Fielding wastewater treatment plan to meet the treated wastewater nitrogen limit;
- Effects on the mauri of the River;
- The requirements of Policy 5-11.

That case concerned a dual land/water discharge proposal. Unlike in the Fielding situation, in this case there is more certainty that upgrades are *possible* and within the control of the permit holder (i.e. not contingent, for example, on the need to purchase more land) to achieve the One Plan targets for nitrogen. The uncertainty relates to whether Stage 2 will be required, however this uncertainty is reducing over time as DOC completes more of the recommended improvements and collects more data. As stated, DOC is committed to implementing these upgrades *if* they are found to be required according to proposed monitoring and a defined set of Environmental Outcomes.

Effects on the mauri of the Wairere Stream, its tributaries, and the Whakapapanui and Whakapapa rivers downstream, have been considered as part of developing this application, in consultation with Ngāti Hikairo, which has a close connection with these water bodies. The assessment of effects on mauri is intertwined to some extent with Policy 5-11, also considered in this AEE, and which has been at the forefront of the Applicant's mind when developing this consent application.

In this case, DOC is committed to a discharge to land via a semi-natural, constructed wetland, which fully meets the intent of One Plan Policy 5.11 (except in the case of emergency). Both the existing

[4] *Manawatu District Council v Manawatu-Wanganui Regional Council* [2016] NZEnvC 53.

and future discharges are to land. It is therefore not relevant for the term of the consent to be driven by considerations around whether, in future, there should to be a move toward land disposal. That situation already exists. For these reasons, it is submitted that a term of 28 years is appropriate and can be justified.

5.6 Other Matters Relevant to the Proposal

5.6.1 Operational Management Plan

An Operational Management Plan for the WWTP is provided at **Appendix 11.** The Operational Management Plan is required to be updated by the proposed conditions every five years, or at any other time when a significant process or operational change occurs.

5.6.2 Asset Management Plan 2016 (AMP) (Draft)

DOC has the responsibility for the provision of community services in Whakapapa and Iwikau Villages. It must plan, maintain and provide community services including the supply and reticulation of drinking water, wastewater collection, treatment and disposal of storm water and other community services. To support DOC in meeting these requirements, an Asset Management Plan (AMP) for the 3 waters thas been developed and it is DOC's intention to have this finalised by November 2017.

The objective of asset management is to meet the required level of service, in the most cost effective manner, through the management of assets for present and future users of the Park. This is done by considering the management strategies as part of the asset lifecycle with the objective to look at lowest long-term costs when making decisions. Understanding these objectives provides the purpose and the scope of the AMP. The proposed AMP intends to guide good decisions for ongoing investment, maintenance and management of DOC's 3 Water assets for Whakapapa and Iwikau Villages.

It will provide clarity to future management and stakeholders so that the whole of life expenditure is affordable and provides the best mix of assets and experiences within the available resources. The AMP will provide for the long-term management of the infrastructure in Whakapapa and Iwikau Villages including planned and preventative maintenance, upgrade and replacement requirements of assets and the subsequent level of funding needed. The AMP will contain a mix of visitor and property assets.

The AMP sets out the core activities and their management by the most affordable means to achieve the outcomes for:

- (i) Water Supply abstraction, treatment and reticulation within the Whakapapa Village
- (ii) Wastewater activity which enables the disposal and treatment of wastewater produced within the Park;
- (iii) Storm water collection and disposal for Whakapapa Village

The AMP considers the next ten-year horizon but should be treated as a living document which will continue to be refined each year as a process of continuous improvement.

The AMP is also used to determine the future costs associated with the operational maintenance and future upgrades of the facilities including the wastewater treatment plant. The AMP supports future planning and securing of capital funding from Treasury to upgrade the wastewater treatment as proposed for this consent application. Securing of this funding is a separate process to the resource consent process and obtained through different legislation requirements. The AMP however compliments the resource consent process as it aligns with the proposed staging of upgrades and the funding sought in support of these capital improvements.

As a government organisation, DOC is centrally funded to perform its functions of conservation across New Zealand. DOC has the ability and authority via the Conservation Act 1987 to recover the fair and reasonable costs of this (including capital charge and depreciation) by way of a levy from the stakeholders (mainly concessionaires) that benefit from provision of these community services. All of the major stakeholders using the community services are legally bound by their respective concession agreements to pay the levy and this is documented through an agreed Memorandum of Agreement. There are four sources of funds to support expenditure (operational and capital):

1. Capital Fund held by DOC;
2. Levies from users;
3. Special bids to Treasury; and
4. Current maintenance funds.

5.6.3 Memorandum of Agreement (MOA)

In 2004 a memorandum of agreement (pursuant to Section 53(2)(i) of the Conservation Act 1987) was set up to establish a framework for the provision of service and performance standards for the Whakapapa Ski Area and Village Sewage Scheme.

The parties in the MOA include all those stakeholders that contribute to the provision of local body services within Whakapapa Village and Iwikau Village according to the defined cost areas. The stakeholders include:

- The Director-General of Conservation acting through the Tongariro/Taupō Conservator
- Ruapehu Mountain Clubs Association Incorporated being registered as an Incorporated Society under the Incorporated Societies Act 1908 having its registered office at Palmerston North (RMCA);
- Ruapehu Alpine Lifts Limited being a registered company having it registered office at Wellington (RAL);
- Skotel;
- Whakapapa Holiday Park; and
- Kah Corporation New Zealand (The Grand Chateau) of the other part.

The MOA was established in 2004 as part of the original plant upgrade first discussed in 1994, and resource consented upgrade in 2002. This upgrade included the reticulation of the village of Iwikau and the ski area of Whakapapa connecting to gravity main, piped down to and included as part of the upgrade of the Whakapapa Village Treatment Plant and discharge to ground.

The purpose of the MOA is to establish, maintain and promote a collaborative and co-operative working relationship between the parties to ensure that the WWTP is constructed, managed, operated and maintained over time to the needs of all parties and the requirements of the resource consent conditions and the Tongariro National Park Management Plan now and into the future.

The funding and apportionment model is bound by existing agreement relevant to the parties' respective leases or licences to fulfil the responsibilities and obligations under the MOA in regard to the recoverable charges set and levied by DOC. DOC has the authority to levy the parties for the recovery of costs and capital charge levies associated with the WWTP and the associated annual running costs.

The portion of capital allocation provided to DOC by the Crown is serviced via a mix of a capital charge levy and depreciation cost recovery payments. The upgraded scheme has three distinct cost areas;

- Cost Area A: above the Top of the Bruce and the Bruce Road reticulation. Costs are split between RAL @ 45% plus specific costs attributed to RAL connections and Iwikau Clubs @ 55% plus specific costs attributed to ski club connections. Each party pays its respective share of the connection costs;
- Cost Area B: Whakapapa Village works. Costs are split between the village connections @ 100%; and
- Cost Area C: the upgraded treatment plant and discharge irrigation field. Costs of this are split between all users; RAL @ 34%, Iwikau Clubs @ 33 % and Whakapapa Village @ 33%.

Comfortable carrying capacities have been set for these villages and the ski area within the Tongariro National Park Management Plan. They are:

- Whakapapa Ski Area 6000 x skiers per day exceeding this on 10 to 20 days a year;
- Iwikau club lodges @ 32 bunks plus 2 wardens bunks x 46 Lodges plus RSC Lodge @ 70x and Hawke's Bay Lodge @ 37x;
- Whakapapa Village 1200 beds;

Each contributor group's share of the capital cost is based on an assessment of their contributing portion of the peak sewage volume and strength based on the respective total allowable bunks and comfortable carrying capacity.

Each contributor's share of the annual operational and maintenance cost will be calculated on the basis of the Iwikau lodges' current bunk numbers, ski area capacity and person equivalent for Whakapapa village contributors and actual total volumes and strength annually.

This model has been discussed with the stakeholders and users since 2000 and currently there is a general acceptance that it is a fair and reasonable method of cost recovery apportionment. This model is supported by the Draft AMP which interfaces with the proposed upgrades and improvements at plant to obtain consent approval and meet the One Plan targets.

5.6.4 Providing for Growth

As noted above, the Tongariro National Park Management Plan limits the comfortable carrying capacity of the park, and goes some way to establishing infrastructure design criteria for the WWTP.

However, historically, these carrying capacities have only come under pressure over winter. Recently projected growth data from the Manawatu Wanganui Growth Strategy (Accelerate 25) has come to light, including RAL future growth plans to attract and increase summer visitors.

This could mean that, while the comfortable carrying capacity of the park will not be exceeded, there will be a higher number of total visitors throughout the year, particularly increasing over historic summer visitor numbers.

As the extent and distribution of this growth, should it occur, is very difficult to predict, DOC has proposed conditions of consent requiring monitoring and reporting of visitor numbers and an assessment of any changes in visitor numbers over time on WWTP performance. This will ensure that DOC has a degree of early warning, should visitor number increases dictate additional WWTP treatment requirements (see proposed conditions in **Appendix 5**).

5.6.5 Facilities Management Contract with Ruapehu District Council

On the 1 July 2015, Ruapehu District Council, under contractual agreement with DOC, took over facilities management of the water services at the Whakapapa Village. The contract provides for the management and operation of the 3 Waters (potable water, storm water and wastewater) in Whakapapa Village. Iwikau Village has private water supply from rainwater tanks for the club lodges and stream water for RAL facilities.

DOC is not expert in the management of these facilities and saw benefit in contracting the services to a provider who specialises in the management of these facilities, particularly wastewater. The contract period is for up to 5 years and aligns with the Ruapehu District Council contract with their contractor, Veolia.

6 ASSESSMENT OF EFFECTS

This assessment of environmental effects of the current discharge as required by s. 104(1)(a) of the RMA is based on a comprehensive suite of studies that DOC has commissioned to consider the environmental effects of the Whakapapa WWTP. Each effect has been assessed and addressed by the respective experts and, as such, this section is a summary of those assessments as it relates to:

- Fresh water quality and ecology effects;
- Terrestrial ecology effects;
- Cultural effects;
- Effects on Whio/Blue Duck;
- Effects on recreational users of the Park;
- Effects on trout fishing and trout spawning;
- Landscape effects;
- Odour effects; and
- Beneficial effects.

6.1 Fresh Water Quality and Ecology Effects

An assessment of freshwater quality and ecology effects of the current discharge from the WWTP was undertaken and is assessed in a report prepared by Aquanet Consulting Limited (**Appendix 9**).

Also provided in **Appendix 9** is a memo from Aquanet Consulting Limited providing updated results of water quality, periphyton and macroinvertebrate monitoring undertaken to 30 June 2016, upstream and downstream of the wastewater discharge from the Whakapapa WWTP.

The following sections are an excerpt of the executive summary from the Aquanet report to highlight its key findings.

In addition, it is also noted that this application seeks consent for the discharge of treated wastewater into water as an emergency measure during extreme weather events.

During such an event, adjacent water bodies (the northern and southern tributaries into the Wairere Stream will also be in high flow, significantly diluting any discharge which may occur from the constructed wetland. It is also identified that the discharge from the wetland in this event will comprise treated effluent which, when mixed will the high volumes of rainfall, will generate a weak concentration of discharge into the local environment. It is identified that there are no sensitive receivers (i.e. water takes) in close proximity to the constructed wetland ensuring potential effects are avoided.

6.1.1 Potential Effects

The Aquanet Consulting Limited report only covers effects of the discharge of treated wastewater from the Whakapapa Village on freshwater quality and ecology. Aspects pertaining to effects on air, groundwater or cultural values are not specifically covered in this report.

Generally speaking, discharges of treated domestic wastewater to streams and rivers can, under some circumstances, give rise to a range of potential effects, which can affect aesthetic, ecological recreational and cultural values of the waterways. These potential effects are considered in this report, on the basis of data available.

6.1.2 Assessment Undertaken

Water quality and ecological monitoring were undertaken by DOC and the Catalyst Group (until June 2015), then Veolia (water quality) since July 2015 and Aquanet (ecology) since October 2015.

The aim and scope of this report is to provide an overall summary of the water quality and ecology data and information collected to date, and an assessment of effects of the historical and current operation of the plant to form part of a new resource consent application package.

The various water quality and ecological indicators have been summarised and compared with One Plan Schedule E Water quality targets. Where monitoring data were insufficient to provide a robust assessment additional monitoring was recommended. A separate "Gap Analysis" (Aquanet, March 2016) was undertaken to summarise the water quality and ecological information and data collected to date in relation to the Whakapapa WWTP and identify information gaps, as well as a programme of investigations starting in October 2015.

6.1.3 Monitoring Results

Monitoring has been mainly undertaken on three streams, with a pair of upstream and downstream sites on each of these streams. A map of the streams and monitoring sites is provided in the Appendices of this report. The intention of these is to measure (by difference between upstream and downstream) the effects of the discharges on in-stream water quality and ecology. The results of water quality and ecological monitoring at these sites indicate the following:

The Southern Tributary

- Is understood to be the primary receiving environment for the past discharges of treated wastewater from the emergency overflow pond into soakage trenches.
- Water quality sampling results indicate that the effects of these discharges on a number of water quality indicators are measurable, with some downstream concentrations exceeding One Plan targets at times (SIN and ammoniacal-N notably). Of particular notice are the unusually (compared with the rest of the data record) elevated concentrations of a range of contaminants measured at the downstream site in late 2015/early 2016. The possible causes of these unusual results are discussed below.
- Periphyton monitoring indicates that periphyton biomass and cover were at times increased compared with upstream, but not to levels such that overall compliance with One Plan targets is compromised. Similar to water quality results, the largest increases in periphyton were measured in late 2015 to early 2016.
- Macro invertebrate communities do not seem to be negatively affected by the discharge.

The Northern Tributary

- Is the receiving environment for the proportion of the discharges from the whole WWTP system that eventually reach surface water, from both the soakage trenches and the irrigation fields.
- Water quality sampling indicates that changes in the concentrations of a range of contaminants are generally measurable and statistically significant, although most One Plan targets seem to be met at the downstream site, with the notable exception of SIN. Similar to what is noted above for the Southern Tributary, a high proportion of elevated results seem to have occurred in late 2015/early 2016.
- Periphyton sampling indicates a general increase in periphyton biomass and cover at the downstream site compared with upstream. Compliance with the periphyton biomass target at the downstream site is uncertain, and additional sampling would be required to provide a firm conclusion.
- There are indications that significant adverse effects on macro invertebrate community health have occurred in 2014 and 2015, but not in 2012 and 2013.

The Wairere Stream

- Receives inputs from the Northern Tributary, and, as such, constitutes the secondary receiving environment for the proportion of the discharges from the whole WWTP system that eventually reach surface water. Monitoring in the Wairere Stream provides an indication of the downstream extent of any effects measured in the Southern or Northern Tributaries.
- Limited water quality data indicates that the only measurable changes in concentrations of contaminants are of ammoniacal nitrogen (and by extension SIN).
- Periphyton monitoring indicates a measurable increase in periphyton growth downstream compared with upstream, but not to a level where significant effects on ecological, aesthetic or recreational values would be expected.
- There are no indications of significant adverse effects on macro invertebrate communities in the Wairere Stream, including as a food source for whio (blue duck), an endemic species classified as “nationally vulnerable”.
- Only limited water quality and ecological data are available for the Wairere Stream, and it is recommended that regular monitoring be continued to confirm the above conclusions.

In all three streams, data indicates that DRP is in naturally moderately elevated supply; by contrast, “background” concentrations of SIN are very low. This means that inputs of SIN into the stream are the likely primary driver of the increased periphyton biomass observed in all three streams at the downstream sites.

With regards to the higher than usual concentrations of a range of contaminants measured in late 2015/early 2016 in both the Southern and Northern Tributaries, it is our understanding that the management of the WWTP during that period was characterised by intense investigations and repairs during which higher than normal volumes of treated wastewater were discharged to the soakage trenches, or on the surface of the irrigation fields, which is a plausible cause for the results obtained during that period. It is also noted that, to some extent, periphyton indicators have followed the same trend. The most recent macro invertebrate samples were taken in October 2015. These results need to be considered in the context of the unusual management of the WWTP system at the time; in particular, it seems questionable whether these results provide a suitable representation of the effects of the WWTP under normal operating conditions.

On the basis of available data, there are indications of some degree of adverse ecological effects on the Northern Tributary, although data available are somewhat insufficient to reach firm conclusions and it is questionable whether the more recent results provide a good representation of the effects of the WWTP under normal operating conditions. These effects seem to be spatially limited to the Northern Tributary, and do not extend to the Wairere Stream.

6.1.4 Recommendations

It is recommended that additional monitoring be undertaken to confirm, or otherwise, these conclusions. In the event that significant adverse effects on the Northern Tributary (or any other stream) are identified or confirmed, and that improvements are required, then it is likely that reducing the inputs of SIN (including ammoniacal Nitrogen) into the surface water system should be the management target.

6.2 Terrestrial Ecology Effects

An assessment of terrestrial ecology effects associated with the development of the proposed constructed wetland area was undertaken and is discussed in a report prepared by Nicholas Singers Ecological Solutions Limited (**Appendix 2**). The following sections are an excerpt of the executive summary from that report to highlight its key findings, with minor edits to reflect the updated constructed wetland design developed by Morphum Environmental Ltd.

6.2.1 Potential Environmental Effects

The construction of waste water treatment wetland will have near to minimal negative ecological impact on the current ecological values of the proposed sites. Effects over time are likely to be positive through replacing introduced dominant vegetation (heather and pasture grasses) with native dominant vegetation. Further because the wetland habitat created will be highly productive (e.g. primary and secondary ecosystem production), this should provide additional resources for native wildlife such as fern bird.

6.2.2 Assessments Undertaken

A site investigation was made and terrestrial plants were identified and described using the Recce method. All wildlife seen or heard was recorded. Ecologically suitable native plants for the development of a waste water treatment wetland have been identified.

6.2.3 Result of Assessment

Excluding area D, areas assessed are dominated by introduced plants especially heather and grasses and locally, in infiltration area A and B, by the native tall tussock, mountain toetoe. Areas G, A, B, C and the borrow pit north of infiltration area A, are most suitable for development into wastewater treatment wetlands being relatively flat and of low ecological value. Area D is less suitable because it has a higher cover of native species and also has a steeper slope than the other areas.

6.2.4 Suggested Approach for Effects Identified

As this proposal will have near to minimal negative ecological impact on the current ecological values of the proposed sites, development should proceed with minimal restrictions. However, there is a large amount of mountain toetoe within infiltration areas A and B. Ideally this tussock should be harvested as a vegetation restoration resource if this area is utilised as a wastewater treatment wetland.

6.3 Effects on Māori Cultural Values

Tangata whenua have a kaitiaki role and with that an intrinsic duty to ensure that the mauri and the physical and spiritual health of the environment is maintained, protected and enhanced. There is also a statutory and planning framework in which decisions in relation to freshwater management (including discharges to land and water) are made that recognises and provides for tangata whenua interests in the management of water as it relates to effects on Māori cultural values. The RMA recognises the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu and other taonga as a matter of national importance.

Section 6(e) of the Act requires that:

> *"...all persons exercising functions and powers under the Act shall recognise and provide for...the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga."*

Section 7 ('Other Matters') identifies kaitiakitanga as a matter that must be had regard to in relation to managing the use, development and protection of natural and physical resources, and section 8 ('Treaty of Waitangi') requires that all persons exercising functions and powers under the RMA shall take in account the principles of the Treaty of Waitangi. Those Principles are discussed in Section 6.7 of the report, titled Cultural Values.

In assessing the actual and potential effects of the consents for the Whakapapa Village wastewater treatment plant, a number of issues arise with respect to adverse effects on cultural values, including potential effects on the tributaries to the Wairere Stream. The adverse effects of the activity on cultural values are considered to be significant, given the nature of the effluent, the quality of the effluent, the location of the plant on the maunga and the effects over land to the stream.

Continuing the discharge activity as it has been occurring in recent times is not considered to be consistent with the protection of cultural values. The following elements of the proposal can avoid, remedy, or mitigate the majority of adverse effects on these values:

- Improving the loading on the WWTP in high rainfall events;
- Improving the quality of the treated effluent through operational improvements at plant;
- The development of a constructed wetland that will treat all wastewater prior to discharge to land through an infiltration area;
- Providing contact with the land and plants through the constructed wetland system;
- Preserving the natural look and feel of the area by collaborative design of the constructed wetland system;
- Improving the receiving environment;

- Investing money to make sure that the plant operations are optimised and managed well by the contractor; and
- Providing an appropriate place for wastewater to be deposited and treated given there is human activity occurring on the maunga.

In working through the resource consent process and developing the above matters, DOC and Ngāti Hikairo have worked collaboratively. DOC is also mindful of the kaitiaki role around the mountain of other Iwi (Uenuku and Ngāti Rangi). DOC have existing relationships with, and will continue to consult with these partners on conservation and consenting matters to do with Tongariro National Park, including the development of the Asset Management Plan for Whakapapa Village.

6.3.1 **Ngāti Tūwharetoa / Ngāti Hikairo**

The Ngāti Tūwharetoa Environmental Iwi Management Plan 2003 supports the proactive participation of hapū in every way possible in decision-making processes that ultimately impacts on taonga and that *"...establishes environmental base lines and provides tools that will help hapū/whanau and the tribe as a whole to achieve and protect those baselines."* The Management Plan also identifies issues around water, including *"discharge of human sewage into water bodies."*

Tangata whenua have a special relationship with water. Water is described as the lifeblood of Papatūānuku (Earth Mother) that in one form fall upon her as the tears Ranginui (the Sky Father). Water is a taonga left by the ancestors to provide and sustain life.

Key goals associated with Te Waipuna Ariki (Water) are:

- Ngāti Tūwharetoa assert and exercise rangatiratanga and Kaitiakitanga over waters within the Tūwharetoa rohe.
- Protect and enhance the mauri for future generations.

Key Issues and Policies in regard to Te Waipuna Ariki include:

- Discharge of human sewage into water bodies.
- Advocate the protection of mauri of water through effective policy and planning instruments.
- Encourage the implementation of land based disposal systems.
- Support proposals that seek hapū involvement to improve water quality and promote efficient use of water quantity.

While the discharge activities of the Whakapapa WWTP over land to the tributary of the Wairere Stream are considered to have adverse effects on the cultural values, DOC, working collaboratively and in consultation, have worked to find solutions and options to avoid, remedy, or mitigate effects through addressing issues around water quality and the ability of the receiving environment to absorb or cope with waste.

This has been supported through:

- Proposed upgrades to the plant as outlined in this consent application.

- Development of a constructed wetland, designed to use the natural functions of wetland vegetation, soils and their microbial population to further treat the finished wastewater.
- Ongoing compliance monitoring and reporting on stream life and ecology through DOC's contractor to Ngāti Hikairo and Horizon's Regional Council.
- Engaging contractors with specialist skills to manage the treatment plant and ensure that the plant is managed, maintained and operated to the best of its ability.
- An ability to collaboratively work together and achieve the best environmental outcomes in the immediate future, and going forward together.
- Trust and confidence with the project team that is supporting this resource consent and the technical advice and planning to achieve the best possible outcome.
- Written approval in terms of the Resource Management Act 1991 provided by Ngāti Hikairo on 4 March 2016 to ensure that the best long term solution is delivered for the maunga and nga awa (**Appendix 12**).

6.3.2 Summary/Conclusion

Effects on Māori customary values are acknowledged but have been, and continue to be, worked through with relevant Iwi and hapū. Ngāti Hikairo has indicated support for the current consent application of the upgraded plant and has provided a letter to this effect.

6.4 Effects on Whio/Blue Duck

The principal potential adverse effect of the proposed activities on Whio/Blue Duck is the possibility of any significant adverse effect on their food source. Whio feed on macro invertebrates, preferentially in clear, fast flowing bouldery streams.

The 2016 Water Quality Monitoring Report identified that the quality of the macro invertebrate community in the Northern tributary to the Wairere Stream appears to be affected by the existing discharge, with a drop of between 39% and 23% in the QMCI score measured in 2014 and 2015 respectively between the upstream control point and downstream monitoring point in this tributary (although the effect is not apparent in the Southern tributary or Wairere Stream itself).

A recent Whio survey report (attached as **Appendix 13**, which also includes an attached memo in support of this work from DOC ecologist Jess Scrimgeour) advises, that the Northern tributary is not particularly ideal habitat for this species and that no birds were seen on the tributaries during the survey on Saturday 27th February 2016. There is better nearby habitat to be found in the Wairere Stream, and more so on the Whakapapanui Stream further downriver where in fact all of the birds sighted during the survey were observed.

According to the survey team which included Bubs Smith, who collectively have recognised experience in this field, the one foreseeable use of Northern tributary for Whio would be as a temporary retreat for individual birds looking for a place to wing moult.

The team further noted the proximity of the tributary of the Northern tributary to the Chateau golf course, which has a resident rabbit population, and the consequent risk to any Whio settling in this area because of the potential presence of mustelids (in association with the rabbits).

A further detraction as bird habitat, again observed by the Whio survey team, is the number of stones along the bed of the Northern tributary that the team described as naturally ‘fused’ or concreted to the bed – making them less suitable for Whio to forage around.

In the event that Whio did come into the tributary they would be likely to find slightly fewer quality macro invertebrates to feed on, according to the results of the 2014/15 QMCI survey. However, it is unlikely that the level of reduction in the QMCI observed along this section of stream would make a material difference to overall food availability to the local Whio population, given the potential presence of Whio in this tributary is limited to the short-term presence of individual moulting bird(s).

Notwithstanding this, the Wairere Stream, as the main habitat for Whio is not impacted by the wastewater treatment plant discharge. The two tributaries provide limited habitat for adult birds and may be used by juveniles during moulting.

6.4.1 Summary/Conclusion

The stream that is the primary receiving water for the land discharge (the un-named tributary) is not frequented by Whio/Blue Duck as it is not prime habitat (unlike the Whakapapanui Stream and, to a lesser extent, the main Wairere Stream). The discharge is consequently unlikely to be having a significant effect on these birds. In the event that Whio went into this area they would still find macro invertebrates to feed on – though the diversity and density of macro invertebrates may be slightly (but not materially) reduced.

The proposed conditions set out an approach to monitor and manage periphyton growth in the tributary on an ongoing basis. The presence of Whio in the Whakapapanui Stream is well known and signs of their presence in the Wairere Stream were identified by the survey team. The water quality report concludes that there is no indication of more than minor effects on macro invertebrate communities in the Wairere Stream, which is the secondary receiving water for the land discharge. By extension no more than minor effects on macro invertebrate communities can be expected in the Whakapapanui Stream affected (because of additional dilution and uptake of contaminants before reaching that river).

6.5 Effects on General Recreational Users of the Park

The WWTP is an essential facility for the majority of recreational use of the Park at Whakapapa and Iwikau. Without a functioning sewerage system, for public health reasons, it would not be possible to continue to provide accommodations, provide for trampers or for skiing on any large scale to occur on the Whakapapa ski field. The same would apply to use of the Visitor Centre at Whakapapa Village, the Chateau Tongariro, the various ski huts, and other facilities and businesses in this area of the Park. The continued operation of the treatment plant is therefore very much in the interests of the majority of recreational users.

One potentially negative impact for recreational users is the current visibility of the plant – particularly the tertiary treatment pond – which can be seen at a distance by trampers on the Great Walk Track (the Northern Circuit) or the Taranaki Falls Track either settling out from or arriving at

Whakapapa Village by foot. The squared shape of the pond and rock wave-lap protection around the inside of the banks identifies it as not a naturally-occurring pond.

No additional 'structures' are proposed by this application. As detailed above, it is also proposed to retain the pond as it provides some buffering for the constructed wetland, extra treatment and operational maintenance benefits. Accordingly, the physical characteristics of the WWTP will exist as has been legally established under previous approvals / permits. The rest of the plant is less conspicuous, except for a few modest sheds.

Notwithstanding this, it is proposed to soften the look of the existing WWTP with strategic planting positioned in the view shafts between the WWTP and the tracks identified above. The proposed planting has been discussed in the 'Landscape Plan' report by Nicholas Singers Ecological Solutions Limited (**Appendix 14**). The landscape Plan has been prepared by Dr Nicholas Singers in this instance as all planting material must be locally sourced in order to comply with the Tongariro National Park Management Plan and given his expert local terrestrial ecology knowledge of what exists in this landscape; what will survive in this landscape and may be suitable to achieve a level of visual screening from the plants available.

As identified, to be consistent with the Tongariro National Park Management, all suitable plants will need to be sourced locally from seed, cuttings, or wild sourced seedlings. This will mean that the goal of reducing the visual impact of the WWTP will not be immediately possible due to these circumstances. Dr Singers has identified that slower growing species such as mountain beech and mountain toatoa will take 2-3 years to reach a suitable planting size from seed.

To assist in assessing visual impacts, a photo montage of what the WWTP may look like following the construction of the wetland is provided as **Appendix 15**.

6.5.1 Summary / Conclusion

The continued operation of the wastewater treatment plant is important for a large number of existing recreational activities in this area of the Park. In this sense the treatment plant is wholly positive for general recreational users, with the only negative impact being a slight visual impact, which is proposed to be mitigated or avoided over time, from the existing tertiary treatment pond.

6.6 Effects on Trout Fishing & Trout Spawning

The upgraded treatment plant will have no significant adverse effect on trout fishing in either the Wairere Stream or waterways downstream. This is in large part because there is no significant trout fishery to speak of above the Tawhai Falls. The falls, 13 m high (along with a second 18 m high falls – the Matariki Falls – about another 4 km downstream) effectively block any upstream movement of trout up into this part of the catchment. The only trout known to exist upstream of the Tawhai Falls are small (max. 15 cm) brook trout which appear to be living there as an isolated population. These are not large enough to be considered game fish.

For the same reason, the catchment area above the Falls cannot be regarded as a significant spawning habitat. Brook trout are a distinct species from brown and rainbow trout, which form the essential of the game fishery in the catchment downstream. Any spawning that occurs in this area will be among the small brook trout, with no connection or feed into the wider regional trout fishery.

6.6.1 Summary/Conclusion

There is no significant trout fishery or spawning in the un-named tributary or in any of the catchment area upstream of the Tawhai Falls. This is due to the isolating effect of the falls. There are no game trout or spawning areas above the falls or in any section of waterway materially affected by the discharge.

6.7 Landscape Effects

6.7.1 Wetland

The main potential landscape effect from the upgraded treatment plant will be the formation of the constructed wetland and infiltration area in the land discharge area G.

The Ecological Assessment (**Appendix 2**) identifies that the constructed wetland design should:

> *"consider the landscape and attempt to be in-keeping with natural wetlands locally. To achieve this amenity planting of large wetland plants such as harakeke and toetoe as well as local terrestrial plants such as manuka and mountain toatoa around the perimeter of any constructed wetland should be undertaken".*

The constructed wetland will be designed to blend into the existing landscape – much of which is already sufficiently damp for most of the year to be dominated by wet-tolerant native plants. The expectation is, therefore, that to a large extent there will be simply retention of existing vegetation. Elsewhere it will be necessary to plant more wet-tolerant species sourced from seed and cuttings obtained within the Park (for example, mountain toetoe and flax).

Appropriately eco-friendly sourced seeds have already been collected, and are now being propagated, for this purpose.

The specific intention is to retain the look and feel of the existing landscape and ensure that all species growing in the constructed wetland, either by natural occurrence or planting, are varieties already occurring in the area adapted to these conditions. Associated earthworks, for the formation of the constructed wetland, will involve subtle bunding only, so as not to visibly disrupt the natural contour of the land.

All constructed wetland formation will be carried out under the direction of a wetland expert; wetland plant ecologist; and landscape designer. Development of the constructed wetland will be in line with works described as ecological restorative planting programmes commonly undertaken by DOC and in consultation with Ngāti Hikairo.

A photo montage of what the constructed wetland may look like is attached in **Appendix 15**.

6.7.2 Existing WWTP Features

In addition to the constructed wetland, plantings will also be undertaken around the existing WWTP for providing an improved visual screening/mitigation of the plant, comprising features such as the tertiary treatment pond and buildings, from the main walking track (Taranaki Falls) to the east. The pond in particular can currently be seen from the track, at a distance, but stands out unnecessarily because of its square shape and the un-natural rock-edge lining. A visual landscape plan has been commissioned by DOC to ensure these existing engineering features are better intergraded into the landscape where possible without affecting the integrity of the infrastructure.

The Ecological Assessment (**Appendix 2**) also identifies that the "the ecological values of the infiltration fields A–C, the borrow pit and area G have been significantly compromised by past development and are dominated by exotic species, especially Yorkshire fog grass and heather". Subsequently, the reinstatement of native, locally harvested vegetation will restore the indigenous vegetated landscape in this location.

In terms of the constructed wetland and surrounding landscaping, appropriate species (seeds) have already been collected from the Tongariro National Park and are being propagated at Taupō Nursery to support the development of the constructed wetland.

A landscape plan has also been prepared to assist with minimising landscape effects and creating landscape enhancements and this is attached as **Appendix 14**.

6.7.3 Summary/Conclusion

Care will be taken in the formation of the new constructed wetland to ensure that it has a natural look in the land discharge area. Precautions will include ensuring only subtle earthworks in the formation of bunds and, where planting is required, the use of Tongariro National Park native species already present in the landscape and naturally adapted to wet conditions. This process will ensure that the new constructed wetland and surrounding landscaping of the WWTP will blend (similar in colour, texture etc.) into the expected vegetated landscape for this area.

6.8 Contaminated Land

The application for replacement resource consents and plans to develop the current disposal fields into a constructed wetland system have led to the requirement for a site contamination investigation under the NES. Lattey Group (Lattey) was engaged by the Department of Conservation (DOC), to carry out an NES Preliminary Site Investigation (PSI) at the WWTP.

The PSI identified that a resource consent is required for the activity of soil disturbance at the site and was recommended that a Detailed Site Investigation (DSI) be undertaken to establish distribution and levels of soil contamination and to establish whether the consent is a controlled or restricted discretionary activity under the National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 (NESCS).

The DSI identified that a restricted discretionary consent under the NESCS is required. The Ruapehu District Council is required to observe and enforce the requirements of the NESCS. Accordingly, an application has been made to the Council to consider the works on contaminated land for the constructed wetland system.

6.9 Odour Effects

There is no history of odour from the existing wastewater treatment plant. DOC has consulted with community at the Whakapapa Village, including both the Chateau Tongariro and the Skotel, being the closet potential sensitive receiving environment for the Whakapapa WWTP. No parties have identified any odour issues with the current Whakapapa plant operations and processes

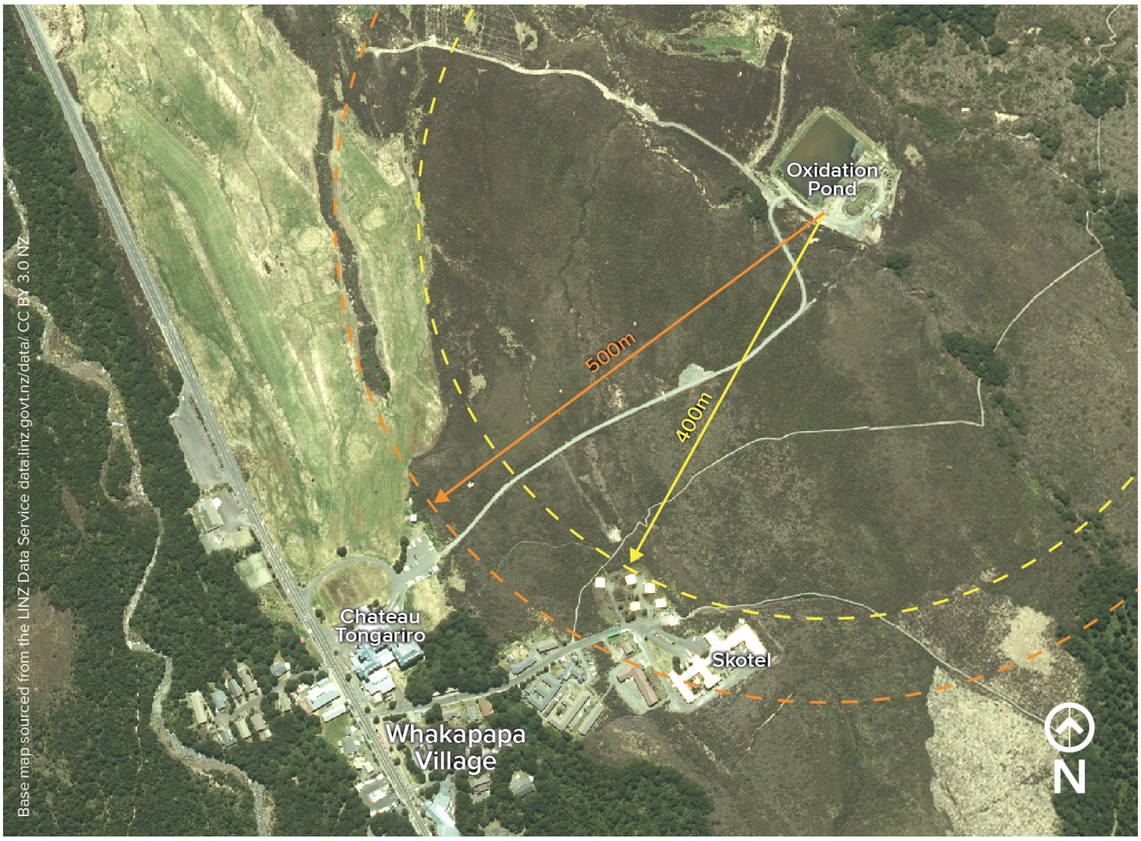

Figure 6: Approximate Distances from Oxidation Pond

There have never been aeration problems within the process. The plant is also sited sufficiently far away from buildings within the village (400 m from the Skotel – **Figure 6**) to avoid any problems with localised odours. The prevailing wind is to the west or the south of the plant which reduces the risk further of odour permeating into Whakapapa village.

6.9.1 Summary/Conclusion

The treatment plant has no existing odour issues and there are no new odour issues anticipated with the upgraded plant.

6.10 Beneficial Effects

The collection, reticulation and treatment of wastewater from Whakapapa and Iwikau Village are an essential service with regard to the protection of public health. Without a reliable sanitary system, it would not be possible for the villages or ski field to operate on any reasonable scale –

meaning the closure and/or significant down-sizing of existing businesses and visitor activities in general, in this area. These provide significant recreational value to visitors from New Zealand and overseas. Similarly, without a well-functioning WWTP, there is potentially significant adverse effects on the social, economic and cultural well-being of the surrounding community.

The establishment of the constructed wetland will also bring benefits, both in terms of treatment outcomes, but also in the replacement of current exotic species with native locally sourced alternatives and improvements for native fauna habitat.

7 PLANNING ASSESSMENT

This section identifies the resource consents required and the RMA activity status of activities proposed for the continued operation and upgrades of the WWTP.

It also sets out, in accordance with the provisions of section 104(1)(b) and 104(1)(c) of the RMA, an assessment of the relevant provisions planning instruments considered to be relevant to the proposal, and other matters considers relevant and reasonably necessary to determine the application. An assessment against Part 2 of the RMA is also provided.

7.1 Resource Consents Required

The resource consents required and RMA activity status of activities proposed for the continued operation and upgrades of the WWTP can be determined with reference to the Horizons One Plan.

It is noted, however, that a resource consent is required from Ruapehu District Council under The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS). A resource consent application under the NESCS has been lodged with the Ruapehu District Council. Further analysis on the NESCS is provided in later in this section.

The resource consents required under the Horizons One Plan are listed in the table below and further analysis is provided in Sections 7.1.1 – 7.1.4. Overall, resource consent approval is being sought for a Discretionary Activity as it relates to the following rules:

Table 5: Resource Consents Required

Activity	One Plan Rule	RMA Activity Status
Discharge of treated wastewater onto land	14-30	Discretionary
Discharge of treated wastewater into water as an emergency measure during extreme weather events	14-25	Discretionary
Discharge of Wastewater to Land from Seepage	14-30	Discretionary
Discharge Permit for the discharge of contaminants to air (odour)	15-17	Discretionary

7.2 Resource Consent for Discharge of Treated Wastewater

The Morphum Environmental Ltd design for the constructed wetland specifies a system of lined wetland cells, leading to an infiltration area as the final discharge point. The constructed wetland is designed to hold the wastewater and treat all flows from the WWTP, with no overflow to surface water.

The discharge of treated wastewater onto land from the WWTP does not meet the permitted activity standards set out in Rules 14-13 to 14-16 (land) because the activity is specifically designed to infiltrate into ground at the discharge point (the infiltration area). On this basis, the activity status defaults to Discretionary under Rule 14-30.

7.3 Resource Consent for Discharge to surface water (in times of emergency)

The application also seeks consent for the discharge of treated wastewater into water as an emergency measure during extreme weather events.

The Morphum Environmental Ltd have identified however that:

> *"flood flows resulting from direct rainfall within the constructed wetland's immediate catchment are able to be detained above the permanent water level (PWL) in cell 4. Based on the 500 mm depth between the crest of the outlet manhole and the lower bund a total volume of 950 m3 will be achieved. This will provide buffering storage for up to the 1 hour, 100 year ARI rainfall event".*

This means that, while high flows have been significantly mitigated through the work completed on I&I and the buffer tank provided at Iwikau Village, during an extreme weather event exceeding a 1 hour, 100 year ARI rainfall event, there may be an overland flow to surface water as the capacity of the constructed wetland and infiltration area is exceeded.

With the benefit of these design details, DOC has sought an additional discharge permit for the discharge of treated wastewater into water as an emergency measure during extreme weather events

One Plan Schedule B, p.B-19 specifies that all sections of rivers that have sources in, and flow within, the Conservation Estate, are defined as "Natural State". Given the location of the WWTP, Rule 14-25 (a) applies which states that the direct discharge of contaminants into water or into or onto land in a reach of a Natural State river is a Discretionary Activity.

7.4 Resource Consent for the Discharge of Wastewater to Land from Seepage

Rule 14-16 provides for the discharge onto or into land of human effluent for the purpose of storing or treating the effluent as a permitted activity. Rule 14-16 (a) requires that effluent storage and treatment facilities must be sealed and that the permeability of the sealing layer must not exceed 1x10-9 m/s.

Other than the designed discharge point within the infiltration area, there are two potential sources of seepage to land from the WWTP infrastructure.

The first potential source is from the tertiary treatment pond. The DBCon Consultant assessment described in Section 4.5 and provided as **Appendix 4** found that no passage of moisture from the pond into the underlying soils was observable. However, it cannot be proved that the tertiary treatment pond meets the maximum 1x10-9 m/s infiltration rate required by Rule 14-16. Should there be a discharge occurring, it is not provided for by other rules in the One Plan and is therefore captured by Rule 14-30 and is a Discretionary Activity.

The second potential sources is from the constructed wetland, prior to the treated wastewater entering the infiltration area. The Morphum Environmental Ltd design specifies a fully lined wetland with a geosynthetic clay liner (GCL). A GCL is a layer of high quality bentonite clay sandwiched between layers of high grade geotextile. Verified testing provides a permeability of $1x10^{-11}$ m/s for GCL which is widely used for similar constructed wetlands. This level of permeability meets the permitted requirements of Rule 14-16 (a).

On the above basis, a resource consent for a Discretionary Activity for any seepage occurring from the tertiary treatment pond is sought.

7.5 Resource Consent for the Discharge of Contaminants to Air (Odour)

While the provisions of Chapter 15 of the One Plan do not make it clear one way or the other whether a consent is required for the WWTP for the discharge of contaminants to air (odour), taking a precautionary approach, DOC is considering that the provisions of Rule 15-17 apply, and therefore a consent for a Discretionary Activity is being requested.

7.6 Section 104(1)(b) (RMA)

Section 104(1)(b) of the RMA requires a consideration of relevant regulations and planning instruments when considering applications for resource consent[5].

The following Section 104(1)(b) analysis considers the relevant provisions of the following:

- National Environmental Standards for Sources of Human Drinking Water (Reg. 2007)
- The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (2011)
- National Policy Statement for Freshwater Management (2014)
- Horizons One Plan (2014)
    - Regional Policy Statement
    - Regional Plan
- Ruapehu District Plan (2013)

7.7 National Environmental Standards for Sources of Human Drinking Water

The National Environmental Standard for Sources of Human Drinking Water (NESDW) directs regional councils (under Regulation 7) to decline discharge permits that are likely to result in community drinking water no longer meeting health quality criteria, or no longer meeting aesthetic determinants, after existing treatment. This Regulation applies where the activity / discharge has the potential to affect registered drinking water supplies (only) that provide no fewer than 501 people with drinking water for not less than 60 days each calendar year.

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[5] Refer to Section 6 for an analysis of any actual and potential effects on the environment of allowing the activity, as required by Section 104(1)(a) of the RMA.

Under Regulation 12, when considering a resource consent application, a consent authority must consider whether the activity to which the application relates may lead to an event which may have a significant adverse effect on the quality of the water at any abstraction point or as a consequence of an event (for example, an unusually heavy rainfall) have a significant adverse effect on the quality of the water at any abstraction point. If either of these applies, a condition of consent must be imposed that specifies certain notification requirements.

In the case of the Whakapapa Village discharge, which is a discharge to land, but ultimately draining to water (either via subsurface or overland flow), the nearest registered downstream drinking water supply serving a population of this size is at Taumarunui, approximately 50 km downstream on the main Whanganui River.

Given these factors, principally the quality of the discharge which may actually enter the waterway and the significant distance to the nearest drinking water abstraction, the discharge from the WWTP cannot be considered to be contrary to the NESDW 2007.

Overall Summary of the NES for Sources of Human Drinking Water 2007

The requirements of the NESDW 2007, and in particular Regulations 7 and 12, do not prevent the granting of consent for this discharge consent or imposition of specific conditions.

7.8 National Environmental Standard for Assessing and Managing Contaminants in Soil

The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) came into force on 1 January 2012 and is issued under sections 43 and 44 of the Resource Management Act. The NESCS applies nationally and in this location, the Ruapehu District Council is required to enforce the NESCS.

As identified above, the application proposes to establish a constructed wetland to aid in the management of disposed treated effluent. Some soil disturbance will be required to establish the constructed wetland proposed under Stages 1. The location of the constructed wetland will be on land which has been subject to the disposal of treated effluent in the past.

The Ministry for the Environment have compiled a Hazardous Activities and Industries List (HAIL), which is a compilation of activities and industries that are considered likely to cause land contamination resulting from hazardous substance use, storage or disposal. Land which has been used for wastewater treatment is identified as an activity which may cause land to be contaminated (G6).

Lattey Group (Lattey) was engaged by the Department of Conservation (DOC), to carry out an NES Preliminary Site Investigation (PSI) at the WWTP.

The PSI identified that a resource consent is required for the activity of soil disturbance at the site and was recommended that a Detailed Site Investigation (DSI) be undertaken to establish distribution and levels of soil contamination and to establish whether the consent is a controlled or restricted discretionary activity under the National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 (NESCS).

The DSI identified that a restricted discretionary consent under the NESCS is required. The Ruapehu District Council is required to observe and enforce the requirements of the NESCS. Accordingly, an application has been made to the Council to consider the works on contaminated land for the constructed wetland system.

Overall Summary of the NES for Sources of Human Drinking Water

Resource consent from Ruapehu District Council under the NESCS is currently being sought.

7.9 National Policy Statement for Freshwater Management (NPSFM 2014)

The NPSFM 2014 directs regional councils to amend their plans to ensure that the various policies of the NPS are implemented.

Horizons Regional Council have assessed whether the One Plan (made operative in December 2014) meets the requirements of the NPSFM 2014, and have reported that The One Plan achieves most NPSFM requirements. A limited process of staged implementation has been proposed to bring the One Plan into full alignment by 2025.

NPSFM 2014 includes a National Objectives Framework ('NOF'). The objective of the NOF is to provide an approach to establish freshwater objectives for national values, and any other values, that is nationally consistent and recognises regional and local circumstances. The provisions of the NOF have been considered in this application; particularly with regards to the definition of environmental outcomes for ammonia, periphyton biomass and *E. coli* that are more stringent than the One Plan targets (refer to proposed conditions).

The NPSFM 2014 also, through Objective D1, requires "the involvement of Iwi and hapū, and to ensure that tāngata whenua values and interests are identified and reflected in the management of fresh water including associated ecosystems, and decision-making regarding freshwater planning, including on how all other objectives of this national policy statement are given effect to." The NPSFM 2014 identifies that "Iwi and hapū have a kinship relationship with the natural environment, including fresh water, through shared whakapapa. Iwi and hapū recognise the importance of fresh water in supporting a healthy ecosystem, including human health, and have a reciprocal obligation as kaitiaki to protect freshwater quality." DOC have worked collaboratively with Iwi and hapū on the development of the revised application as detailed further in section 8 (consultation) below, which is completely consistent with the direction of the NPSFM 2014.

Overall Summary of NPS for Freshwater Management

In addition to the degree to which the One Plan already meets the requirements of the NPSFM 2014 (refer to analysis in Section 7.3.6 below) DOC have sought to integrate NPSFM 2014 into the application, particularly through the consideration of appropriate in-stream environmental outcomes and standards to adopt and proffer through conditions. The application is therefore not considered to be contrary to the NPSFM 2014.

7.10 Horizons One Plan

The One Plan is a combined Regional Policy Statement and Regional Plan, which became fully operative on 19 December 2014.

7.10.1 **Regional Policy Statement**

Part I of the One Plan is the Regional Policy Statement. It sets out the regionally significant resource management issues, and outlines the objectives, policies and methods that will be used to address them.

The following outlines an assessment of the application against Part I of the One Plan, in terms of the relevant objectives and policies. For succinctness, the following is assumed to be read alongside the full text of the One Plan, and therefore One Plan provisions are not replicated verbatim here unless considered useful for the analysis.

Chapter 2: Te Ao Māori

Chapter 2 describes the resource management issues and environmental outcomes sought by tangata whenua, and provide links to provisions in other chapters of the Plan that seek to deliver on these outcomes.

The following matters from Te Ao Māori are considered of relevance to the application.

- *Issue 2-1: Water quality and demand*
- *Take 2-1: Te kounga o te wai me te hiawai*

- *Issue 2-5: Monitoring and enforcement*
- *Take 2-5: Te aroturuki me te ūruhitanga*

- *Objective 2-1: Resource management*
- *Whāinga 2-1: Te whakahaere rauemi*

- *Policy 2-1: Hapū and iwi involvement in resource management*
- *Kaupapa 2-1: Te whakauru mai o ngā hapū me ngā iwi ki roto i te whakahaere rauemi*

- *Policy 2-4: Other resource management issues*
- *Kaupapa 2-4: Ētahi take whakahaere rauemi anō*

The above issues, objectives and policies identify that in terms of water quality, the disposal of sewerage to water, in treated form or otherwise, are culturally abhorrent and confirm that land-based treatment is preferred.

As accentuated above, the intended current operation of the WWTP is a discharge to land of finished effluent from the treatment plant by sub-surface dripper irrigation. This system no longer functions as intended with overland flow to an un-named tributary of the Wairere Stream occurring.

It is proposed to replace the failing dripper irrigation system with a constructed wetland and infiltration area. The constructed wetland is intended to act as a bio filter by removing pollutants such as nitrogen before the treated effluent is discharged to land through an infiltration area. The constructed wetland is also understood to be able to provide an added benefit of serving as a habitat for native wildlife. In addition to providing for cultural consideration in a dual World Heritage National Park, the constructed wetland and infiltration trench design ensures the wastewater has contact with the earth (Papatūānuku).

Accordingly, as the discharge is to land, the proposal is considered to be consistent with Chapter 2 (Te Ao Māori) of the One Plan.

Chapter 3: Infrastructure

Chapter 3 outlines regionally significant issues for infrastructure, energy, waste hazardous substances and contaminated land, and sets out the objectives, policies and methods that derive from these issues.

> ***Objective 3-1: Infrastructure and other physical resources of regional or national importance***
> ***Policy 3-1: Benefits of infrastructure and other physical resources of regional or national importance***
>
> *(a) The Regional Council and Territorial Authorities must recognise the following infrastructure as being physical resources of regional or national importance:*
> *…*
> *(viii) public or community sewage treatment plants and associated reticulation and disposal systems*
>
> *(c) The Regional Council and Territorial Authorities must, in relation to the establishment, operation, maintenance, or upgrading of infrastructure and other physical resources of regional or national importance, listed in (a) and (b), have regard to the benefits derived from those activities.*
>
> ***Policy 3-3: Adverse effects of infrastructure and other physical resources of regional or national importance on the environment***
>
> *In managing any adverse environmental effects arising from the establishment, operation, maintenance and upgrading of infrastructure or other physical resources of regional or national importance, the Regional Council and Territorial Authorities must:*

(a) *recognise and provide for the operation, maintenance and upgrading of all such activities once they have been established,*

(b) *allow minor adverse effects arising from the establishment of new infrastructure and physical resources of regional or national importance, and*

(c) *avoid, remedy or mitigate more than minor adverse effects arising from the establishment of new infrastructure and other physical resources of regional or national importance, taking into account:*

   (i) *the need for the infrastructure or other physical resources of regional or national importance,*

   (ii) *any functional, operational or technical constraints that require infrastructure or other physical resources of regional or national importance to be located or designed in the manner proposed,*

   (iii) *whether there are any reasonably practicable alternative locations or designs, and whether any more than minor adverse effects that cannot be adequately avoided, remedied or mitigated by services or works can be appropriately offset, including through the use of financial contributions.*

Policy 3-1 identifies the Whakapapa WWTP as being of regional and national importance. The ongoing, feasible and affordable operation of the WWTP must therefore be considered in these terms and the benefits it provides to the communities of Whakapapa and Iwikau Villages, including visitors to the Tongariro National Park.

The WWTP is a piece of critical infrastructure as it provides services which, if interrupted, would have a serious effect on the people within the Region or a wider population, and which would require immediate reinstatement.

The proposal is essentially an upgrade of the existing infrastructure as documented in Section 5. It is proposed to replace the existing, poorly performing land disposal system with a constructed wetland discharging to land through an infiltration area, which will improve the quality of the treatment of the discharge. In addition to the treatment provided by the constructed wetland, the applicant has also proposed to implement a raft of WWTP upgrades to better improve plant operation as described in Section 5.

Chapter 5: Water

Chapter 5 outlines the objectives and policies for freshwater management in the region, including water quality.

The One Plan identifies the “quality of many rivers and lakes in the Region has declined to the point that ecological values are compromised and contact recreation such as swimming is considered unsafe. The principal causes of this degradation are:

a. nutrient enrichment caused by run-off and leaching from agricultural land, discharges of treated wastewater, and septic tanks

b. high turbidity and sediment loads caused by land erosion, river channel erosion, run-off from agricultural land and discharges of storm water

c. pathogens from agricultural run-off, urban run-off, discharge of sewage, direct stock access to water bodies and their beds and discharges of agricultural and industrial waste"[6].

To better manage water quality, the Objectives generally require that Schedule B values are provided for. The Schedule B Values for the Upper Whakapapa Water Management Sub-zone (Whai 2b) are outlined in Table below, together with their respective management objectives. Commentary is provided on the relationship between the management objective and the proposal.

Objective 5.1 of the RPS provides for surface water bodies and their beds to be managed:

> *"... in a manner which safeguards their life supporting capacity and recognises and provides for the Values in Schedule B."*

Under Objective 5.2, that surface water quality is managed to ensure that:

> *"... water quality is maintained in those rivers ... where the existing water quality is at a level sufficient to support the Values in Schedule B [and] ... enhanced in those rivers ... where the existing water quality is not at a level to support the Values in Schedule B."*

And, under Objective 5-4 the beds of rivers will be managed in a manner which:

a. sustains their life supporting capacity
b. provides for the in stream morphological components of natural character
c. recognises and provides for the Schedule B Values
d. provides for infrastructure and flood mitigation purposes.

These Objectives are in turn translated into Policies in the RPS, including Policy 5-4, which requires that rivers will be managed in a manner which:

> *Where the existing water quality does not meet the relevant Schedule E water quality targets within a Water Management Sub-zone, water quality within that sub-zone must be managed in a manner that enhances existing water quality in order to meet:*
>
> *i) the water quality target for the Water Management Zone in Schedule E, and/or*
> *ii) the relevant Schedule B Values and management objectives that the water quality target is designed to safeguard.*
>
> *For the avoidance of doubt:*

[6] Horizons One Plan; Section 5 Water; Issue 5-1: Water quality; page 5-6

i) *in circumstances where the existing water quality of a Water Management Sub-zone does not meet all of the water quality targets for the Sub-zone, (a) applies to every water quality target for the Sub-zone*

ii) *in circumstances where the existing water quality of a Water Management Sub-zone does not meet some of the water quality targets for the Sub-zone, (a) applies only to those water quality targets not met.*

The Schedule B Values referred to above include both 'Zone-wide' and 'Site-specific' Values.

Zone-wide Values for the Upper Whakapapa (Whai_2b) Water Management sub-zone include Life-supporting Capacity (LSC), Aesthetics (AE), Contact Recreation (CR), Mauri (Mau), Industrial Abstractor (IA), Irrigation (I), Stock water (SW), and Existing Infrastructure (EI).

The following table provides an assessment of these Values in the context of the Whakapapa WWTP discharge, and further Values are discussed in Table 5.

Table 6: Summary of Zone-Wide Values

Value	Comment on Relevance to Whakapapa WWTP Discharge
LSC	The existing WWTP discharge has an acknowledged effect on macro invertebrates in the 'Northern tributary' to the Wairere Stream (refer to detailed discussion later in this AEE). The proposed upgrade will address and rectify these effects.
AE	The existing (and proposed future) discharge does not significantly adversely affect aesthetic values. The discharge, upon reaching any of the receiving waters, and after reasonable mixing, is not visible. Enhanced periphyton growth is apparent in the un-named tributary, but not at problem levels, and will be further reduced as a result of proposed upgrades to the plant.
CR	The existing discharge generally complies with *E.coli* targets for contact recreation, notwithstanding periodic spikes in *E.coli* counts. Performance in respect of *E.coli* will be improved, and remain compliant, as a result of the proposed upgrade.
Mau	The mauri of the receiving water will be improved as a result of the proposed upgrades.
IA	The water quality requirements for Industrial abstraction are covered Schedule E water quality targets.
I	The water quality requirements for Industrial abstraction are covered Schedule E water quality targets.
SW	The current (and post-upgrade) discharge has no effect on the downstream use of water for stock water.
EI	The integrity of existing infrastructure is not compromised by the existing (or post-upgrade) discharge.
CAP	The capacity of a water body and its bed to assimilate pollution is not exceeded. The treated effluent from the Whakapapa WWTP is contained within the tertiary pond and constructed wetland.

Value	Comment on Relevance to Whakapapa WWTP Discharge
SOS-A	The Whakapapa River, Whakapapaiti Stream, Waikare Stream, Mangahuia Stream, Whakapapanui Stream and Papamanuka and tributaries also have 'Site of Significance – Aquatic in Schedule B, Table B-3, p.B-27. A recent Whio survey report (attached as **Appendix 13**) advises, however, that the Northern tributary is not particularly ideal habitat for this species and that no birds were seen there during the survey on Saturday 27th February 2016. There is better nearby habitat to be found in the Wairere Stream, and more so on the Whakapapanui Stream further downriver where in fact all of the birds sighted during the survey were observed.
TF	The Values of TF (Trout Fishery) applies to the Upper Whakapapa, to source, but not to (as in this case) the Whakapapa tributaries.
TS	The Values of TS (Trout Spawning) applies to the Upper Whakapapa, to source, but not to (as in this case) the Whakapapa tributaries.

The following values are <u>not</u> identified as being present in this subzone:

- Sites of Significance – Riparian (SOS-R)
- Inanga Spawning (IS);
- Amenity (AM)
- Whitebait Migration (WM)
- Sites of Significance – Cultural (SOS-C)
- Domestic Food Supply (DFS)
- Flood Control and Drainage (FC/D).

<u>Natural State (NS)</u>
The 'Site specific' Schedule B Values for relevant to discharges from the Whakapapa Village wastewater plant, are those described in Table 5.2 of the RPS and defined on page B-19. Chief among these is the Value of "*Natural State*". The Management Objective for '*Natural State'* surface water (Table 5.2, p.5-10 & Schedule B, p. B-17) is that...

"The river and bed are maintained in their natural state"

The term 'natural state' is not further defined in the RPS. Nor are there any specific quantitative water quality targets given for this Value. We are reliant on the Water Quality Targets / Standards that apply more generally to the Upper Whakapapa catchment (in Schedule E, p. E-9 of the One Plan).

The earlier technical reports for the development of the Council's Water Management Values and Water Quality standards note that the Natural State Value "seeks to recognise and protect the water bodies <u>currently in, or close to, their natural state</u>" (emphasis added).

This is understood to mean that the natural quality of any water defined as 'Natural State' should not be diminished, but only improved, from its existing condition, as at the date that the Natural State classification came into effect.

This is consistent with the April 2007 Horizons Technical Report (*Identifying community values to guide water management in the Manawatu-Wanganui Region: Technical Report to Support Policy Development*) that originally provided advice for the development of the current classification system in the One Plan.

The 2007 report, p.31, in reference to the Natural State classification, recognises that with the differing pre-existing qualities and characteristics of the various natural state waterways in the region, and lack of specific pre-existing data on these waterways, it would be impractical to establish a single 'numerical' water quality standard for 'Natural State'.

The report recommends instead a 'narrative' standard from the Third Schedule to the RMA: that "*the natural quality of the water shall not be altered*". The report further recommends (p.32) that for consentable activities, including discharges, the onus would then be on the Applicant "*to define what the natural state of the water is and prove the activity does not alter it*".

Accordingly, the 'natural state' of the un-named tributary to the Wairere Stream (where effects have been demonstrated to be occurring as a result of discharges from the WWTP) would be defined as the water quality that existed at the time that the 'Natural State' classification for this stream came into effect. That water quality at that time is known and defined by the results of water quality monitoring carried out in support of the existing consent for the wastewater treatment plant. Therefore, any future re-consenting of the Whakapapa Village wastewater plant discharge should not 'alter' (in any negative way) this pre-existing water quality condition.

The upgrades to the WWTP and the constructed wetland process will improve the quality of the Wairere Stream and tributaries.

Additionally, Policy 5-23 of the RPS (Natural State and Sites of Significance – Aquatic), requires that activities within the sites included in Schedule B must be managed in a manner which:

(a) *avoids adverse effects on these Values in the first instance, or*
(b) *for infrastructure and other resources of regional and national importance, or activities that result in an environmental benefit, remedies or mitigates those effects where it is not practicable to avoid them, and maintains the habitat and spawning requirements of the species identified.*

It is considered that the WWTP is infrastructure of regional and national importance and the proposal outlined in the application (particularly the setting of environmental outcomes and standards in the proposed conditions as described in Section 5.5) appropriately remedies or mitigates the effects where it is not practicable to avoid them. The proposal will maintain the habitat and spawning requirements of the species identified, in particular Whio/Blue Duck.

Water Supply Value (WS)

The Whakapapanui Stream and tributaries also have '*Water Supply Value*' in Schedule B, Table B-10, p.B-75. The Water Supply Values are here in respect of the water supplies for the townships of Piriaka and Taumarunui, approximately 40 – 50 kilometres downstream (although in fact Piriaka is on a separate spring supply). The Management Objective for this Value is that:

> *"The water is suitable, after treatment, as a drinking water source for human consumption."*

The Water Quality Targets in Schedule E (under Policy 5-2), other than where they are incorporated into permitted activity rules, as conditions to be met...

> *"must be used to inform the management of surface water quality ..."*

Policy 5-4 explains that where existing water quality does not meet Schedule E targets then the quality of the water must be managed in a manner that enhances existing water quality in order to meet the target and/or relevant Schedule B Values and Management Objectives that the water quality targets are designed to safeguard. That is to say: water quality can either meet the relevant targets in Schedule E, or, if unable to achieve those targets, can be managed to at least ensure that the relevant Schedule B Values and Management Objectives are met. This allows some flexibility in the application of the water quality targets, providing the essential values of a waterway are protected and sustained.

This is relevant to the current application in the context of, for example, the management of periphyton and nutrients in the receiving waters. Periphyton growth is what affects, or may affect, the Natural State Values of the stream (and therefore must be strictly controlled).

Nutrients (nitrogen and phosphorus) contribute to periphyton growth, and are therefore implicated in the maintenance of Natural State Values, but are not an 'effect' on Natural State Values in their own right.

In addition, if the discharge is a 'point source' discharge (and at times it is possible that there may be a point source discharge to the receiving water from the Whakapapa Village wastewater treatment facility due to overland flow during extreme weather events) then, under Policy 5-9, the management of such discharges must have regard to:

(i) the degree to which the activity will adversely affect the [relevant] Schedule B Values ...

(j) whether the discharge, in combination with other discharges ... will cause the Schedule E water quality targets to be breached.

(k) the extent to which the activity is consistent with contaminant treatment and discharge best management practices.

(l) the need to allow reasonable time to achieve any required improvements to the quality of the discharge.

(m) whether the discharge is of a temporary nature or is associated with the necessary maintenance or upgrade work and the discharge cannot practicably be avoided.
(n) whether adverse effects resulting from the discharge can be offset by way of a financial contribution ...
(o) whether it is appropriate to adopt the best practicable option

For human sewage, specifically, which the Whakapapa Village wastewater contains, Policy 5-11 of the RPS requires that, notwithstanding other policies, before entering a surface water body all 'new' discharges of treated human sewage (and all 'existing' discharges of human sewage, at the time of re-consenting, or by 2020, whichever is earlier) must ...

i. be applied onto or into land, or
ii. flow overland, or
iii. pass through an alternative system that mitigates the adverse effects on the mauri of the receiving water body

In the case of the Whakapapa Village treatment and disposal system the discharge is already applied to land and/or flows overland. The proposed upgraded treatment system has been specifically designed with Policy 5-11 in mind and is intended to fully implement this policy as soon as is reasonably practicable.

<u>Groundwater</u>
The relevant groundwater policies are:

Groundwater Quality
Policy 5-6: Maintenance of groundwater quality
(a) Discharges and land use activities must be managed in a manner which maintains the existing groundwater quality, or where groundwater quality is degraded/over allocated as a result of human activity, it is enhanced.
(b) An exception may be made under (a) where a discharge onto or into land better meets the purpose of the RMA than a discharge to water, provided that the best practicable option is adopted for the treatment and discharge system.
(c) Groundwater takes in the vicinity of the coast must be managed in a manner which avoids saltwater intrusion.

Discharges and Land Use Activities Affecting Water Quality
Policy 5-7: Land use activities affecting groundwater and surface water quality

The management of land use activities affecting groundwater and surface water must give effect to the strategy for surface water quality set out in Policies 5-2, 5-3, 5-4 and 5-5, and the strategy for groundwater quality in Policy 5-6, by managing diffuse discharges of contaminants in the following manner:

(a) identifying in the regional plan targeted Water Management Sub-zones. Targeted Water Management Sub-zones are those subzones where, collectively, land use

activities are significant contributors to elevated contaminant levels in groundwater or surface water

(b) identifying in the regional plan intensive farming land use activities. Intensive farming land use activities are rural land use activities that (either individually or collectively) make a significant contribution to elevated contaminant levels in the targeted Water Management Subzones identified in (a) above

(c) actively managing the intensive farming land use activities identified in (b) including through regulation in the regional plan, in the manner specified in Policy 5-8

(d) the Regional Council must continue to monitor ground and surface water quality in Water Management Sub-zones not identified in (a) and rural land uses not identified in (b). Where monitoring shows the thresholds in (a) and (b) are met then the regional plan must be amended so that those further Water Management Sub-zones and rural land uses are included in the management regime set out in (c).

Given the topography, soil type and climate of the area, and the proximity of surface water, groundwater will naturally eventually migrate to surface water (being the unnamed southern and northern tributaries to the Wairere Stream). For this reason, no mounding of groundwater is expected to occur.

There are also no uses of groundwater that could be affected by the discharges in this location i.e. between the WWTP (including the tertiary treatment pond and the constructed wetland infiltration area) and the streams to which the groundwater will eventually migrate.

As noted above, the tertiary treatment pond has very low permeability.

Policy 5-7: As discussed above, the discharge to land as proposed gives effect to the strategy for surface water quality set out in Policies 5-2, 5-3, 5-4 and 5-5, and the strategy for groundwater quality in Policy 5-6.

Chapter 6: Landscape and Indigenous Biological Diversity

Schedule G provides a list of some regionally outstanding natural features and landscapes in the Manawatu-Wanganui Region. The Tongariro National Park is identified as an Outstanding Natural Feature or Landscape. The characteristics and values of the Tongariro National Park are listed as:

(i) Visual and scenic characteristics, particularly the park's visual prominence in the Region and the contrast of the Rangipo desert with adjacent landscapes

(ii) Geological features including the Rangataua Lava Flow

(iii) Recreational values, particularly tramping and snow sports

(iv) Scientific value, particularly the volcanic landscape

(v) Ecological value, particularly the mountainous ecology and the extensive tussock grasslands and wetlands supporting rare indigenous flora

(vi) Importance to tangata whenua

Objective 6-2 requires adverse effects, including cumulative adverse effects, on the natural character of wetlands, rivers and lakes and their margins, are:

(i) avoided in areas with outstanding natural character, and
(ii) avoided where they would significantly diminish the attributes and qualities of areas that have high natural character, and
(iii) avoided, remedied, or mitigated in other areas.
(iv) promote the rehabilitation or restoration of the natural character of the coastal environment, wetlands, rivers and lakes and their margins.

The only physical change proposed to occur to the WWTP as a result of this application in the construction and establishment of constructed wetland to aid in the treatment of the wastewater.

The Tongariro National Park Management Plan identifies that only indigenous plants which have been grown from seed or cuttings collected in the park and its vicinity should be used for revegetation or landscaping.

The proposal will use locally sourced indigenous plants in accordance with the position identified in the Tongariro National Park Management Plan. The use of local plants from the local environment will ensure a visual connectivity with the existing environment is achieved with the wetland integrating in this landscape. Seeds for propagation have already been collected with Iwi in anticipation of the construction of the wetland in early 2017. Accordingly, it is considered that the introduction of the constructed wetland in the manner proposed will not have a significant visual impact on the Tongariro National Park, and will enhance an area that has been historically highly modified by human activities since the 1940s.

Chapter 7: Air

Chapter 7 outlines the objectives and policies for air quality management in the region. The following policies objectives are considered relevant.

Objective 7-1 ambient air quality
A standard of ambient air quality is maintained which is not detrimental to amenity values, human health, property or the life-supporting capacity of air and meets the national ambient air quality standards.

Policy 7-2 Regional Standards for ambient air quality
In addition to the National Environmental Standards set out in Policy 7-1, ambient air quality must be managed in accordance with the regional standards set out in Table 7.3.

Table 7.3 Regional Standards for Ambient Air Quality.

Contaminant	*Regional Standard*
Odour	*A discharge must not cause any offensive or objectionable odour beyond the property boundary.*
Dust	*A discharge must not cause any noxious, offensive or objectionable dust beyond the property boundary.*
Smoke and water vapour	*A discharge must not result in any objectionable or offensive smoke or water vapour beyond the property boundary.*
Agrichemicals	*A discharge must not give rise to noxious or dangerous levels of agrichemicals in terms of human health, non-target plants or animals, or property.*
Gases and other airborne contaminants	*A discharge must not result in noxious or dangerous levels of gases or other airborne contaminants^ beyond the property boundary.*

Policy 7-3 Regulation of discharges to air
Discharges of contaminants into air will be generally allowed, provided:

(a) the effects of the discharge are consistent with the approach set out in Policy 7-1 for implementing the National Environmental Standards for ambient air quality, and

(b) the discharge is consistent with the regional standards for ambient air quality set out in Policy 7-2.

The Whakapapa WWTP is located approximately 400 m from the Skotel and in excess of 500 m from the Chateau Tongariro, being the two closest sensitive receiving environments. DOC has consulted with these parties who have both identified that they have no records of any odour issues from the operation of the WWTP. Accordingly, the proposal is considered to maintain the ambient air quality in this environment and will not be detrimental to amenity values, human health, property or the life-supporting capacity of air.

A condition of consent has been proposed to manage any potential effects which may materialise from the continued operation of the Whakapapa WWTP.

7.10.2 **Regional Plan**

Part II of the Horizons One Plan is the Regional Plan. It specifies the objectives, policies and regional rules on natural and physical resource use.

The following outlines an assessment of the application against Part II of the One Plan, in terms of the relevant objectives and policies. For succinctness, the following is assumed to be read alongside the full text of the One Plan, and therefore One Plan provisions are not replicated verbatim here unless considered useful for the analysis.

Chapter 14: Discharges

Chapter 14 outlines the objectives, policies and rules relevant to discharges from the Whakapapa WWTP to land and water.

> ***Objective 14-1 Management of discharges to land and water and land uses affecting groundwater and surface water quality***
>
> *The management of discharges onto or into land (including those that enter water) or directly into water and land use activities affecting groundwater and surface water quality in a manner that:*
>
> *(a) safeguards the life supporting capacity of water and recognises and provides for the Values and management objectives in Schedule B,*
>
> *(b) provides for the objectives and policies of Chapter 5 as they relate to surface water and groundwater quality, and*
>
> *(c) where a discharge is onto or into land avoids remedies or mitigates adverse effects on surface water or groundwater.*
>
> ***14-2: Consent decision-making for discharges to land***
>
> *When making decisions on resource consent applications, and setting consent conditions, for discharges of contaminants onto or into land the Regional Council must have regard to:*
>
> *(a) the objectives and policies of Chapter 5 regarding the management of groundwater quality and discharges,*
>
> *(b) where the discharge may enter surface water or have an adverse effect on surface water quality, the degree of compliance with the approach for managing surface water quality set out in Chapter 5,*
>
> *(c) avoiding as far as reasonably practicable any adverse effects on any sensitive receiving environment or potentially incompatible land uses, in particular any residential buildings, educational facilities, churches, marae, public areas, infrastructure and other physical resources of regional or national importance identified in Policy 3-1, wetlands, surface water bodies and the coastal marine area,*
>
> *(d) the appropriateness of adopting the best practicable option to prevent or minimise adverse effects in circumstances where:*
>
> > *(i) it is difficult to establish discharge parameters for a particular discharge that give effect to the management approaches for water quality and discharges set out in Chapter 5,*
> >
> > *(ii) the potential adverse effects are likely to be minor, and the costs associated with adopting the best practicable option are small in comparison to the costs of investigating the likely effects on land and water,*
>
> *(e) avoiding discharges which contain any persistent contaminants that are likely to accumulate in the soil or groundwater, and*
>
> *(f) the objectives and policies of Chapters 2, 3, 6, 9 and 12 to the extent that they are relevant to the discharge.*

Policy 14-3: Industry-based standards

The Regional Council will examine on an on-going basis relevant industry-based standards (including guidelines and codes of practice), recognising that such industry based standards generally represent current best practice, and may accept compliance with those standards as being adequate to avoid, remedy or mitigate adverse effects to the extent that those standards address the matters in Policies 14-1, 14-2, 14-4 and 14-5.

Policy 14-4: Options for discharges to surface water and land

When applying for consents and making decisions on consent applications for discharges of contaminants into water or onto or into land, the opportunity to utilise alternative discharge options, or a mix of discharge regimes, for the purpose of mitigating adverse effects, applying the best practicable option, must be considered, including but not limited to:

a) discharging contaminants onto or into land as an alternative to discharging contaminants into water,

(b) withholding from discharging contaminants into surface water at times of low flow, and

(c) adopting different treatment and discharge options for different receiving environments or at different times (including different flow regimes or levels in surface water bodies).

Policy 14-8: Monitoring requirements for consent holders

Chapter 14 requires a consideration of the relevant Policies 5-1 to 5-5 and this is provided under Section 6.5 above (Regional Policy Statement) as well as relevant objectives and policies of Chapter 2.

An assessment of the values and management objectives in Schedule B is provided above. The WWTP is generally consistent with the values and management objectives for the Upper Whakapapa water sub-zone. The land based discharge is intended to avoid adverse effects on surface water.

Policy 14-4 is particularly relevant to the Whakapapa WWTP as the system is intended to discharge contaminants into land as an alternative to discharging contaminants into water. In this regard, the Whakapapa WWTP is consistent with Policy 14-4.

In terms of Objective 14-2(f), the relevant objectives and policies of Chapters 2, 3 and 6, and to the extent that they are pertinent to the discharge, are discussed at each relevant chapter within Section 7.3.4 (Horizons One Plan).

Proposed conditions of consent identify the monitoring requirements for consent holder (Policy 14-8) and are imposed to ensure actual or potential adverse effects are adequately managed.

Chapter 15: Air

Chapter 15 outlines the objectives, policies and rules for discharges to air from the Whakapapa WWTP.

Objective 15-1: Air quality

Policy 15-2: Consent decision-making for other discharges into air

The Whakapapa WWTP has not previously held resource consent for discharges to air and no complaints have, to our knowledge, been received regarding odour. The consent for discharges to air is being sought on a precautionary basis with a set of conditions proposed to manage any potential effects (**Appendix 5**).

7.10.3 Overall Summary of One Plan

The Horizons One Plan includes a number of policy directions relevant to these applications. These are as follows:

(a) There are a number of specifically recognised "Values" (as defined in One Plan Schedule B) attached to the eventual receiving environment. These Values must be safeguarded.

(b) The Plan specifies water quality targets for the receiving water. These targets "must be used to inform" decision-making on the current application, although the consenting authority has the ability to allow departures from strict adherence to these targets if there is sufficient reason, and providing that the essential Values of the waterway, listed above, are 'safeguarded'.

(c) Where existing water quality does not currently meet Schedule E targets (the case here with parameters for QMCI, DRP and SIN), the water quality *must* be improved so that either the targets are met *or* associated Values are otherwise safeguarded.

(d) Where there are 'point source' discharges (which in the case of the Whakapapa Village discharge could potentially occur in the event of overland flow from the land disposal area occurring during extreme weather events), the consent authority must have regard to whether One Plan Schedule B Values are affected; whether Schedule E water quality targets are breached; and whether the proposed treatment and disposal system represents the best practicable option.

(e) The consent authority has the discretion to allow reasonable time for the consent-holder to achieve required improvements and, if necessary, to complete trial and investigation work leading to future improvements. The consent authority may also allow for continued discharges while plant upgrades are being undertaken if, in the meantime, the effects of the discharge (in reference to Policy 5-9) cannot be practically avoided.

(f) Applicants are encouraged to consult directly with hapū and Iwi to establish the nature of relationships and traditions relating to land and water and to have regard to the mauri of water.

The proposal to treat the wastewater by a constructed wetland and discharge to land is consistent with the objectives and policies of the One Plan as it appropriately manages the effects of nationally and regionally important infrastructure by improving the quality of the water in the tributaries to the Wairere Stream and the Wairere Stream and safeguards freshwater ecosystems.

7.11 Ruapehu District Plan

The Ruapehu District Plan ('District Plan') governs land use in the District. Under section 4(3) of the RMA, however, the controls in the District Plan relating to land use do not extend to activities carried out within the boundaries of land held or managed under the Conservation Act (and any other Act specified within in Schedule 1 of that Act, including the National Parks Act), except where land is held under any of these various Acts for 'administrative purposes', and providing the activity is *"consistent with a ... conservation management plan ... and does not have a significant adverse effect beyond the boundary of the land"*.

While this means that no land use consents are required from the Ruapehu District Council, some objectives and policies of the District Plan may still be relevant and may be considered under s104 (1)(b)(vi) of the RMA.

The relevant objectives and policies of the District Plan to the proposal are considered to be contained in the following sections below. A brief assessment has also been provided on the consistency of the proposal against those sections of the District Plan.

7.11.1 **Infrastructure**

The District Plan recognises the position of infrastructure of regional or national importance and to ensure that adverse effects from infrastructure and other physical resources are avoided as far as reasonably practicable. It is considered the proposal is consistent with the policy direction for infrastructure under the District Plan

7.11.2 **Indigenous Vegetation and Habitats of Indigenous Fauna**

The District Plan seeks the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna. The assessment of Dr Nick Singers identifies that the "*construction of waste water treatment wetland will have near to minimal ecological impact on the current ecological values of the proposed sites*". The proposal is therefore not considered to be inconsistent with this policy direction.

7.11.3 **Outstanding Natural Features and Landscapes**

The District Plan seeks the protection of the values of identified areas of outstanding natural features and landscapes from inappropriate subdivision, use and development. The development in this instance is limited to the construction of a wetland to aid in the discharge to land of the treated effluent from the Whakapapa WWTP. The changes will be limited to some minor land disturbance and removal of existing exotic plant species. It is proposed to establish some amenity planting of large wetland plants such as harakeke and toetoe around the perimeter of any constructed wetland.

The plants will be source locally (consistent with Tongariro Management Plan) and accordingly will not be incongruous in this environment.

A planting plan has been provided (**Appendix 14**) to further soften the visual infrastructure at the plant (also refer to **Appendix 15** for a photo montage of the constructed wetland area). The addition of the wetland would enhance the landscape values by softening the modified habitat of grasses.

Overall the proposal is considered to be consistent with the outstanding natural features and landscapes provisions of the District Plan.

7.11.4 **Tangata Whenua Values and Māori Land**

Tangata whenua have involved in consultation throughout the process and have been integral to the development of the application. It is considered that Section 6(e) of the RMA has been recognised and provided for and that the Principles of the Treaty of Waitangi have been taken into account. See further discussion on Section 6(e) of the RMA in Section 7.6.2 below.

7.11.5 **Protected Areas Zone**

The Whakapapa Village and surrounds are located in a 'protected areas zone' where the protection of the natural, amenity, historic, recreational and cultural values is required. The policy requires the recognition and to provide for the protection of Māori cultural values, including managing development within the area gifted by Horonuku Te Heuheu in 1887 within the Tongariro National Park so that adverse environmental effects are avoided, remedied or mitigated.

The protected area zone policies also seek to recognise Tongariro National Park and, in particular, the volcanoes as an outstanding natural feature, and to require protection of the Park and the volcanoes from the adverse effects, if any, associated with land use and development. It is considered the proposal protects the natural, amenity, historic, recreational and cultural values of the area.

7.11.6 **Network Utilities**

The District Plan seeks to enable the efficient development, maintenance and operation of network utilities, while avoiding, remedying or mitigating any significant adverse effects on the environment. The application demonstrates that it is consistent with this policy direction of the District Plan.

7.11.7 **Overall Summary of Ruapehu District Plan**

Overall, it is considered the proposal in consistent with the relevant objectives and policies of the Operative District Plan.

7.12 Section 104(1)(c) (RMA)

Section 104(1)(c) of the RMA requires a consideration of other matters considered relevant and reasonably necessary to determine the application.

The following Section 104(1)(c) analysis considers the relevant provisions of the following:

- Conservation Act 1987
- National Parks Act 1980
    - General Policy for National Parks (2005)
    - Tongariro/Taupō Conservation Management Strategy (2002-2012)
    - Tongariro National Park Management Plan (2006-16)
    - Tongariro National Park Bylaws (1981)
- Ngāti Tūwharetoa Environmental Iwi Management Plan (2003)

7.13 The Conservation Act 1987

The Conservation Act 1987 established the Department of Conservation and directs the administration and management of all land and resources under DOC's control (other Acts also direct the management of lands administered by DOC).

Section 4 of the Conservation Act 1987 requires DOC to interpret and administer that Act, and the Acts listed in the first schedule which includes the National Parks Act 1980, so as to give effect to the principles of the Treaty of Waitangi.

Section 6 of the Conservation Act 1987 sets out the functions of DOC. Of particular relevance to this application are sections 6(a), (ab), (b), (c) (i), and (e) which state:

(a) To manage for conservation purposes all land, and all other natural and historic resources, and all other land and natural and historic resources whose owner agrees with the Minister that they should be managed by the Department;

(ab) To preserve so far as practicable all indigenous freshwater fisheries, and protect recreation freshwater fisheries and freshwater habitats;

(b) To advocate for conservation of natural and historic resources generally;

(c) To promote the benefits to present and future generations of:

(i) The conservation of natural and historic resources generally and the natural and historic resources of New Zealand in particular;

(e) To the extent that the use of any natural or historic resources for recreation or tourism is not inconsistent with its conservation, to foster the use of natural and historic resources for recreation, and allow their use for tourism.

Part 3A of the Conservation Act requires Conservation management strategies to be developed. Conservation management strategies are 10-year regional strategies that provide an overview of conservation issues and give direction for the management of public conservation land and waters, and species for which the Department has responsibility.

Their purpose is to implement general policies and establish objectives for the integrated management of natural and historic resources, and for recreation, tourism, and any other conservation purposes[7].

The Conservation Management Strategy for the Tongariro National Park is assessed below.

7.14 National Parks Act 1980

The Tongariro National Park is recognised as an 'existing national park' under Section 6(1) (a) of the National Parks Act 1980.

The National Parks Act 1980 aims to preserve in perpetuity for their intrinsic worth and for the benefit use and enjoyment of the public those parts of the country that contain scenery of such distinctive quality, ecological systems, or natural features so beautiful, unique, or scientifically important that their preservation is in the national interest.

Part I and V of the Act are relevant to this application. Part I deals with the principles to be applied in national parks. These include: preservation in their natural state; preservation of native plants and animals and removal of introduced ones, as far as possible; preservation of archaeological and historical sites and objects; maintenance of soil, water and forest conservation values; and freedom of access to the public, as far as possible. Part I also deals with new parks, additions to parks, excluding land from parks, and establishing wilderness areas. Part V deals with the control and management of national parks. Part V also covers aspects such as the preparation of conservation management strategies and plans and the granting of concessions.[8]

The Tongariro Conservation Management Strategy and Tongariro Management Plan as identified in Part V is assessed below.

7.14.1 General Policy for National Parks (2005)

The purpose of the General Policy is to implement the National Parks Act 1980 and to provide consistent national direction for the administration of national parks through conservation management strategies and national park management plans.

The three types of planning documents have a hierarchy that derives from linked requirements in the National Parks Act 1980 and the Conservation Act 1987, which are specifically identified as:

1. General Policy implements and cannot derogate (i.e. detract) from legislation;
2. Conservation Management Strategies implement general policies approved under the National Parks Act 1980 and other Acts and cannot derogate from any general policy; and
3. A National Park Management plan cannot derogate from any relevant conservation management strategy.

[7] http://www.doc.govt.nz/about-us/our-policies-and-plans/doc-and-resource-management/conservation-management-strategies-and-plans/
[8] http://www.doc.govt.nz/about-us/our-role/legislation/national-parks-act/

If a course of action is proposed or an issue arises on which a national park management plan is silent, the General Policy (as well as the National Parks Act 1980 and the relevant conservation management strategy) will still need to be taken into account for any direction or guidance it gives on the issue.

It is considered that the proposal to develop and maintain a land-based integrated sewage treatment system for the Whakapapa and Iwikau villages and the full range of possible relevant policy direction including Treaty of Waitangi Responsibilities (Section 2), Public Participation in National Parks (Section 3), Preservation of Indigenous Species, Habitats, Ecosystems and Natural Features (Section 4), Historical and Cultural Heritage (Section 5) and Utilities and Roading (Section 10) have been adequately covered in the Tongariro National Park Conservation Management Strategy. Accordingly, an assessment of the proposal has not been undertaken against each of the individual policies of the General Policy.

7.14.2 **Tongariro/Taupō Conservation Management Strategy**

A conservation management strategy is a statutory document, prepared in accordance with part IIIA of the Conservation Act 1987, which implements general policies and establishes objectives for integrated management of natural and historic resources. The conduct of activities on public conservation land can only take place in accordance with the relevant conservation management strategy. This document, the Tongariro/Taupō Conservation Management Strategy, sets out the Department of Conservation's management directions for Tongariro/Taupō Conservancy for the next 10 years.

Section 4.5.10 provides the management objectives for the Tongariro National Park, which are identified as:

1. *To achieve an integrated approach to protect the natural and historic values of all land in Tongariro-Ruapehu, regardless of tenure, in co-operation with other landowners and local authorities.*
2. *To manage the pristine zone of Tongariro/Ruapehu giving due priority to its inherent cultural and intrinsic values.*
3. *To achieve, through advocacy, greater protection of areas and habitats of high natural and historic value on private land, firstly through liaison and co-operation with other landowners and secondly through statutory planning processes.*
4. *To manage Tongariro National Park in accordance with the Tongariro National Park Management Plan.*
5. *To control plant pests, including heather (Calluna vulgaris), and to eliminate Pinus contorta.*
6. *To protect the soil and water conservation values of other areas, by (a) advocating the protection of riparian vegetation, and (b) advocating the protection of remaining forested catchments through statutory and non-statutory processes.*
7. *Where privately owned land adjoining Tongariro National Park is for sale, to consider the appropriateness of its addition to the national park.*

8 *To continue the management of the Karioi Rahui on the flanks of Mt Ruapehu, to provide for the integrated management of natural resources utilising expertise of Ngāti Rangi and the broader Ruapehu District community.*

9 *To develop and maintain a land-based integrated sewage treatment system for the Whakapapa and Iwikau villages.*

10 *To remove the exotic plantation forest from within Tongariro National Park.*

11 *To undertake surveys and research to gain a better understanding and knowledge of natural and historic values on and off public conservation land.*[9]

This proposal to develop and maintain a land-based integrated sewage treatment system for the Whakapapa and Iwikau villages is consistent with Policy 9 above.

7.14.3 **Tongariro National Park Management Plan (2006-16)**

The Tongariro National Park Management Plan ('the plan') has been prepared in accordance with the National Parks Act 1980 and sets DOC's proposed intentions for managing Tongariro National Park through until 2016.

Wastewater Treatment

The Tongariro National Park Management Plan (TNPMP) recognises the existence and necessity of the Whakapapa Village wastewater treatment plant as a support for activities in the Park.

Policy 4.1.4(6) (Water) of the Plan (as well as 4.1.17(1)), which requires that:

> *"All effluent in Whakapapa and Iwikau villages (except at Downhill Ski Club and Ruapehu Hut) will be reticulated and discharged through an approved land-based sewage treatment plant located in Whakapapa Village."*

The treatment plant is located in a gazetted Amenities Area within the Park. These areas are:

> *"set aside to provide for the development and operation of public amenities at a scale and intensity which is not found elsewhere in the park".* [TNPMP, p.196]

Activities that...

> *"require the provision of significant services and facilities associated with the principal recreation activities in the park, must be located within designated amenities areas ... or outside the park*." [TNPMP, p.128]

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[9] Tongariro/Taupo Conservation Management Strategy 2002 – 2012; Section 4.5.10 Management Objectives; Page 223.

Wetlands

An objective of the TNPMP is to protect and enhance ecosystems, to provide for self-sustaining populations of indigenous plants (Objective 4.1.7.1(b) (Indigenous Plants). Policy 3 expands on this further stating:

> *"Only indigenous plants which have been grown from seed or cuttings collected in the park and its vicinity should be used for revegetation or landscaping. Where indigenous species have been lost from the park and its vicinity, and are required for a reintroduction programme, they may be sourced from elsewhere. Species will be sourced in accordance with the plant distribution limits of the Tongariro National Park Plant Species List."*

Policy 2 also identifies that "regeneration of areas which have been modified or damaged by human induced activities or animal pests may be assisted by restoration planting."

The wetland is proposed to be constructed is parts of the Whakapapa Amenity Area which have been modified in the past. The reintroduction of locally sourced indigenous plants in this area via the constructed wetland will support the reintroduction of the indigenous ecosystem (Biodiversity Policy 4.1.5 (5)).

Landscape

The construction of the wetland to aid in the treatment of effluent discharged to land will be the only physical change as a result of the proposal. This has the potential to impact on the landscape or visual characteristics found in this part of the Tongariro National Park.

The TNPMP provides objectives and policies in managing the landscape values of the National Park, which read:

Objectives -

a. *To retain the natural landscape of Tongariro National Park in perpetuity.*

b. *To restore landscape values where adverse effects of development or exotic plants have not caused irreversible consequences.*

c. *To ensure that infrastructure is designed and located to avoid impacts on landscape values*

Policies -

1. *Facilities should be designed and sited to avoid impacts on landscape values.*
2. *Design of infrastructure should ensure that it will blend into the environment, reducing the impact of facilities on the landscape.*
3. *Where infrastructure is redundant it will be removed.*
4. *Any earthworks carried out should not exacerbate natural erosive processes or have adverse impacts on watercourses.*
5. *Any disturbance of vegetated landscapes in an approved works programme will be accompanied, as a condition of approval, by a restoration and planting plan.*

6. *Landscape assessments and design will be undertaken by appropriately qualified specialists.*

DOC have engaged an appropriately qualified terrestrial ecologist in Dr Nick Singers to assess the ecological values and identify what indigenous plants found in the vicinity of the WWTP would be appropriate as a wetland plant or to deliver some visual screening of the WWTP from recreational users on tracks in close proximity to the WWTP. This evaluation has also been supported from NIWA in terms of the selected ability of any plants to perform as required for wastewater treatment as part of a constructed wetland. Both the constructed wetland and landscape planting will be ecologically suitable and visually connect with the existing landscape.

Overall Summary/Interpretation of Tongariro National Park Management Plan

The Whakapapa Village wastewater treatment plant is located in an area within the Park reserved for these types of activities and the on-going operation of the plant is consistent with the Park Management Plan. The constructed wetland and landscape planting will be 'visually connected' with the landscape found in this location given the indigenous plants to be established.

7.14.4 Tongariro National Park Bylaws 1981

Section 56 of the National Parks Act 1980 provides for the Minister to make bylaws. Bylaws allow for the regulation of activities that cannot be achieved through policies. They regulate a number of activities. This proposed does not require any approvals under the bylaw.

7.15 Ngāti Tūwharetoa Environmental Iwi Management Plan (2003)

The Ngāti Tūwharetoa Environmental Management Plan contains a number of polices (p.22) relating to water quality and to the discharge of human waste. These include:

- Advocate the protection of mauri of water through effective policy and planning instruments.
- Prohibit all discharges of human waste directly into waterways and promote effluent treatment acceptable to ngā hapū.
- Encourage the implementation of land based disposal systems e.g. dairy farm effluent.
- Support proposals that seek hapū involvement to improve water quality and promote efficient use of water quality.

In the case of the Whakapapa Village wastewater treatment plant the proposed disposal method for the treated wastewater will be a discharge to land from a constructed wetland.

DOC, as applicant for consenting of the WWTP, has also sought the involvement of Ngāti Tūwharetoa in this consent process (as discussed in the Consultation section of this AEE). Tūwharetoa have in turn deferred all communication to the relevant hapū, Ngāti Hikairo. That engagement is on-going. Ngāti Hikairo whanau have also been involved in recent seed collections (with assistance from consultant ecologist Dr. Nick Singers) for propagation and planting of suitable native wetland species in the proposed constructed wetland. A letter from Ngāti Hikairo, in support of the application and proposed treatment upgrade, has been received and is included in **Appendix 12**.

Overall Summary / Interpretation of NTEIMP

The proposed upgraded wastewater treatment and disposal system will be consistent with the Iwi Management Plan policy of promoting land-based disposal systems. That is notwithstanding acknowledged sensitivity regarding the treatment plant being located on the maunga.

7.16 Hazardous Substances and Installations

The Fourth Schedule to the RMA (clause 6(1) (c)) requires that, if the proposed activity includes the use of hazardous substances and installations, an assessment must be provided of any risks to the environment that may be likely to arise. Operators who run facilities within the National Park recognise its special nature and the need to manage systems in the most environmentally friendly manner. No or Low phosphate detergent and readily degradable toilet papers are used onsite by Kah group and RAL.

Hazardous substances are involved in the day-to-day operation of the Whakapapa Village wastewater treatment plant and may form part of the plant upgrades. Best practice is prescribed in using and storage of chemicals. An Emergency Management Register of all chemicals is provided to the Fire Service along with Material Safety Data Sheet and maximum quantities held onsite. All Material Safety Data Sheet are provided in red weather proof cases at the front of each plant, should an emergency occur. The site is covered by Veolia Environmental Quality Plan and Health and Safety. Both are audited locally and from Head Office.

DOC cannot entirely control what is put down the drain at club huts, hotel rooms etc. that are connected to the sewer network and there is, therefore, the possibility of hazardous substances reaching the treatment plant via the sewerage system if the system is misused in this fashion.

In that event, the process tanks would provide a buffer and intercept most organic and non-organic contaminants, with these contaminants either chemically or biologically decomposing or dropping out as sludge, though the degree of capture will depend on the specific substance in each case and full capture cannot always be guaranteed. Notwithstanding this, to our knowledge there have been no such incidents with the Whakapapa Wastewater Treatment Plant to date.

7.17 Section 105 – Consideration of Alternative Methods

Sections 105 set out additional matters that need to be considered in relation to applications for discharge permits. More specifically s 105(1) (c) of the RMA states:

> *"If an application is for a discharge permit or coastal permit to do something that would contravene section 15 or section 15B, the consent authority must, in addition to the matters in section 104(1), have regard to—*
>
> *(c) any possible alternative methods of discharge, including discharge into any other receiving environment."*

In 2014 DOC engaged MWH consultants to consider the options available for disposing of treated effluent and prepared an Issues and Options Report (See **Appendix 16**) for a summary table of the alternatives considered as part of the overall resource consent process. The option analysis took into account the land area required, maintenance, costs and ecological issues or benefits. Of all the options, improvements to plant operation and the use of a constructed wetland was the preferred option as it was considered to best address ecological effects, longevity of the scheme and the lack of engineering complexity for maintenance purposes.

It also would use an area of land that had been highly modified to create a constructed wetland area that could be planted to fit into the landscape. Importantly it was also preferred by Iwi for cultural reasons as a softer more natural approach in the tertiary treatment of effluent.

The following provides a short summary of the alternative options considered:

7.18 Pipe Effluent to the National Park Wastewater Treatment Plant

The distance from Whakapapa to National Park Village is approximately 16 km, with most of that downhill. It would be technically feasible to pipe this distance but on arrival at the National Park treatment facility would then add a significant additional load to the existing plant, which the plant has not been built to cope with, which would incur significant costs for DOC and operational management of the plant for Ruapehu District Council. Additionally, the receiving environment at National Park would not be able to cope with this extra volume of wastewater.

This option has been extensively assessed in terms of disposal outside of the National Park including piping it to the Plant at National Park. Option analysis and consideration of alternatives dates back many years but documentation around this starts in c.1994. Connecting Iwikau Village to the Whakapapa Village wastewater treatment plant stems from these considerations and there was a recommendation to pipe it outside of the Park due to environmental and cultural reasons. The cost implications of doing this and the private land owners issues have meant that this option has always been discounted. All options analysis over the years involved extensive consultation with affected parties, stakeholders, Iwi, Ruapehu District Council and the Board.

In addition to the MWH assessment, the following reports include extensive consideration of alternatives over the years which support the decision on the current resource consent application including the development of a constructed wetland:

- Royds Consulting, September 1994 "Whakapapa Sewage Scheme Feasibility Study “and” Iwikau Sewage Scheme Feasibility Study".
- Hackwell K, September 1994. "An Environmental Assessment of Further Options for Sewage Treatment for Iwikau and Whakapapa”.
- Resource Consent Application – Whakapapa Wastewater Treatment Plant, Beca, 1998 – summary and history of consideration of alternatives

7.19 Continued Treatment at Whakapapa but Discharge outside the Park

There are no viable alternative sites currently known to be available outside the Park where treated wastewater could be discharged. This makes the disposal of treated wastewater outside the Park not an option at the present time.

7.20 Treatment Variants

The proposed upgraded treatment system has been developed from a review of several alternative systems and system variants. The comparison and analysis of alternatives is set out in the accompanying Veolia Engineering Report (*Conceptual upgrade options assessment relating to Resource Consent application; Whakapapa WWTP*, Veolia, 2016), attached to this AEE as **Appendix 3.** The proposed system is from the conclusion to this analysis (though noting that in the final design phase for the plant upgrade there may be further iterations on the current notional design of the scheme).

7.21 Continue with Existing Treatment & Disposal System

There are acknowledged problems with the existing treatment and land disposal system. Some of this reflects the age and condition of the plant and pipe network, maintenance of those assets but also, more fundamentally, reflects rising expectations for level of treatment and method of disposal that wastewater plants must now provide. The new challenge for the Whakapapa WWTP may be to bring into the treatment system a more effective means of removing nitrogen from the effluent and to reduce resulting periphyton growth.

The other challenges are to get more control on flows into the plant (through I&I work and flow-buffering) and to establish a more reliable land discharge system. These issues need to be addressed if Whakapapa is to have a plant that complies with modern expectations, as expressed through the One Plan. It is accordingly not an option for DOC to continue with the existing treatment and disposal system in its current condition. DOC is actively gathering information and securing funding in support of the required upgrades.

7.22 Section 107 RMA

Section 107(1) of the RMA requires that a consent authority may not grant a discharge permit if, after reasonable mixing, the discharge gives rise to either:

- *the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:*
- *any conspicuous change in the colour or visual clarity:*
- *any emission of objectionable odour:*
- *the rendering of fresh water unsuitable for consumption by farm animals:*
- *any significant adverse effects on aquatic life.*

That is unless, under 107(2), the consent authority is satisfied:

(a) that exceptional circumstances justify the granting of the permit; or
(b) that the discharge is of a temporary nature; or
(c) that the discharge is associated with necessary maintenance work— and that it is consistent with the purpose of this Act to do so.

The finished effluent from the upgraded wastewater treatment plant will be essentially clear during normal operation and visually indistinguishable from normal stream water after mixing. The Water Quality report concludes that, effects on water clarity or colour are likely to be no more than minor, based on the lack of measurable effects on in-stream Total Suspended Solids (TSS) concentrations. There are at present, and will continue to be, no conspicuous oil or grease films, scums or floats or floatable of suspended materials entering the receiving water. Nor are there, or will there be, any conspicuous changes to the visual colour or clarity of any receiving water or emission of objectionable odour or rendering of water unsuitable for consumption by farm animals downstream.

As regard to effects on aquatic life, the report by Aquanet identifies that in the Northern tributary, there are indications that significant adverse effects on macro invertebrate community health have occurred in 2014 and 2015, but not in 2012 and 2013. The proposed upgrading of the treatment plant will, however, ensure that this adverse effect is of only a temporary nature insofar as the programme of works laid out in this application will progressively, and within the specified timeframes, bring the QMCI in line with One Plan targets by meeting the Environmental Outcomes in the proposed conditions of consent.

Once met, the Environmental Outcomes over time will become standards that must be met for the remaining duration of the permits. It is also noted that significant adverse effects only seem to have occurred in the last two years of monitoring (2014 and 2015), and that no significant effects were measured on previous years (2012 and 2013), which adds to the temporary nature of the effects. On this basis, given the proposed upgrade works, the granting of consent for the proposed discharge would be consistent with and allowed under RMA 107(1).

The existing treatment plant discharge passes four of the five the tests of Section 107(1) of the RMA, as regards objectionable visual and/or odour effects but currently does not pass the test of not giving rise to any significant adverse effect on aquatic life at one site for 2 of the 4 years for which data has been collected.

That is on account of 2014/15 monitoring results indicating a reduction in QMCI (macro invertebrate community index) in the Northern tributary to the Wairere Stream. However, as this will be only a temporary effect, until such time as the treatment plant upgrade programme is completed and QMCI results return to One Plan target levels, the consent authority can be satisfied that the exception under s.107(2)(b) is met.

7.23 Part 2 of the RMA

The analysis under s.104(1) as provided in section 6 (s.104(2)(b)) must be subject to Part 2 of the RMA.

7.24 Section 5 – Sustainable Management

The Whakapapa WWTP services the needs of the Whakapapa Village and Iwikau village for an efficient, effective and sanitary system for treating and disposing of the community’s sewage and wastewater.

The WWTP is a piece of critical infrastructure the operation of which is regionally and nationally significant given the recreation values of this National Park, the numbers that visit from all parts of the country

In providing this service the treatment plant helps to meet the health needs of the community and in so doing enables the people in the community to more generally provide for their social, cultural and economic wellbeing. Without an effective sewerage system, the villages would not be liveable and businesses (the ski field, hotel, restaurants etc.) would not be able to function. This in turn would have significant adverse social and economic effects, locally, regionally and nationally.

A well-designed, well-run wastewater treatment system can allow these needs to be met while safe-guarding the life-supporting capacity of the environment and avoiding, remedying or mitigating adverse effects.

7.25 Section 6 – Matters of National Importance

Of the matters listed in Section 6 of the Act, the clauses of potential relevance to the current application are considered to be s6(a) "*the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development",* s6(b) *"the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development;* s6(c) "*the protection of ... significant habitats of indigenous fauna*" and s6(e) "*the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga*".

7.26 Section 6(A) – Preservation of natural character

s6(a) is considered potentially relevant, should the continued use of the WWTP result in adverse impacts on the natural character of the Northern or Southern Tributary or the Wairere Stream itself. Given that no works are proposed within the bed of any of these waterways, that the discharge will be occurring to a constructed wetland and ultimately to land via an infiltration area, and that improvements in the WWTP will improve water quality outcomes, the proposal is considered to be consistent with s6(a).

7.27 Section 6(b) - Outstanding natural features and landscapes

In respect of s6(b), the Whakapapa Village wastewater treatment plant is located within an area of outstanding natural feature and landscapes as identified under the Ruapehu District Plan and Horizons One Plan. The proposal will see the development and construction of a wetland to aid in the treatment of wastewater discharged from the Whakapapa WWTP. The constructed wetland will be developed with indigenous plants sourced from seed or cuttings collected in the Park.

The range of wetland species to be used for the constructed wetland has been assessed by Dr Nick Singers. It is identified that constructed wetland design should "*consider the landscape and attempt to be in-keeping with natural wetlands locally. To achieve this amenity planting of large wetland plants such as harakeke and toetoe around the perimeter of any constructed wetland should be undertaken*".

The constructed wetland will replace some exotic vegetation which has been able to establish in this modified environment and accordingly it is considered long term that the proposed constructed wetland will provide more connectivity with the natural landscape in this area than currently exists. Overall the proposal is considered to be consistent with s6(b) of the RMA.

7.28 Section 6(c) Protection of ... significant habitats of indigenous fauna

The Wairere Stream, as part of the larger Whakapapanui catchment, is a habitat for Whio / Blue Duck. A consideration for the AEE, and in respect of RMA Section 6(c), is therefore any effects from the discharge on Whio and the habitat of the aquatic insects that are their food-source.

The wastewater treatment plant discharge has, to date, resulted in enhanced periphyton growth in the un-named tributary to the Wairere Stream that is the primary receiving water – although not to an extent that is considered significant as measured against One Plan targets. There is also evidence of compositional change in the downstream macro invertebrate community but uncertainty as to the significance of this change; a QMCI decrease in one of the two branches to the un-named tributary (the northern branch) in two of the four years of monitoring and no significant reduction or increase in QMCI in the other (southern) branch[10]. There is no significant effect in the Wairere Stream itself, which is the primary Whio habitat. It is recognised that the tributaries provide limited habitat for the Whio. Regardless, the proposal will improve treatment outcomes and, as a result, in-stream values.

7.29 Section 6(e) - The relationship of Māori and their culture and traditions with their ancestral and, water, sites, waahi tapu, and other taonga

In respect of 6(e), there is an acknowledged relationship of local Iwi and hapū to waterways in the area. Dialogue with the relevant Iwi groups is on-going. Iwi personnel have also been actively involved in the recent Whio survey and wetland seed collection. Support for the proposal from Ngāti Hikairo has been obtained and is appended to this application for consent (**Appendix 12**). DOC has also consulted with Uenuku and Ngāti Rangi around Mount Ruapehu who have an area of interest in the Whakapapa WWTP. These discussions are ongoing and will continue in relation to this consent application and all other matters between DOC and Iwi.

7.30 Section 7 – Other Matters

Section 7 of the RMA sets out the matters that particular regard must be had to in managing the use, development and protection of natural and physical resources. Most aspects of section 7 of the RMA are relevant to the proposal and are discussed in turn below.

(a) Kaitiakitanga: DOC has consulted with Ngāti Hikairo and has sought their support for the proposed consenting and plant upgrade. Refer to the 'Consultation' section of this AEE for further details and **Appendix 12** for a letter of support.

[10] Refer to: Aquanet Consulting (8 March 2016) *Whakapapa Village WWTP: Summary of freshwater quality and ecological monitoring to January 2016.*

(aa) The ethic of stewardship: DOC recognise a stewardship role in providing a sanitary system for the treatment and disposal of sewage and wastewater from Whakapapa Village and Iwikau Village in an environmentally sustainable manner.

(b) The efficient use and development of natural and physical resources: The existing treatment plant is a physical resource. It is efficient to continue to utilise this existing infrastructural investment.

(ba) The efficiency of the end use of energy: not applicable to this application.

(c) The maintenance and enhancement of amenity values: Care will be taken to ensure that the proposed upgraded plant, including the constructed wetland, will be blend into the Tongariro National Park landscape. A landscape plan has been prepared to also better screen the actual wastewater plant from specific view points from within the village and on local tracks.

There are no known problems of odour arising from the WWTP oxidation pond or discharge field. DOC have received feedback from directly adjacent neighbours including the Skotel and Chateau Tongariro and other stakeholders and residents within the village who have never experienced any odour issues from the WWTP. The continued operation of the plant assists allowing persons to continue to continue to enjoy the wider amenity values of the National Park and Whakapapa ski fields.

(d) Intrinsic value of ecosystems*:* Proposed improvements to the quality of effluent from the Whakapapa Village wastewater treatment plant will benefit the intrinsic value of the aquatic ecosystem.

(f) Maintenance and enhancement of the quality of the environment: The proposed treatment upgrade will enhance the quality of the environment as identified in section 6 above.

(g) Any finite characteristics of natural and physical resources: not applicable to this application.

(h) The protection of the habitat of trout and salmon: Neither the Wairere nor its tributaries are significant trout habitat (with game-sized fish being entirely absent). In any case the proposed treatment upgrade will improve overall water quality, and consequently invertebrate habitat, in the tributaries to the Wairere Stream.

(i) The effects of climate change: It is noted that the effects of climate change may influence the flow regime of the Wairere Stream by more extreme weather events (either dry or wet lasting longer) and a change in temperature may change the number of snow events. The proposed improvements (including such measures as I&I) will to some extent increase the WWTP resilience to the effects of climate change.

(j) The benefits to be derived from the use and development of renewable energy: not applicable to this application.

7.31 Section 8 – Treaty of Waitangi

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi). DOC's relationships with the Crown's Treaty partners are central to its work and are guided by the following:

DOC will achieve healthy partnerships with Māori and meet the Crown's obligations to Māori under section 4 of the Conservation Act 1987 by applying Treaty principles practically in its work.

For practical purposes, the Treaty principles most relevant to DOC's work include:

Partnership - mutual good faith and reasonableness

The Crown and Māori must act towards each other reasonably and in good faith. These mutual duties of reasonableness and good faith describe the nature of the relationship between the Crown and Māori. They are the core of what has been described as the Treaty partnership. This principle is about how the Crown should behave to Māori and Māori to the Crown.

Informed Decision-Making

Both the Crown and Māori need to be well informed of the other's interests and views. When exercising the right to govern, Crown decision makers need to be fully informed. For Māori, full information needs to be provided in order to contribute to the decision-making process. This is connected closely to the principles of good faith and active protection. Consultation is a means to achieve informed decision-making.

Active Protection

The Crown must actively protect Māori interests retained under the Treaty as part of the promises made in the Treaty for the right to govern. This includes the promise to protect tino rangatiratanga and taonga. Active protection requires informed decision-making and judgement as to what is reasonable in the circumstances.

Redress and Reconciliation

The Treaty relationship should include processes to address differences of view between the Crown and Māori. The Crown must preserve capacity to provide redress for proven grievances from not upholding the promises made in the Treaty. Māori and the Crown should demonstrate reconciliation as grievances are addressed.

DOC has an ongoing relationship with local Iwi and this is supported by the establishment of the Project Advisory Group specific for this project. The Project Advisory Group has been involved in the planning, commissioning of reports and reviews which were undertaken in the development of this AEE, as well as whio monitoring, wetland seed collection, constructed wetland visual inspection and site selection. The principles of the Treaty of Waitangi support this consultation process, working collaboratively together for this consent process. See Section 7, Cultural Values for further information.

8 CONSULTATION

Extensive consultation regarding wastewater collection, treatment and disposal within the Tongariro National Park has occurred over many years with the stakeholders, the community, Iwi groups and users of the wider Park.

A Consultation Plan was prepared in August 2015 in support of the earlier resource consent application, to document how and when consultation could occur. Given the process and timeframes to date, not all potentially affected parties have been directly consulted prior to the lodging of this application. It is DOC's intention to consult further on this application for consent following lodgement and notification leading up to the actual hearing.

Affected parties who have been consulted and with whom it is intended to consult further include:

- Ngāti Hikairo
- Uenuku Charitable Trust
- Ngāti Rangi
- Whakapapa/Iwikau Stakeholders (RAL Iwikau, Kah Corporation – Chateau/Tavern/Ferguson Cafe, Skotel, Iwikau clubs/lodges, Whakapapa Holiday Park and Store, Whakapapa Village clubs/lodges, GNS Science, NZ Fire Service)
- Ruapehu District Council
- Horizon's Regional Council
- Fish and Game NZ (Auckland/Waikato Region)
- Genesis Energy NZ Limited (Tokaanu)
- CNI Blue Duck Trust
- Hillary Outdoors Education Centre (OPC)
- Forest and Bird
- Any other parties that come forward as part of the consenting process

8.1 Tangata Whenua

Tongariro National Park is a dual World heritage site, recognised for its natural and cultural values. The Park, as it relates to Whakapapa and Iwikau Village, is within the rohe of Ngāti Tūwharetoa who hold mana whenua and kaitiakitanga over the central plateau. The rohe boundary was confirmed by the Native Land Court in 1886. Ngāti Hikairo is a hapū of Ngāti Tūwharetoa. In addition, there are other Iwi around the Tongariro National Park, including Ngāti Rangi and Uenuku, who may have overlapping interests in the Park.

Given the recognised mana whenua status, DOC have consulted and worked with Ngāti Hikairo in the preparation of the current resource consent application and associated process. Consultation has also been undertaken and will continue with Ngāti Rangi and the Uenuku Charitable Trust as having adjoining interests in the land and rohe of the Tongariro National Park and surrounds.

8.2 Whakapapa / Iwikau Stakeholders

DOC holds regular quarterly meetings with 'the Stakeholders', as residents and business owners within the Whakapapa and Iwikau Villages who contribute financially, through a community services levy, to a Department of Conservation 'local authority' budget for the maintenance and operation of community services at Iwikau and Whakapapa Villages, including sewage treatment, water supply, street lighting, rubbish collection, fire-fighting, roading (including snow clearing) and the Eruption Detection System.

Meetings specific to this resource consent process are documented as follows:

- *10 July 2014* – a meeting to outline timeframes and options analysis between the Stakeholders, DOC and consultants.
- *8 October 2014* – presentations for engineering design, constructed wetland concept, measuring of flows, the resource consent process, community services levy and the 2004 MOA.
- *3 March 2015* – a further meeting documenting the project plan and financial commitment from DOC, preparation of an Asset Management Plan (AMP) through Veolia, the resource consent process to date, cost recovery as it relates to the consent process, and storm water reduction 'quick wins'.
- *19 June 2015* – a meeting around resource consent updates, the new contract with Ruapehu District Council to manage the 3 waters for Whakapapa, further development of the AMP, and business case planning to secure future funding.
- *5 November 2015* – a meeting to outline resource consent process and timeline, Gap Analysis in terms of data, monitoring sites, Ngāti Hikairo Project Advisory Group, meeting with Horizons RC, Contract with RDC operational improvements, AMP timeframes, and high level discussion around a Long Term Community Plan.
- *15 April 2016* – a meeting with stakeholders, including Ngāti Hikairo representatives, to provide an update on the Asset Management Plan and resource consent progress to date. Uenuku sent their apologies for being unable to attend this meeting due to conflicts with treaty discussions and felt they were well informed of the current position.
- *21 October 2016* – meeting with the stakeholders to provide an update on the resource consent and discuss the AMP for the 3 waters particularly around the project works and cost to each stakeholder.

DOC's approach has been to reflect its commitment to ensuring that community services infrastructure within Whakapapa and Iwikau Villages is:

- Fit for purpose;
- Affordable to all the contributors;
- Meets the legal, statutory and environmental standards required by DOC and other local authorities;
- Ensures protection of the cultural values of the Maunga;
- Has support from Tangata Whenua, business and the broader community;
- Meets and at times exceeds the visitor expectations of the gateway to Tongariro National Park as an iconic site;
- Is future proofed and allows options for growth of visitors to both the villages and park as a whole;

- Is consistent with the Community Services provisions and policies within the Tongariro National Park Management Plan;
- Meets the responsibilities and obligations under the Tongariro National Park Management Plan and the World Heritage Guidelines for the management of the site**.**

Overall the feedback to date is that the resource consent process is generally supported by the stakeholders with an emphasis on making good decisions, with the right team, and being cost effective and affordable for all given the limited number of contributors and uncertainty around lease periods. (See **Appendix 12** for letters of support)

One of the main stakeholders in this group is RAL (Ruapehu Alpine Lifts Ltd). RAL advise that they support the consenting of the Whakapapa Wastewater Treatment Plant. As a stakeholder and a community service user within the Iwikau and Whakapapa Village, DOC has regularly held workshops and meetings in support of the resource consent process including for the proposed lodgement of the updated resource consent application. In addition, at the request of the stakeholders, DOC has had the original consent process peer reviewed through Ruapehu District Council's Engineering Consultant, Veolia who have recommended additional improvements to plant treatment and process. RAL support this review, recommendations and the future granting of resource consent.

The Ruapehu Mountain Club Association (RMCA) president has attended all the stakeholder meetings and collectively they have written a letter of support for the consent application for the Whakapapa WWTP and this is contained in **Appendix 12**.

Letters of support have also been provided from the Skotel and the Chateau Tongariro.

8.3 Ngāti Hikairo and Project Advisory Group

Working collaboratively, DOC and Ngāti Hikairo have established a Project Advisory Group specifically to support the consultation process as it relates to the current application for the Whakapapa Village wastewater treatment plant. The Advisory Group has evolved out of a wider co-management strategy that will continue to develop in anticipation of future Treaty Settlements as this relates to Tongariro National Park.

The task of the Project Advisory Group is to support the consent renewal process and work to gain a better understanding of the effects of the activity on cultural values and to determine whether the treatment plant reconsenting is within the boundaries of cultural acceptance. The collective benefits of the Advisory Group include:

- A better understanding of the project/resource consent: what has gone before and how it is proposed to manage effects on the environment in partnership into the future.
- For DOC to better understand the cultural values and environmental expectations of Ngāti Hikairo / Ngāti Tūwharetoa (the parties with recognised treaty settlement status).
- To reach agreement around avoiding, remedying and/or mitigating any potential adverse effects as a result of the re-consenting of the treatment plant.

- To have open discussion around the consenting process, operational requirements and functions of the plant, and develop good communication and ongoing relationships.
- Operational improvements at the plant, capital investment in the asset and a staged plan for those improvements.

With this approach a letter was prepared by Te Rūnanganui o Ngāti Hikairo ki Tongariro on 30th October 2015 (See **Appendix 12**) and sent to DOC and Horizons Regional Council supporting in principle an engagement with DOC and the establishment of the Project Advisory Group to assist in developing clear and transparent guidelines to mitigate any potential impacts on customary values and the environment.

Ngāti Hikairo have attended the project meetings and provided feedback and input to the resource consent process. In their letter of approval dated 4 March 2016 the trustees have advised:

- That they are support of the collaborative approach in seeking resource consent approval, including options analysis, improvements and upgrades to the WWTP to meet the statutory requirements required to continue to operate the plant.
- The primary motivation for Ngāti Hikairo is to ensure that the best possible long term solution is sought in the best interest of the Maunga and nga awa. Therefore, Ngāti Hikairo are directed to be more "solution-focussed" rather than "process driven" to achieve an outcome that benefits the "mana o nga Maunga".
- Te Rūnanganui o Ngāti Hikairo ki Tongariro Trust have confidence with the project team that has been brought together and are reliant on their technical advice and planning in their given fields to achieve the best possible outcome.
- In accordance with the Resource Management Act 1991, the trustees support the proposal and give their written approval to the resource consent application submitted by DOC for the Whakapapa Wastewater Treatment Plant and are supportive of an adaptive approach proposed by DOC as part of resource consent approval given by Horizons Regional Council going forward.

The work of Project Advisory Group has included the review of information, a site visit to the Whakapapa WWTP, and regular meetings. This includes, specifically:

- A review of background information in regard to the original resource consent and discussion around the proposed resource consent.
- Meetings to establish a framework for the Project Advisory Group and reporting around this.
- Support in principle of the project and the team for the resource consent process including viewpoints and values of Ngāti Hikairo.
- A review of the Ngāti Tūwharetoa - Environmental Iwi Management Plan 2003, with particular reference to Te Waipuna Ariki – Water goals, issues, policies and methods.
- Onsite meeting on 11 September 2015 to discuss the resource consent process, data collection and analysis of options.

- Ongoing attendance and invitation to attend project meetings, stakeholder meetings, meeting with Council, and on-going technical meetings in support of the WWTP resource consent process.
- Overall support of the resource consent process as confirmed by Ngāti Hikairo in the letter dated 4 March 2016.

8.4 Uenuku Charitable Trust

Uenuku Charitable Trust (Uenuku) is a tribal entity established in early 2014 at the direction of the Iwi. A hui-ā-iwi on 1 February 2014 called for "a fresh start" in favor of establishing a charitable trust to provide a collective voice for Uenuku hapū, marae, claimants and uri as part of the Whanganui District Collective (Central).

The website for the Uenuku Charitable Trust states its main purpose "is to protect Uenuku identity and assets, to build a stronger economic, social and cultural base for the people of Uenuku, and to support Iwi aspirations in all spheres of life."

DOC has an ongoing relationship with Uenuku who have an 'area of interest' in the Tongariro National Park as it relates to Whakapapa Village and the wastewater treatment plant. Through the consultation process it is understood that the boundary for mana whenua between Ngāti Tūwharetoa and Uenuku is at the Whakapapaiti and Mangahuia Stream.

As the treatment plant site is within the area of interest for Uenuku DOC have met Aiden Gilbert (Chairperson for Uenuku) who has indicated that the stance for the majority of Iwi is that the direct discharge of sewage to surface water is culturally unacceptable and that the protection of the mauri of waterways is important for the present and future generation to ensure that the rivers and streams that flow from the headwaters of the Maunga are clean and healthy from the mountains to the sea. In the simplest form the position will always be that untreated wastewater should not directly enter streams and waterways, and this is the same for Uenuku.

DOC continues to provide email updates on the resource consent application and continues to consult with Uenuku on the project and resource consent application as the project moves forward. Including the development of the Asset Management Plan which is integral to the infrastructural improvements.

8.5 Ngāti Rangi

Ngāti Rangi are the people of the land with mana whenua around the mountain as it relates to the Whanganui area and Ohakune on the southern side of Mount Ruapehu. They also have an interest in all matters, including resource consent approval processes under the Resource Management, as relates to Tongariro National Park.

Ngāti Rangi prepared a Taiao (Environmental) Management Plan in 2014. The stated purpose of the Plan is to "... provide clarity and structure to the Ngāti Rangi approach to environmental management. Ultimately it provides a framework by which Ngāti Rangi can actively fulfil our role as tangata tiaki."

The key purpose of the document is:

> *"first and foremost for our people, a living document to aid in addressing the issues they have expressed. And secondly, for the managers of the environment to understand further our relationship with the taiao, what we deem to be culturally inappropriate activities, and those activities and actions that enhance and benefit our taiao."*

DOC has engaged with Ngāti Rangi regarding the resource consent renewal process for the Whakapapa Village wastewater treatment plant since 2014. This process, along with dealing with other environmental and business matters, is on-going

8.6 Fish & Game New Zealand

DOC contacted Fish and Game in August 2015 and advised that the resource consent for discharge at the Whakapapa wastewater treatment plant was in the process of being renewed and that once a draft resource consent application had been prepared a copy would be forwarded to discuss further.

In February 2016, DOC sent an email outlining what the process is and the next steps forward in terms of consultation as an affected party. Fish and Game replied via email that the Whakapapa River is one of the region's greatest treasures and they looked forward to working with DOC on the resource consent. A further phone conversation explained that the current discharge is to land, overland where it may at times be to tributary of the Wairere Stream, and that future operational improvements and further mitigation through the use of constructed wetland would improve on the current situation.

A draft copy of the resource consent was sent electronically on 14 March 2016 to continue these discussions around water quality with Fish & Game. Discussions with Fish and Game will continue throughout the consent process.

8.7 Genesis Energy

DOC contacted the Environmental and Hydrology Team at Genesis Energy regarding the type of information they collected on the Whakapapanui Stream and in terms of the actual resource consent application. Initial informal discussion was that Genesis Energy was unlikely to have an interest in the resource consent renewal of the WWTP.

A draft copy of the resource consent was sent electronically on 14 March 2016 to continue these discussions around water quality.

8.8 Ruapehu District Council

The Ruapehu District Council (RDC), while providing the contract for facilities management of the Whakapapa and Iwikau Villages, is also considered to be an affected party in terms of Section 95 of the RMA. Given this relationship, RDC have been kept informed on the resource consent process and have provided a letter of support from the Chief Executive, in principle, (dated 8 March 2016) for the renewal of the resource consent application.

RDC acknowledges that "Tongariro National Park is a cornerstone of tourism in the Ruapehu District, attracting almost one million visitors annually. Tourists visit some of its biggest attractions including two major ski fields, Whakapapa and Turoa located on the slopes of Mount Ruapehu and one of New Zealand's Great Walks – the northern circuit, and the Tongariro Alpine Crossing. Whakapapa Village provides support to this tourism industry and RDC is committed to working with DOC to ensure safe, reliable wastewater collection networks and treatment system that is sustainable and effective for the Ruapehu District. Effective and efficient wastewater collection and disposal is essential to protect the environment and to maintain public health."

Specifically, RDC has requested that the following statement be included with the Whakapapa WWTP resource consent application:

1. *Ruapehu District Council has been involved in discussion surrounding the application for the renewal of the Whakapapa wastewater resource application since July 2015. There is ongoing collaborative effort between RDC and DOC to avoid, remedy, or mitigate cultural and environmental effects associated with the renewal of the resource consent noted in the letter and operation of the plant.*
2. *We have not had the opportunity to review the final application documentation at the present time however we have been presented with the key elements of the application.*
3. *We acknowledge that a term of consent of 30 years is being sought.*
4. *We have been advised that we will be provided with a full copy of the final application when it is lodged to enable us to complete a full review.*
5. *On the basis of the above points, we wish to advise Horizons Regional Council that we support, in principle, the renewal of the Whakapapa wastewater resource consent by DOC, subject to viewing the final consent application documentation*. (See **Appendix 12**).

8.9 CNI Blue Duck Trust

DOC met with the CNI Blue Duck Trust on Friday 11 March 2016 outlining the history of the wastewater treatment plant and the proposed consenting process and assessment of environmental effects.

The Whio survey report and memo from the DOC ecologist was provided to the members of the trust for further reading and the ongoing process for being involved in the resource consent application process was outlined. The Trust has stated that they are interested in the consenting process.

A copy of the draft application was provided to the Trust on 31 March 2016 for their feedback and ongoing discussion. Consultation with the CNI Blue Duck Trust will continue throughout the consent process.

9 CONCLUSIONS

DOC has undertaken a comprehensive technical review of the WWPT, its operations and effects. Key findings include:

- Historically high infiltration and inflow ('I&I) of stormwater and groundwater into the WWTP network;
- No effective flow buffering;
- The inability of the existing plant to cope with such large hydraulic loads;
- Inflows of snow melt water with the I&I suppressing microbiological process activity in the plant due to the cooler temperatures.
- Comparatively high ammonia content in wastewater entering the WWTP;
- A severely clogged and ineffective dripper irrigation system;
- An adverse change in the macroinvertebrate community in an un-named tributary to the Wairere Stream ('Northern Tributary') downstream of the WWTP discharge; and
- The Southern Tributary and Wairere Stream itself do not show significant adverse effects.

In response to the matters identified in a range of comprehensive engineering and environmental reports, and through consultation with Ngāti Hikairo, Uenuku, Tongariro National Park stakeholders and other parties, replacement consents are being sought based on the following approach to managing the environmental effects of the ongoing discharge of treated effluent from the WWTP:

a. Approximately 1.1 hectares of constructed wetland area will be developed as a core component of the treatment process. This places a high degree of reliance on natural treatment processes, in response to direction provided through consultation with Ngāti Hikairo and Uenuku, and in recognition of the surrounding environment and its significance.

b. A series of comprehensive improvements to the WWTP and the underground pipe network are proposed to improve treatment performance, noting that many of these improvements have already been implemented in the period following the June 2016 application.

c. A staged approach to implementing future engineering improvements at the WWTP and to the development of the constructed wetland is proposed to allow sufficient time for detailed design and commissioning of works.

d. Effluent quality standards are proposed such that effluent leaving the WWTP and entering the constructed wetland will be managed to a high degree, and to a known and predictable quality.

e. Environmental Outcomes are proposed for the Northern and Southern tributaries which establish an adaptive management approach, to respond to the uncertainties associated with developing a treatment system dominated by natural processes, the difficulties associated with predicting in-stream ecological responses to changes in the wastewater treatment process, and to account for some current data limitations.

f. Environmental standards are proposed for the Wairere Stream, to provide certainty that effects beyond the immediate vicinity of the WWTP are carefully managed.

This is a practical and responsible strategy. It acknowledges that substantial improvements are required, and locks these in as mandatory, together with the development of an extensive constructed wetland to provide natural treatment processes that are consistent with the location and surrounding landscape. It also sets a clear requirement for effluent quality and environmental standards in the Wairere Stream, and a clear target for treatment performance by defining Environmental Outcomes for the unnamed northern and southern tributaries. The environmental standards and Environmental Outcomes are stringent, in several cases more stringent than the applicable One Plan targets, and reflect the high conservation and cultural values that exist in the area. The approach also recognises that there are many variables, and that other works may be needed after the mandatory first stage in order to achieve satisfactory compliance.

The adaptive Stage 2, while not anticipated to be necessary, is provided for to account for any uncertainty in future performance. It is also provided to recognise that while stringent environmental standards need to be achieved, spending on new plant and equipment needs to be approached cautiously and with the benefit of full information on actual plant performance and environment effects at that time. This gives certainty to stakeholders and scheme ratepayers that any future additions and modifications are necessary, effective at addressing any identified issues, and represent a cost-effective spend.

The proposed approach is consistent with the purpose of the Act - namely the protection of natural and physical resources in a way which enables people and communities (the scheme ratepayers and the wider local and regional economy that is built around the sustainability of these operations and businesses) to provide for their social, economic and cultural wellbeing and for their health and safety, while (as a result of the plant improvements and the function of the WWTP as a whole) sustaining the potential of natural resources; safeguarding the life supporting capacity of water; and avoiding, remedying and mitigating adverse effects.

It is acknowledged that the proposed upgrade strategy will take some time to fully implement. Under Policy 5-9 of the One Plan, however, the Council has the ability to grant consent under these conditions. That is by having regard to, among other things:

(d) the need to allow reasonable time to achieve any required improvements to the quality of the discharge;

and

(e) whether the discharge is of a temporary nature or is associated with necessary maintenance or upgrade work and the discharge cannot practicably be avoided.

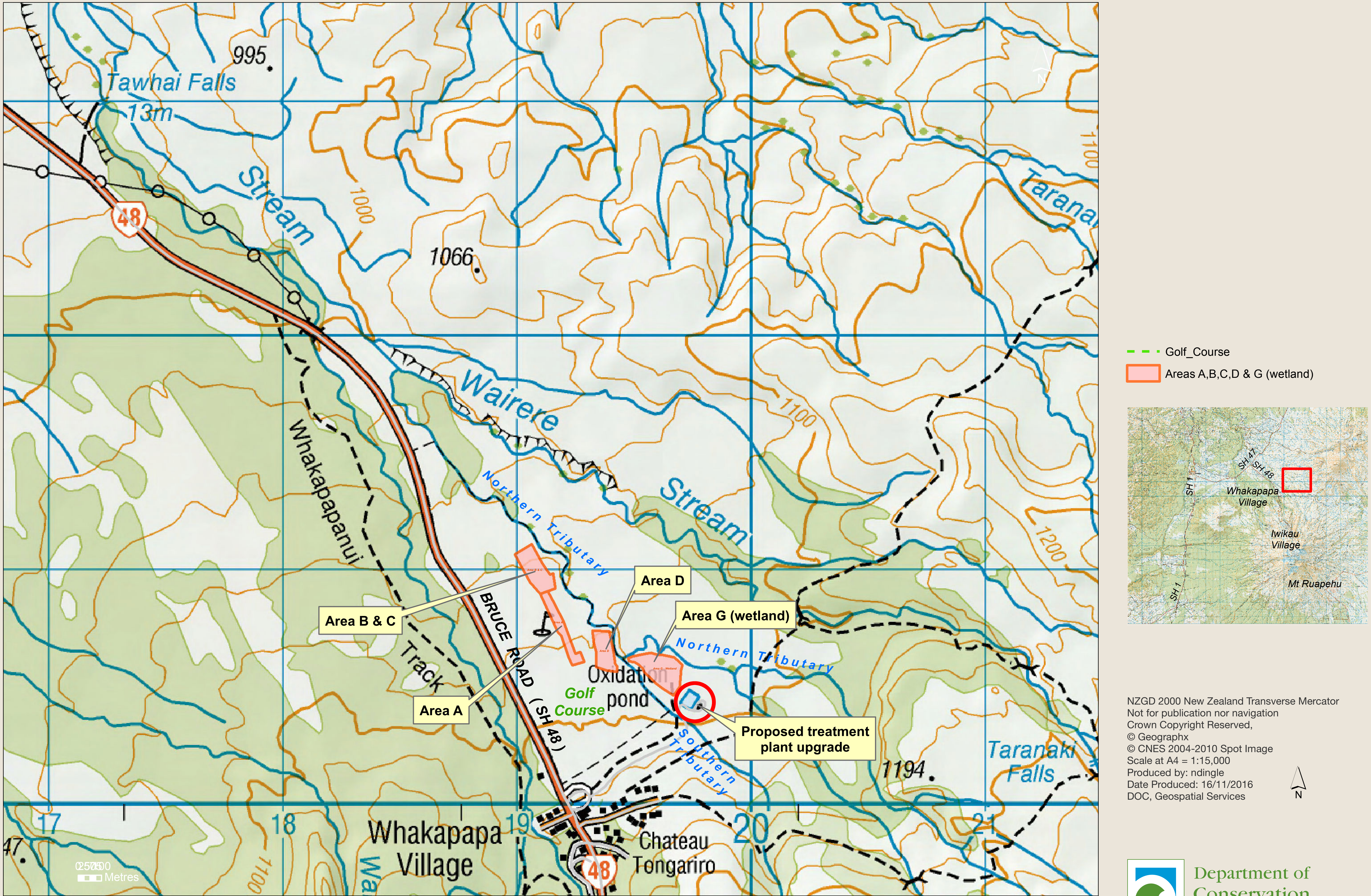
In this case the continuation of the higher discharges, caused by overloading, will be a temporary situation and DOC have already commenced works (2015 and 2017 and ongoing) to address some of these issues.

In order to allow sufficient time for improvements to bed down and the constructed wetland area to become fully established, it will be necessary to allow reasonable time to achieve the required improvements in the operation of the WWTP and quality of the discharge. While this work is underway, the WWTP will be required to continue to provide an essential public health and environmental protection service for Whakapapa and Iwikau Village and ski field. The application seeks to strike a balance between these needs.

Based on the regional significance of the infrastructure, the essential nature of the service, the adverse environmental effects and the approach established through the proposed conditions, the application is considered to be generally consistent with the requirements of the relevant planning documents and Part 2 of the RMA.

APPENDIX 1

TOPOGRAPHICAL PLANS AND CURRENT CONSENT PERMIT



NZGD 2000 New Zealand Transverse Mercator
Not for publication nor navigation

Scale at A4 = 1:15,000
Produced by: ndingle
Date Produced: 16/11/2016
DOC, Geospatial Services

Department of Conservation
Te Papa Atawhai

Whakapapa Waste Water Treatment Plant

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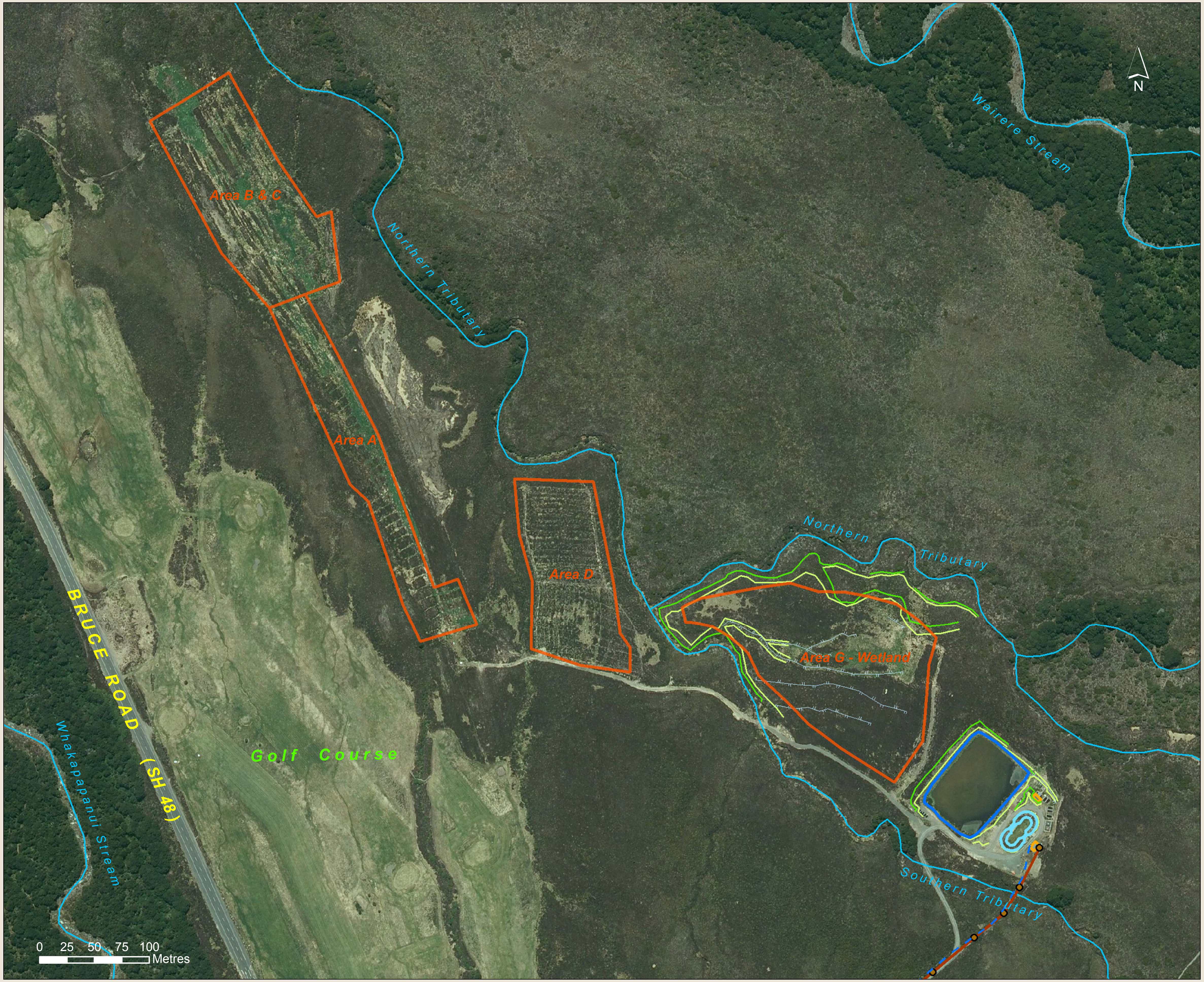
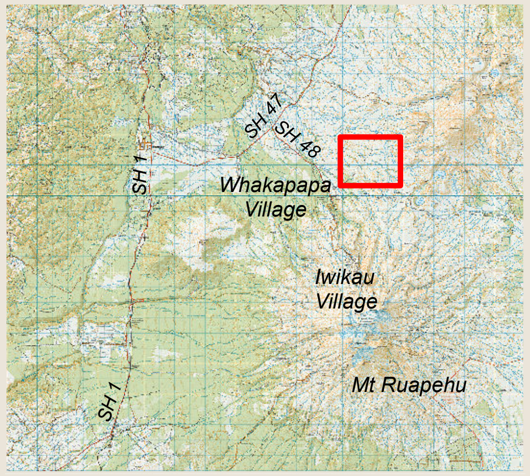
newzealand.govt.nz



- Golf_Course
- Areas A,B,C,D & G (wetland)
- Water Supply line
- Wastewater point inlet
- Wastewater line
- Pasveer ditch
- Tertiary treatment pond
- Ditch
- Bottom_of_the_Bank
- Top_of_the_Bank
- Structures (buildings)



NZGD 2000 New Zealand Transverse Mercator
Not for publication nor navigation

Scale at A4 = 1:3,500
Produced by: ndingle
Date Produced: 16/11/2016
DOC, Geospatial Services

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Whakapapa Waste Water Treatment Plant

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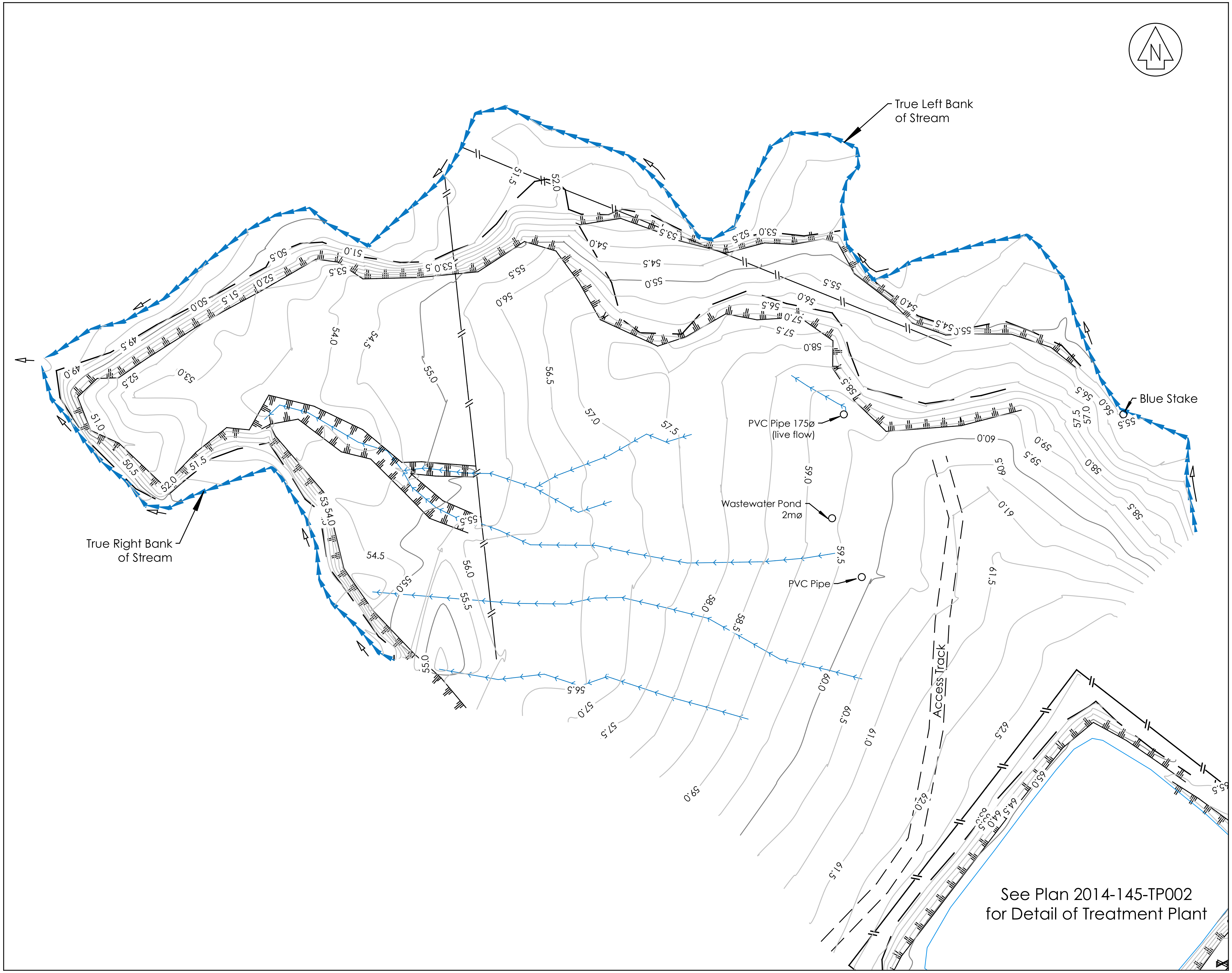


cheal
www.cheal.co.nz

NOTES:

Asbuilt utilities may have other services in close proximity which are not shown for the purposes of this plan.
Please identify existing utility locations and depths with Ruapehu District Council GIS before any field investigation or construction.

Underground services shown are indicative only.
It is the contractors responsibility to identify existing utility locations and depths prior to construction.

Reduced Levels are in terms of: an assumed datum
Origin: ALP 18 SO 434324
R.L: Assumed 100.00.
Contour Interval: 0.5m

LEGEND:

- Top of Bank
- Bottom of Bank
- Fence
- Channel Invert
- Access Track
- Stream Flow
- Stream Bank

Rev	Date	Amendment	By	Chk	App
A	22/07/14	CLIENT ISSUE	MR	DS	AGM

Project Title
DEPARTMENT OF CONSERVATION
WHAKAPAPA VILLAGE
NATIONAL PARK

Drawing Title
WHAKAPAPA WASTE WATER
DISPERSAL FIELD

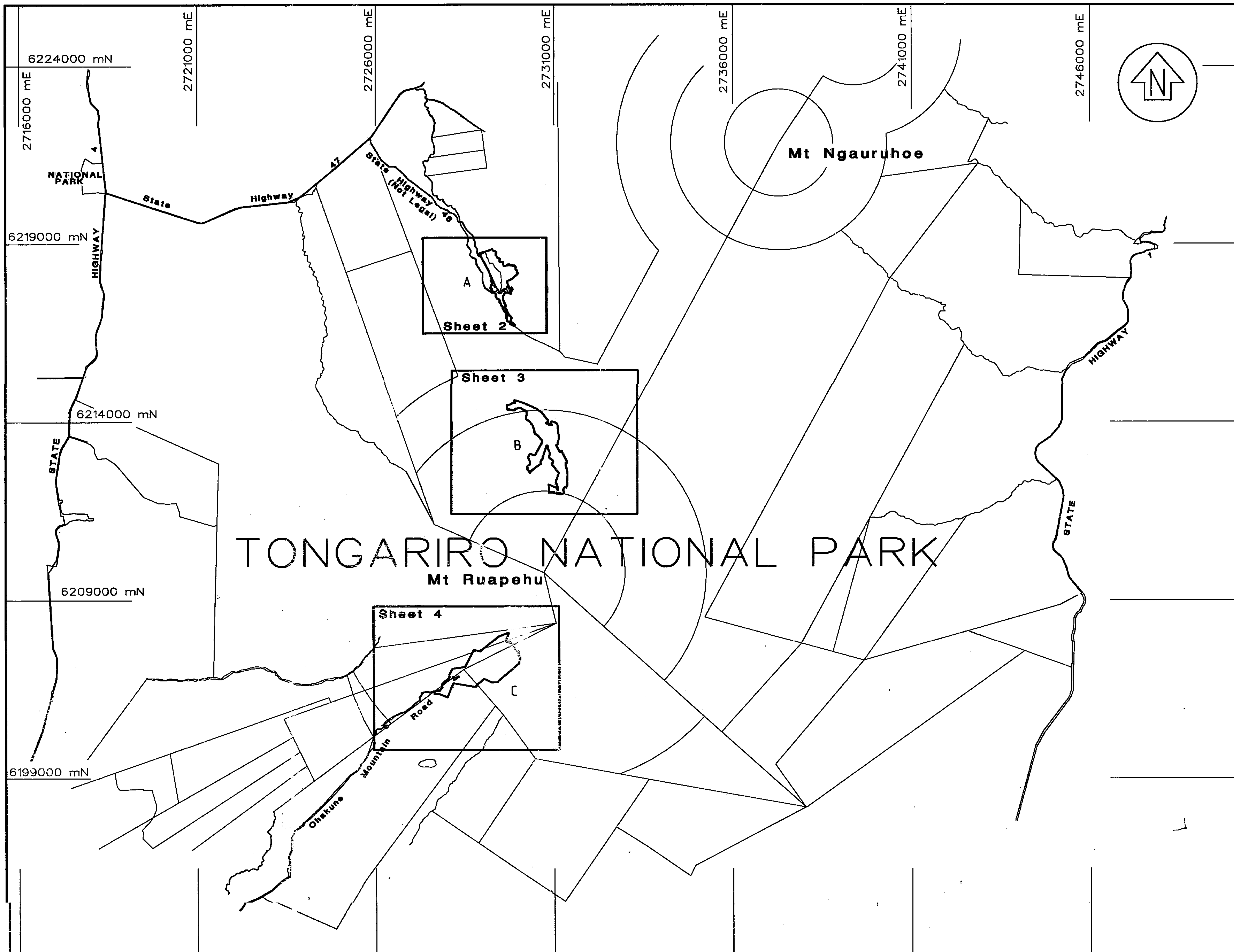
Surveyed	D. SHERRIT	18/07/14	DS
Designed			
Drawn	M. RYDER	22/07/14	MR
Checked	D. SHERRIT	22/07/14	DS
Approved	A. MOSS	22/07/14	AGM

Status: RESOURCE CONSENT

Scale A1 -
A3 1:1000
A3

Drawing Number: 2014-145-TP001
Rev: A

F:\0.Cheal Consultants\2014\2014-145\12D\14_145 DoC Whakapapa Wastewater\DoC Whakapapa Wastewater 22/Jul/2014 01:26PM



Approvals

This plan is to be read in conjunction with orthophoto prints held by the Chief Surveyor as miscellaneous drawing number M 678

Internal Grid in NZMG
Amenity boundary taken from Orthophoto obtained from Aerial Survey 9364 flown 4th July 1984

Total Area

Comprised in

I,
Registered Surveyor and holder of an annual practising certificate (or who may act as a registered surveyor pursuant to section 25 of the Survey Act 1986) hereby certify that this plan has been made from surveys executed by me or under my directions, that both plan and survey are correct and have been made in accordance with the Survey Regulations 1972 or any regulations made in substitution thereof.

Dated at Wellington this .... day ....
of .... 19 .... Signature ....

Field Book *Traverse Book* *p.*
Reference Plans

Examined .... Correct ....

Approved for Gazette Purposes Only

27/11/1995 .... Chief Surveyor

Deposited this.......day of..................19......

.... **District Land Registrar**

File 6475–C2007
Received 27/11/1995
Instructions: 672804

SO 37523

LAND DISTRICT: WELLINGTON
Survey Block & District:
NZMS 261 Sheet S 19 & 20, T 19 & 20

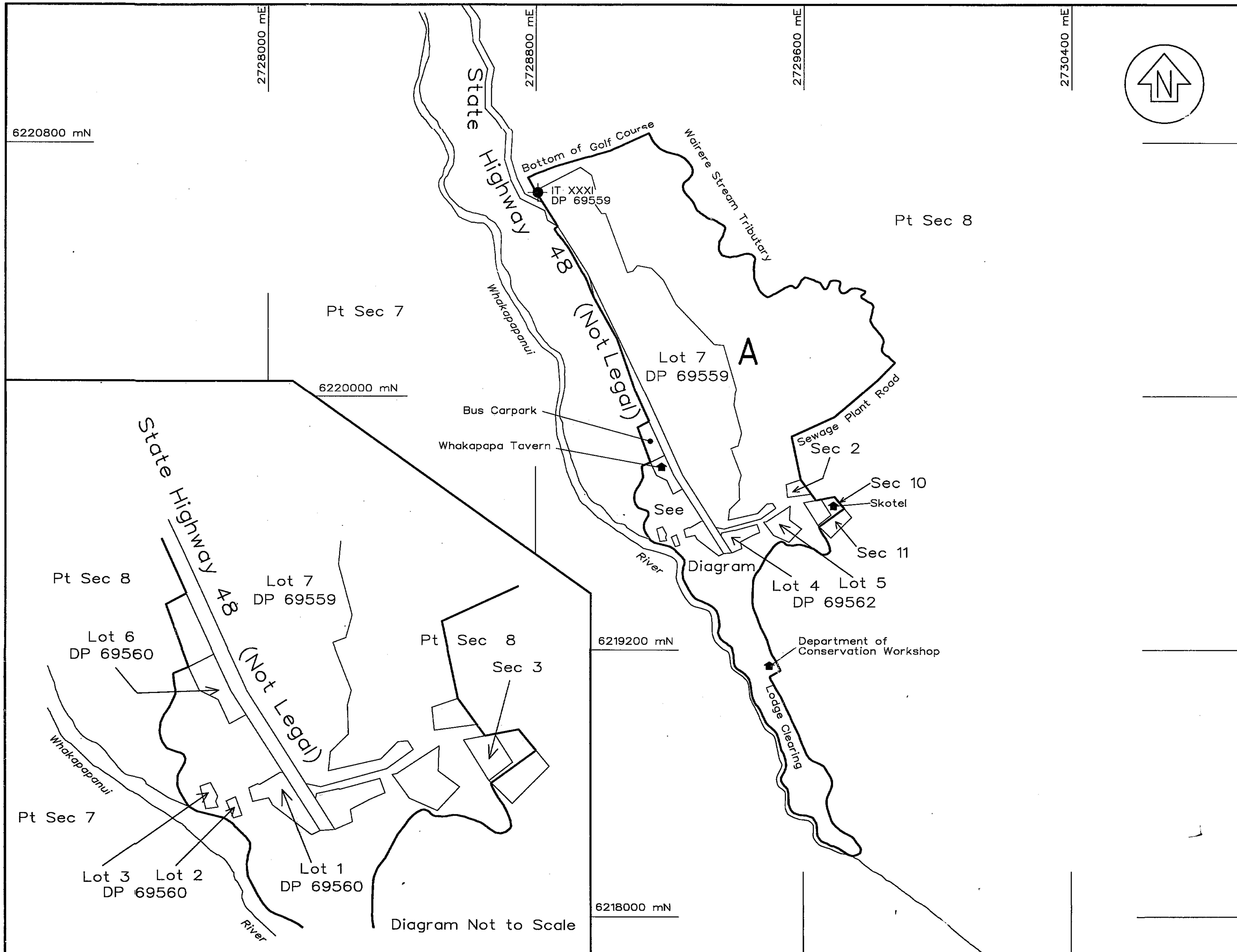
Plan showing Tongariro National Park Amenities

TERRITORIAL AUTHORITY: RUAPEHU DISTRICT
Surveyed by Department of Survey & Land Information
Scale 1 : 80 000 **Date : Sept 1995**

W.A. ROBERTSON, DIRECTOR GENERAL/SURVEYOR GENERAL, DEPARTMENT OF SURVEY AND LAND INFORMATION, NEW ZEALAND

[redacted] **Sheet 1 of 4**

Approved LM 94/09 DOSLI FORM D15



Approvals

Control Point	New Zealand Map Grid Coordinates
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Internal Grid is NZMG
Amenity boundary taken from Orthophoto obtained from Aerial Survey 9364 flown 4th July 1984

Total Area

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~~*Dated at Wellington this .... day .... of .... 19 .... Signature ....*~~

Field Book *Traverse Book* *p.*
Reference Plans

Examined .... *Correct* ....

Approved for Gazette Purposes Only

27/11/1995 .... **Chief Surveyor**

Deposited this.......day of.................19.....

.... **District Land Registrar**

LAND DISTRICT: WELLINGTON
Survey Block & District: III RUAPEHU
NZMS 261 Sheet S 19&20 Record Map S19/8.4 S20/8.1

Plan showing Tongariro National Park Amenity Areas Whakapapa Village

TERRITORIAL AUTHORITY: RUAPEHU DISTRICT
Surveyed by Department of Survey & Land Information
Scale 1 : 8000 **Date : Sept 1995**

File 6475-C2007
Received 27/11/1995
Instructions: 672804

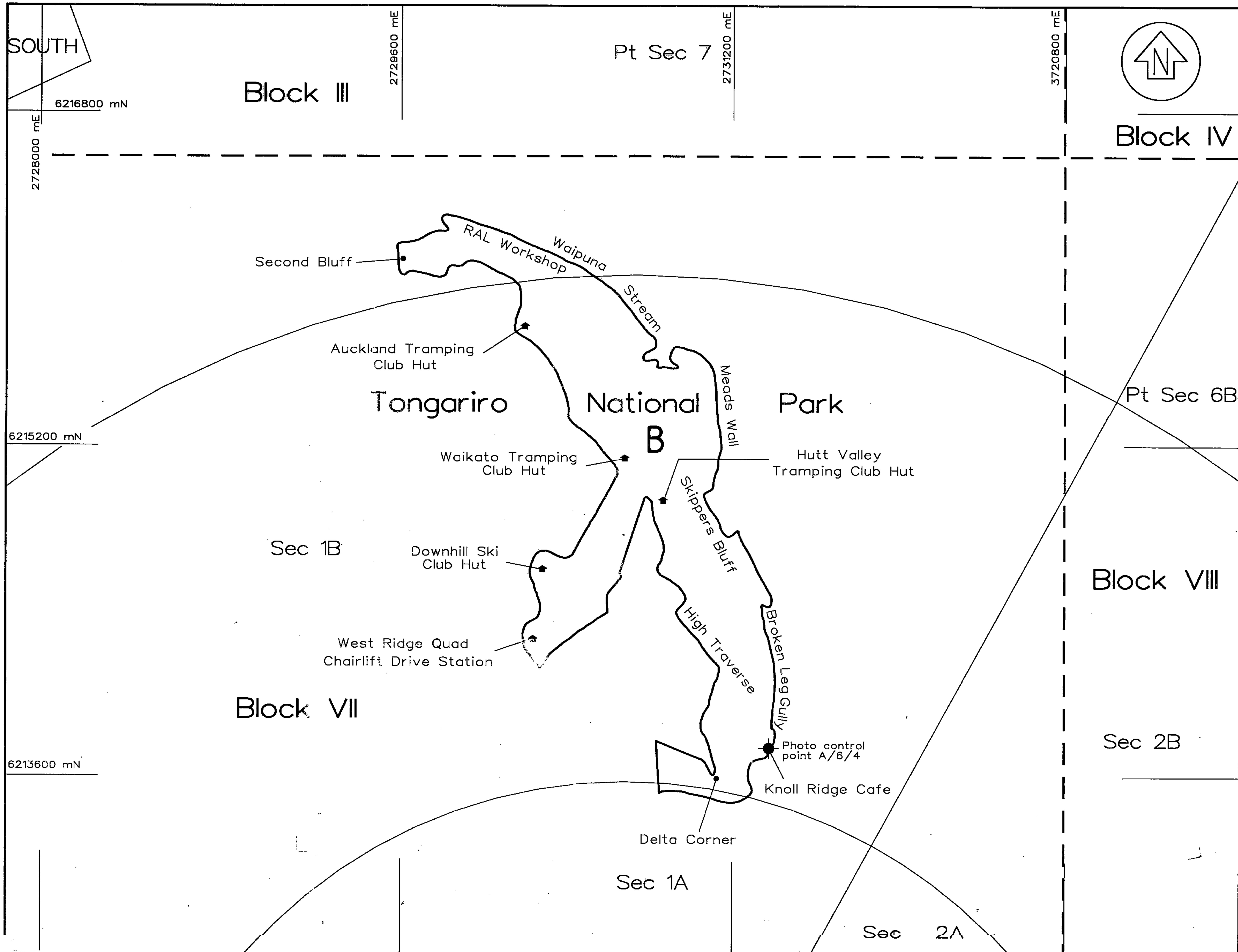
SO 37523

W.A. ROBERTSON, DIRECTOR GENERAL/SURVEYOR GENERAL, DEPARTMENT OF SURVEY AND LAND INFORMATION, NEW ZEALAND

[redacted]

Sheet 2 of 4

Approved LM 94/09 DOSLI FORM D15



Approvals

Control Point	New Zealand Map Grid Coordinates
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Internal Grid is NZMG
Amenity boundary taken from Orthophoto obtained from Aerial Survey 9364 flown 4th July 1984

Total Area

Comprised in

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Dated at Wellington this .... day of .... 19 .... Signature ....

Field Book Traverse Book p.
Reference Plans

Examined .... Correct ....

Approved for Gazette Purposes Only

27/11/1995 .... Chief Surveyor

Deposited this .... day of .... 19 ....

.... District Land Registrar

File 6475–C2007
Received 27/11/1995
Instructions: 672804

SO 37523

LAND DISTRICT: WELLINGTON
Survey Block & District: VII, VIII RUAPEHU
261 Sheet T 20 Record Map T20/1.1

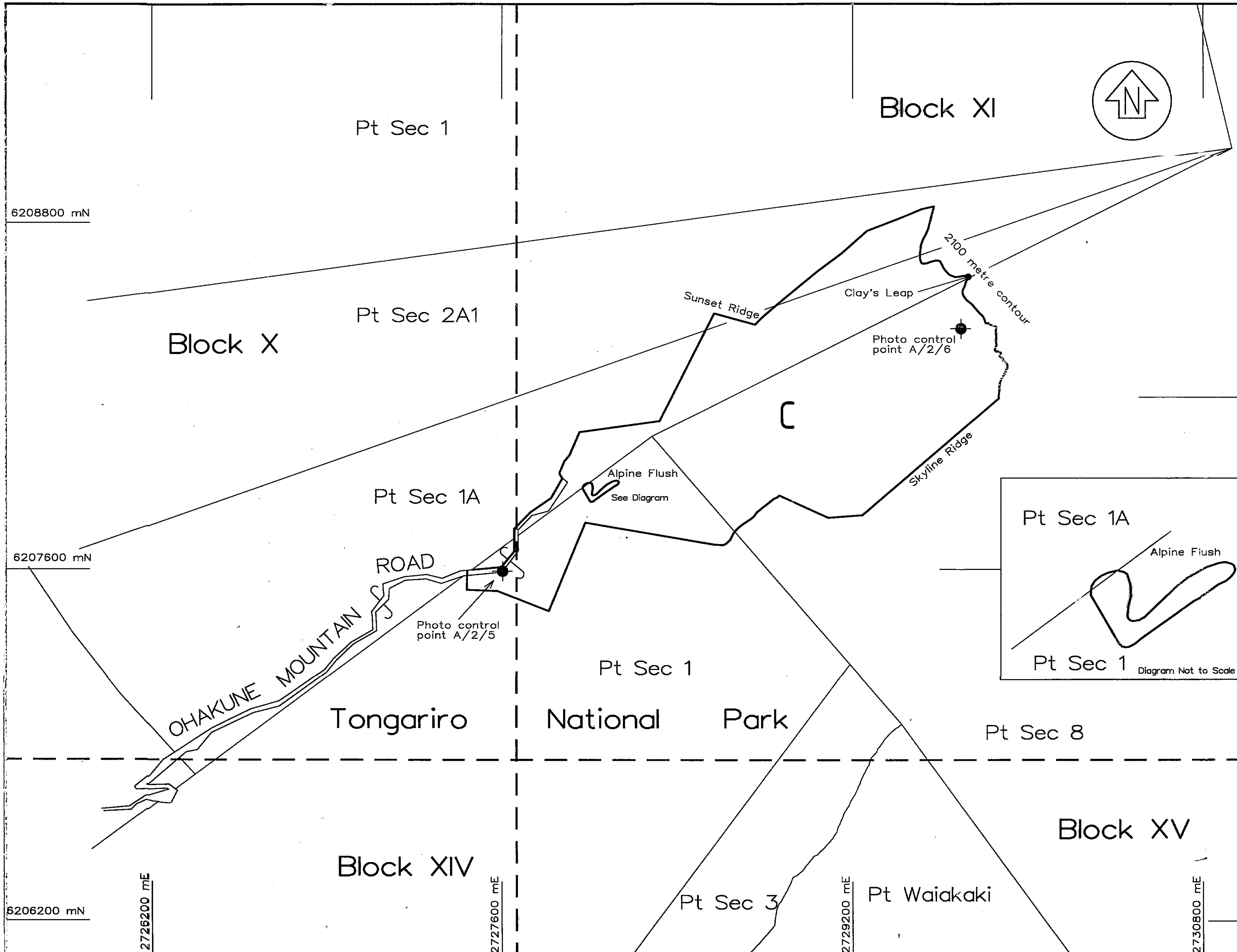
Plan showing Tongariro National Park Amenity Areas Whakapapa Skifield

TERRITORIAL AUTHORITY: RUAPEHU DISTRICT
Surveyed by Department of Survey & Land Information
Scale 1 : 12 500 Date : Sept 1995

W.A. ROBERTSON, DIRECTOR GENERAL/SURVEYOR GENERAL, DEPARTMENT OF SURVEY AND LAND INFORMATION, NEW ZEALAND [redacted]

Sheet 3 of 4

Approved LM 94/09 DOSLI FORM D15



Approvals

Control Point	New Zealand Map Grid Coordinates
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Internal Grid is NZMG
Amenity boundary taken from Orthophoto obtained from Aerial Survey 9364 flown 4th July 1984

Total Area

Comprised in

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Dated at Wellington this .... day of .... 19 .... Signature ....

Field Book *Traverse Book p.*
Reference Plans

Examined .... Correct ....

Approved for Gazette Purposes Only

27/11/1995 .... **Chief Surveyor**

Deposited this.......day of...............19.....

..............................**District Land Registrar**

File 6475-C2007
Received 27/11/1995
Instructions: 672804

SO37523

LAND DISTRICT: WELLINGTON
Survey Block & District: X,XI,XIV,XV RUAPEHU
NZMS 261 Sheet S 20 Record Map S20/8.2

Plan showing Tongariro National Park Amenity Areas - Turoa Skifield

TERRITORIAL AUTHORITY: RUAPEHU DISTRICT
Surveyed by Department of Survey & Land Information
Scale 1 : 12 500 **Date : Sept 1995**

W.A. ROBERTSON, DIRECTOR GENERAL/SURVEYOR GENERAL, DEPARTMENT OF SURVEY AND LAND INFORMATION, NEW ZEALAND

[redacted] **Sheet 4 of 4**

Approved LM 94/09 DOSLI FORM D15

horizons
regional council

Private Bag 11025
Manawatu Mail Centre
Palmerston North 4442
P 06 952 2800
F 06 952 2929
www.horizons.govt.nz

17 January 2012

Department of Conservation
P O Box 71029
MT RUAPHEU 3951

Attention Mere Mokoraka

File ref: 7/5/DOC
MET:MET

Dear Mere

DECISION – RESOURCE CONSENT NO. 105684 – DISCHARGE PERMIT – WHAKAPAPA VILLAGE, STATE HIGHWAY 48, MOUNT REUAPEHU

We are pleased to advise that your resource consent application has been granted. The decision is enclosed and because it is a legal document we urge you to keep it in a safe place.

Please find enclosed for your convenience a plain copy of your consent conditions for ease of reference. Please make sure you read and understand the consent conditions. As a resource consent holder you are responsible for complying with these conditions. Failure to do so will result in enforcement action.

Rights of Objection
Under to section 357A of the Resource Management 1991 (RMA), the applicant has the right to object to the decision made, including conditions. Any such objection must be made in writing to Horizons Regional Council, outlining the reasons for the objection and must be made within 15 working days from the decision.

Compliance Monitoring
In accordance with Regional Council policy, staff from our Environmental Protection Team will monitor your resource consent, to ensure that you are complying with the consent conditions. The Environmental Protection Team can be contacted during normal office hours on freephone 0508 800 800.

On-going Charges
The Regional Council sets fees for the monitoring of resource consents, which are reviewed annually and presented in the Long Term Council Community Plan (LTCCP). As the consent holder you are responsible for payment of these fees over the lifetime of your consent.

Annual charges for the cost of research associated with the resources used or impacted upon by your activity will also be invoiced to you. These annual charges are also set annually and presented in the LTCCP.

Transfer of your Consent
Please be aware that if the property to which your consent relates is sold you will need to transfer this consent to the new owner(s). There is no cost involved. A transfer form, which must be completed by both the current and future owner, can be obtained from Horizons Regional Council, by contacting the Consents Team or from our website www.horizons.govt.nz.

Kairanga
Marton
Palmerston North
Taihape
Taumarunui
Wanganui
Woodville

horizons
regional council

Change of Contact Details
If at any time your contact details change (eg postal address, telephone numbers (landline, fax or mobile) and/or email address), please advise the Regional Council in writing so that we can update our records.

Surrender of your Consent
If you no longer undertake the activity authorised by your resource consent you can surrender your consent by confirming so in writing.

Expiry
Your consent will expire on 1 December 2014.

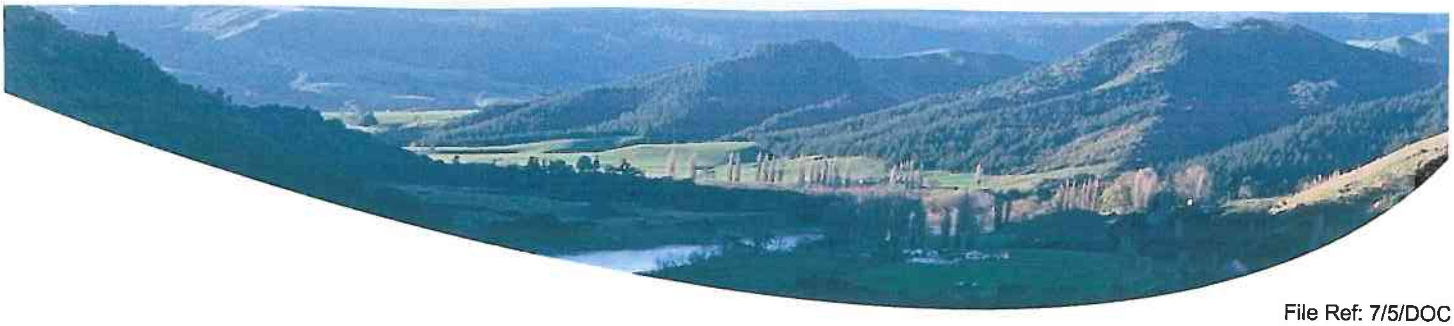
Customer Survey
Please also find attached our customer survey. We appreciate you taking the time to complete this survey and we have attached a self addressed envelope for ease of return. Your thoughts and comments on the consent process are a valued source of on-going feedback and improvement.

If you are uncertain about any aspects of the consent or your rights of appeal please do not hesitate to call us.

Yours sincerely

Michelle Tucker
CONSENTS ADMINISTRATOR

Encls Decision and consent conditions
Customer survey form and self addressed envelope



File Ref: 7/5/DOC
LMS:MET

Discharge Permit - 105684

CONSENT GRANTED

To

Department of Conservation

To

discharge treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu

SUBJECT TO THE ATTACHED CONSENT CONDITIONS

Location

Address for activity:	Whakapapa Village, State Highway 48, Mount Ruapehu
Legal description:	Tongariro National Park
Valuation number:	06090/176/01
Map reference:	NZMS260 S19:296-201 NZTopo50 BH34:196-585

Details of Resource Consent

Granted:	11 January 2012
Expiry:	1 December 2014
Review:	July 2012 and 2013
Replacing consent number:	101961
Effluent / Contaminant:	treated wastewater
Maximum rate of discharge:	700 cubic metres per day (700 m^3/day)

horizons
regional council

DECISION ON AN APPLICATION FOR A NON-NOTIFIED DISCHARGE PERMIT (TO LAND) UNDER THE RESOURCE MANAGEMENT ACT 1991

CONSENT HOLDER
Department of Conservation
Whakapapa Village
P O Box 71029
MOUNT RUAPEHU 3951

DECISION DATE 11 January 2012	**FILE REFERENCE** 7/5/DOC
CONSENT NUMBER 105684	**CONSENT TYPE** Discharge Permit (discharge to land)
ADDRESS FOR ACTIVITY Whakapapa Village, State Highway 48, Mount Ruapehu	**MAP REFERENCE** NZMS260 S19:296-201 NZTopo50 BH34:196-585
LEGAL DESCRIPTION Tongariro National Park	**VALUATION NUMBER** 06090/176/01
CONSENT PLANNER Leana Shirley	

1. BACKGROUND

Department of Conservation (DOC) were issued a consent in October 2002 to discharge tertiary treated wastewater to land (consent number 101961). The Whakapapa Wastewater Treatment Plant upgrade had not been completed at the time of granting the consent and so the applicant was also issued resource consent to discharge wastewater to water for a period of 3 years (consent number 101960). The wastewater treatment plant upgrade was carried out and completed in 2004.

On 10 September 2003, DOC applied for a variation to change consent conditions 6 and 7 of consent 101961 to account for changes to the system design (use of the oxidation pond for overflows), the additional volume of wastewater needing to be applied to land and the increased rate of discharge to land. Throughout the process, the applicant advised of other operation issues they had experienced and needed to address through the variation application. This application was never resolved as it was determined in 2010 that the application was outside the scope of original consented activity and therefore it was not appropriate to consider the application under section 127 of the Resource Management Act.

On 18 February 2011, DOC applied for a new consent to discharge treated wastewater to land. This application was amended via letter on 29 July 2011.

2. APPLICATION

On 18 February 2011, an application was received from, Department of Conservation; to discharge UV treated wastewater to land. The application details were as follows:

- Discharge up to 12,000 cubic metres per year of wastewater and stormwater from the emergency overflow pond (old oxidation pond) into land via a series of ground soakage trenches;
- Discharge contaminants into land through the base and sides of the unlined emergency overflow pond; and
- Discharge up to 700 cubic metres per day (700 m^3/day) of UV treated wastewater to land via drip irrigation at a rate of 3.5 litres per hour (3.5 L/hr) over a total land disposal area of 2.96 hectares.

On 29 July 2011, a letter amending the application was received requesting the applicant be issued a short term consent for three years to continue to discharge wastewater to land as follows:

- Discharge up to 700 cubic metres per day of treated wastewater to land during storm events and peak flow (winter);
- Discharge an annual average of 170 cubic metres per day of treated wastewater to land;
- Discharge to land via drip-line irrigation at a rate of 3.5 L/hr to a 2.96 hectare disposal field; and
- Discharge tertiary treated wastewater to the unlined emergency overflow pond and then to ground soakage via three existing ground soakage trenches.

The applicant amended the application after a meeting with Manawatu-Wanganui Regional Council staff highlighted potential issues relating to nutrient loading and the long term sustainability of the discharge activity. The applicant has proposed to undertake investigations into stormwater removal, nutrient loading, land disposal, plant performance and undertake intensive monitoring over the next 12 months. DOC then intends to use the information gathered to determine what level of treatment / additional infrastructure is required to ensure the effects of the discharge are minor.

The applicant has sought a term of 3 years for this resource consent.

This application was lodged to replace resource consent 101961 which expires on 18 September 2022.

3. THE SITE

The discharge occurs within Tongariro National Park which is administered by Department of Conservation. The Whakapapa Wastewater Treatment Plant site comprises of a total of 5.2 hectares. The discharge to land occurs through buried dripper lines situated on the old airstrip and tundra sites east of the Chateau golf course.

The site falls within the Cherry Grove (Whai_2) Water Management Zone and the Upper Whakapapa (Whai_2b) Water Management Sub-Zone.

4. PLANNING ASSESSMENT

The application has been assessed against the following statutory documents.

4.1 Land and Water Regional Plan (2003)

The discharge of treated wastewater to land from a wastewater treatment plant falls for consideration as a Discretionary Activity under DL Rule 13 of the Land and Water Regional Plan (2003).

4.2 Proposed One Plan (2010)

The discharge of treated wastewater into and on land is considered to be a Discretionary Activity under POP Rule 13-27 of the Proposed One Plan (2011) as it is unable to comply with the performance criteria of POP Rule 13-25. Specifically the discharge contains sewage and exceeds 50 cubic metres per day (50 m^3/day).

4.3 Overall Assessment Based on Regional Plans

The proposal has been assessed as a Discretionary Activity under the Land and Water Regional Plan and the Proposed One Plan (2010).

5. EVALUATION

5.1 Section 104

Section 104(1) of the Resource Management Act 1991 outlines the matters that the consent authority is to have regard to when considering applications for resource consent, subject to Part II of the Resource Management Act. I have assessed the application under these matters. Note that only the relevant sections, or parts of sections of statutory documents as applicable to this resource consent have been assessed in this report.

5.1.2 Environmental Effects

This application and subsequent amendments have been assessed with regard to the actual and potential adverse environmental effects by Harold Barnett, Manawatu-Wanganui Regional Council's Environmental Scientist.

<u>Discussion</u>
This proposal has the potential to result in adverse environmental effects on soil, groundwater and surface water quality. Below is an assessment of effects on these aspects.

Given the volume of wastewater initially proposed to be discharged and the land application area available, it was determined that the nutrient loading and hydraulic loading would potentially have more than minor effects. High hydraulic loadings are suspected to come from large stormwater inflows entering the wastewater reticulation following large storm events coinciding with the peak 'holiday' ski season. Nutrient loading, calculated from information provided in the initial application (dated February 2011) showed the loading on the land application area to be up to 667 kg N/ha/yr during peak flow. This loading rate is much higher than the limits specified in the Land and Water Regional Plan and Proposed One Plan and the effects of discharging at the above loading would potentially have more than minor effects on the soil quality, groundwater resource and adjoining surface water resource.

Given the sensitive nature of the receiving environment, a meeting was held between Horizons staff and the applicant to discuss Horizons' concerns regarding the application. Discussions at the meeting highlighted that there is limited information available on the treatment plant's performance and quality of wastewater being discharged. Following this meeting, the applicant formally amended the application to request a short term to allow for the necessary monitoring and investigations to be carried out and decisions to be made on appropriate upgrades and treatment measures to ensure the effects of the discharge in the long term are no more than minor.

The applicant has indicated that the focus of the investigation and remedial actions over the next 3 years will be to address hydraulic loads and concentration of nitrogen. This will involve improving plant performance (reduction in nitrogen, suspended solids and BoD_5) and also reducing the hydraulic loading through addressing key elements such as stormwater infiltration. Addressing these aspects will be critical elements behind ensuring the actual and potential effects of the discharge activity are no more than minor. The applicant provided a suite of suggested conditions as mitigation in combination with standard discharge conditions for the on going discharge to land under the current regime for three years.

Mitigation / conditions
In addition to the conditions proposed by the applicant, conditions addressing the following matters have been imposed to mitigate effects over the duration of this consent:

- Development and implementation of an Operation and Management Plan for the treatment plant and land application activities;
- Provision of an Annual Monitoring Report which covers all monitoring and an assessment of the results against consent conditions to be submitted by 1 March each year of the consent;
- Monitoring conditions, to monitor surface water quality to determine / provide more certainty on the level of effect the discharge is having on the nearby streams; and
- Soil monitoring conditions to determine / provide more certainty on the level of effect the discharge is having on soil quality.

Conclusion
The proposal put forward in the initial application was discovered to have adverse effects that may be more than minor due to plant performance, hydraulic loading and nutrient (nitrogen) loading. The applicant has proposed to operate as they currently do for a maximum of three years, while undertaking the necessary investigations and monitoring to determine how the plant should be operated and whether any upgrades or additional treatment are required. While the current discharge may have potential adverse effects over the duration of this consent, I am satisfied that the mitigation proposed by the applicant combined with the conditions imposed and the short term will mean that the overall adverse effects are sufficiently mitigated.

5.2 Objectives and Policies

The following identifies the relevant objectives and policies of both operative and proposed Regional Policy Statements and Regional Plans

5.2.1. Regional Policy Statement

Operative Regional Policy Statement

Objective 12 seeks to maintain the life supporting capacity of the streams and rivers.

Objective 13 seeks to maintain and improve the groundwater quality.

Policies 13.1 and 13.2 seek to prevent discharges to land where there will be a significant adverse effect on the quality of the groundwater and the potential users of the groundwater for domestic water supplies.

It is considered that the land discharge can be sufficiently managed to ensure the discharge of effluent to land will mitigate the potential effects on the surface and ground water. In addition, this application is for a short term consent (3 years) while monitoring and investigations into the operation of the plant and potential upgrades are undertaken. Therefore it is considered that this application is consistent with the objectives and policies of the Regional Policy Statement.

Proposed Regional Policy Statement (2010 version)
Objective 6-2 relates to water quality and seeks to maintain the existing groundwater quality or improve it where degraded.

Policy 6–2 relates to the maintenance of groundwater quality and requires management of land use activities to maintain the quality with the exception being when discharge to land being a better option, achieves the purpose of the RMA than discharge to water.

In this case, it is considered the application of wastewater can be managed to mitigate the potential effects on water quality. Given the sensitive receiving environment of the location of this activity, discharge to land is considered to be a better option than discharging to water in achieving the purpose of the RMA. As such it is considered that the application to discharge treated wastewater to land is consistent with the objectives and policies of the proposed Regional Policy Statement.

5.2.2 Land and Water Regional Plan (2003)

DL Objective 1 and 2 seeks to improve the groundwater quality and reduce nutrient leachate.

DL Policy 2 identified matters that need to be considered for resource consent applications.

DL Policy relates to restrictions around nitrogen loadings from wastewater discharges. The proposed discharge is for a short term (3 years) and a condition of consent will require the applicant to manage the discharge to mitigate the effects of nitrogen loading over the term of the consent.

The proposed discharge via dripper tubes consists of tertiary treated wastewater and the discharge from the old oxidation pond is secondary treated. The wastewater will be managed to ensure the discharge is evenly spread over the land to minimise any effect.

The application is therefore considered that the proposal is not contrary to the objectives and policies of the Land and Water Regional Plan.

5.2.3 Proposed One Plan as Amended by Decisions (2010)

Objective 13–1 relates to the discharges to land and water and requires any discharges that may enter water to have regard to the values associated with the water body and to avoid any adverse effects on that water body.

Policies 13-2 and 13-2B note the matters the Regional Council must have regard to when considering an application to discharge to land. The Regional Council must also consider alternative discharge options and the best practicable option available.

In this case, the discharge will need to be managed to ensure there is no surface runoff into both the Wairere Stream and its unnamed tributary. The consent is for a short term while the applicant monitors and investigates suitable treatment and plant management options. Therefore it is considered that the proposal is not inconsistent with the objectives and policies of the Proposed One Plan.

Overall Conclusion
After considering all of the relevant objectives and policies of both the operative and proposed Regional Plans, I consider that the proposed activity is consistent with the relevant Objectives and Policies.

5.3 Section 105

This consent is considered to be for a short term, while monitoring and investigations into proposed upgrades occur. However while the discharge is monitored and treatment is investigated, the current discharge will need to continue and as such it is considered that the discharge to land is the most practicable option while developing a longer term solution.

Having considered alternatives to this discharge and in particular alternative receiving environments, I was satisfied that the proposed discharge method was the most appropriate method of wastewater disposal for this site.

5.4 Section 107

Section 107 of the Resource Management Act specifies that a consent authority shall not grant a discharge permit to do something that would otherwise contravene section 15 if, after reasonable mixing the contaminant or water discharged, is likely to give rise to all or any of the following effects in the receiving waters:

(a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
(b) Any conspicuous change in the colour or visual clarity;
(c) Any emission of objectionable odour;
(d) The rendering of fresh water unsuitable for consumption by farm animals; and
(e) Any significant adverse effects on aquatic life.

This application is for a discharge of treated wastewater to land. There is potential for the discharge to reach water either via ground soakage or run-off. However, based on the level of treatment, the nature of the discharge (i.e. to land) and the management of the activity, I am comfortable that the discharge will not give rise to any of the above effects.

Having considered section 107, I am satisfied that the proposed discharge in its current form is consistent with the provisions of this section.

5.5 Part 2 of the Resource Management Act 1991

Part 2 of the Resource Management Act 1991 RMA includes the purpose and principles of the RMA, matters of national importance and other matters.

The proposal is considered to be consistent with the purpose and principles of the RMA as the wastewater treatment facility will provide for the development of community infrastructure to provide social, economic and cultural wellbeing whilst ensuring there adverse effects on the life supporting capacity of air, water, soil and ecosystems are sufficiently mitigated. The actual and potential effects are considered to be remedied by the short duration of consent, management of the facility and mitigated by appropriate conditions.

6. CONSENT DURATION

The Regional Policy Statement Objective 34 and Policy 34.2 allows for the duration of the consent to be considered on the merits of the application and has a number of factors that can be considered when determining the duration of a consent.

Policy 11A-5 of the POP (2010) states that consent expiry dates shall be set to the date sought by the applicant unless there are reasons that make this inappropriate. This policy also notes that consents shall be set to a common catchment expiry date identified within the POP.

The applicant has sought a term of 3 years for this consent. This term is considered appropriate and will therefore be included in the decision.

7. RECOMMENDATION

I recommend that the resource consent application by Department of Conservation for a Discretionary Activity to discharge treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu be granted for a term of 3 years expiring on 1 December 2014 pursuant to sections 104, 104B, 105, 107 and 108 of the Resource Management Act 1991 for the following reasons:

- the activity has been assessed by Manawatu-Wanganui Regional Council's Environmental Scientist. Based on this assessment I am satisfied the actual and potential effects of the proposal are sufficiently mitigated;
- the activity is not contrary to any relevant Objectives or Policies; and
- the activity is consistent with the purpose and principles of the Resource Management Act 1991.

And subject to the following conditions:

General

1. The consent holder shall undertake the activity in general accordance with the consent application and its associated plans and documents first lodged with Manawatu-Wanganui Regional Council on 18 February 2011, and further information received on:

   a. 29 July 2011 via letter, being an amendment to the requested consent term and proposed activity.

   Where there may be contradiction or inconsistencies between the application and further information provided by the applicant, <u>the most recent information applies</u>. In addition, where there may be inconsistencies between information provided by the applicant and conditions of the resource consent, the conditions of the resource consent apply.

   Advice Note: Any change from the location, design concepts and parameters, implementation and/or operation may require a new resource consent or a change of consent conditions pursuant to section 127 of the Resource Management Act 1991.

2. The activities authorised by this discharge permit shall be restricted to:

   a. discharge of treated wastewater via subsurface dripper tubes to an area of land no less than 2.96 hectares; and

b. the discharge of treated wastewater into land via a series of three infiltration trenches; and
c. the discharge of treated wastewater to land through the base and sides of the unlined emergency overflow pond

on land being legally described as Tongariro National Park at approximate map reference NZMS260 S19:296-201 / NZTopo50 BH34:196-585 as shown on the attached plan (Plan C105684A) attached to and forming part of this consent.

Land discharge restrictions

3. The maximum volume of treated wastewater (hereafter referred to as wastewater) authorised to be discharged into and onto land via subsurface dripper tubes and ground soakage (trenches) shall not exceed 700 cubic metres per day (700 m^3/day).

4. Subject to Condition 3, the average annual discharge of wastewater into and onto land shall not exceed 170 cubic metres per day (170 m^3/day).

5. The discharge of treated wastewater to land via subsurface irrigation shall not exceed a hydraulic loading rate of 1litre per hour per square metre of land (1 L/hr/m^2).

6. The consent holder shall ensure that only secondary or tertiary treated wastewater is discharged into the emergency overflow pond (old oxidation pond) when required during high flow (storm) events.

7. By **30 June 2014** the consent holder shall cease discharging treated wastewater from the emergency overflow pond (old oxidation pond) and all wastewater shall be discharged via the subsurface land application system.

8. The discharges into and onto land authorised by this consent shall comply with the following separation distances:

   a. 20 metres from bores, surface waterbodies and/or artificial watercourses; and
   b. 20 metres from any residential buildings, public places and amenity areas where people congregate, education facilities and public roads.

   Advice note: Condition 8 applies to both the discharges to land via subsurface irrigation and the discharge via infiltration trenches.

Odour

9. The activities authorised by this consent shall not cause any objectionable odour to the extent where it causes an adverse effect beyond the bounds of the wastewater treatment plant and land disposal area site.

   Advice note: Odour will only be considered objectionable, after a Manawatu-Wanganui Regional Council officer has considered the Frequency, Intensity, Duration, Offensiveness and Location of the odour (FIDOL factors).

Operation and Maintenance Plan

10. By **30 April 2012**, the consent holder shall update the existing Operation and Maintenance Plan (titled *Whakapapa Wastewater Treatment Plant Operations Manual,*

June 2006) and submit the updated Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager. The plan shall include but not be limited to:

a. A description of the entire treatment and disposal facilities including plans showing the buildings, treatment facilities, distribution lines for land disposal and infiltration trenches;
b. A description of the routine inspection and maintenance procedures to be undertaken at the treatment plant (i.e. the buffer pond, sedimentation basins, oxidation pond, filtration unit and UV sterilisation) and wastewater disposal area and procedures for the recording of all maintenance and repairs undertaken;
c. Procedure(s) for the managing, recording and reporting of daily wastewater applications (rates and volumes) to the disposal area;
d. An outline of the procedure for monitoring volumes and quality of wastewater inflow into the treatment plant and outflow to land disposal
e. A description of how the irrigation (sub-surface dripper tube and infiltration trench) systems will be operated and managed;
f. A description of the procedure(s) for the management of activated sludge and biosolids generated at the wastewater treatment plant including the dewatering and offsite disposal measures;
g. Details on the frequency that the irrigation lines are flushed to prevent/minimise blockages and ensure wastewater is irrigated evenly;
h. The management of odour from activities at the treatment plant;
i. A description of procedures for the management of unforeseen emergency situations such as failures of pumps and mechanical parts at the plant, blockages in the reticulation system, pipeline ruptures and power outages;
j. The maintenance of a daily weather register to record daily rainfall and wind direction;
k. a list of names of appropriate contact people in the event of system malfunction, including contact telephone numbers; and
l. the keeping of a complaints register to record any complaints received with regard to wastewater collection, reticulation, treatment and disposal (i.e. date, time, complainant, nature of complaint, what was done about it or what went wrong, who repaired it and how.

11. Should alterations to the Maintenance and Operations Plan be made as a result of changes to the treatment plant, land application area and/or wastewater scheme, the consent holder shall submit a revised copy of the Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager by **1 June** of each year.

12. The consent holder shall ensure that the wastewater treatment plant is operated in accordance with the Operation and Maintenance Plan at all times.

Recording

13. **By 1 March 2012,** the consent holder shall install and maintain, in a fully operational condition, flow meter(s) at the Wastewater Treatment Plant to accurately measure the volume of wastewater entering the plant and exiting the plant. The flow meters shall have a pulse counter output traceably calibrated to +/- 5 % or better.

14. The consent holder shall monitor the flow meters to keep an accurate record of the daily volumes entering the wastewater treatment plant and the volumes discharged to land via subsurface irrigation under this consent.

15. The consent holder shall keep an accurate daily record of the volume and treatment level of wastewater entering the emergency overflow pond and infiltration trenches. If no wastewater is discharged to the pond or trenches on any day, a 'nil' measurement shall be recorded.

Advice note: To achieve compliance with conditions 14 and 15 the consent may need to install an additional flow meter at the outlet of the irrigation field pressure pump.

16. A copy of the records required by Conditions 14 and 15 shall be forwarded to Manawatu-Wanganui Regional Councils Environmental Protection Manager by **31 May** each year in the Annual monitoring report required by Condition 30 or upon request.

Monitoring Programme

Wastewater and water quality sampling

17. Commencing **1 January 2012**, the consent holder shall collect a monthly sample of the tertiary treated wastewater in the 'wet well' (after wastewater has been through UV treatment) prior to the wastewater being discharged to land. Monthly wastewater sampling shall continue until **1 January 2014**.

18. Commencing **1 January 2012**, the consent holder shall collect a monthly instream sample both upstream and downstream of the wastewater treatment plant in the unnamed tributary of the Wairere Stream and in the Wairere Stream at the sites below as shown on Plan C105684B attached to and forming part of this consent. Monthly stream sampling shall continue until **1 January 2014**.

19. The wastewater and instream sampling required by conditions 17 and 18 shall be analysed for the following:

    a. pH;
    b. Dissolved Oxygen;
    c. Dissolved Carbonaceous BOD_5;
    d. Total Suspended Solids;
    e. Dissolved Reactive Phosphorus;
    f. Dissolved inorganic nitrogen (i.e. sum of nitrate, nitrite and ammoniacal nitrogen);
    g. Total ammoniacal nitrogen; and
    h. Ecoli.

20. All wastewater sample analysis required by conditions of this consent shall be undertaken by an independent laboratory accredited to IANZ.

Macro-invertebrate sampling (water quality sampling)

21. Commencing **August 2012,** the consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake macro-invertebrate sampling once between the months August to October (winter/spring) each year of this consent in both the unnamed tributary of the Wairere Stream and the Wairere Stream.

22. The macro-invertebrate sampling required by Condition 21 shall be undertaken following a period of at least three weeks without a significant flood event as an instantaneous river flow exceeding 9.063 m^3/second as recorded at the Whakapapa at Footbridge flow recording site operated by Genesis Energy). .

Advice note: Flow information at this site can be found visiting the Genesis Energy website http://www.genesisenergy.co.nz under the rivers, lakes and rainfall tab.

23. The macroinvertebrate sampling required by Condition 21 shall be undertaken at the following sites as shown on Plan C105684B:

    a. Unnamed Tributary of the Wairere Stream upstream of the Whakapapa Village Wastewater Treatment Plant (point 1 on Plan C105864B);
    b. Unnamed tributary of the Wairere Stream downstream of the Whakapapa Village Wastewater Treatment Plan (point 2 on Plan C105864B);
    c. Wairere Stream downstream of the unnamed tributary confluence (point 3 on Plan C105864B); and
    d. Wairere Stream upstream of the Whakapapa Village Wastewater Treatment Plant (point 4 on Plan C105684B).

24. The macro-invertebrate sampling required by Condition 21 shall follow Protocols C3 (hard bottomed quantitative), P3 (full count with subsampling option) and QC3 (Quality control for full count with subsampling option) from the Ministry for the Environment's *"Protocols for sampling macro-invertebrates in wadeable streams"* (Stark et al. 2001). Sampling shall involve:

    a. Collection of 5 replicate 0.1 m^2 Surber samples at random with a 20 m section of riffle habitat at each sampling site;
    b. Full count of the macro-invertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macro-invertebrate Community Index (MCI); and
    c. Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT individuals.

    Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 21-24 can be implemented.

Periphyton and algae sampling (water quality sampling)

25. The consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake an assessment of the percentage cover, biomass, chlorophyll a, AFDW and community composition of periphyton, filamentous algae and cyanobacterial mats in riffle habitat as close as possible to the sites selected under condition 23.

26. The periphyton and algae assessment shall be undertaken seasonally, once during the months; February, May, August and October regardless of flow during the first two years of this consent (2012 and 2013). The periphyton and algae assessment shall include:

    a. A visual assessment of the percentage cover of both filamentous algae and algal mats (to the nearest 5%) at 5 points across each of four transects encompassing run habitat and extending across the width of the stream(s) at each sampling site. The visual monitoring methods shall follow the protocols outlined in Appendix 2 of *"A periphyton monitoring plan for the Manawatu-Wanganui Region"* (Kilroy et al. 2008). Reported estimates shall include:
        i. Percentage cover of visible stream bed by bacterial and/or fungal growths (sewage fungus) visible to the naked eye;
        ii. Percentage cover of visible stream bed by filamentous algae more than 2 cm long;

iii. Percentage cover of visible stream bed by diatoms or cyanobacteria mats more than 0.3 cm thick;
iv. Percentage cover of visible stream bed by diatoms less than 0.3 cm thick; and
v. Percentage cover of visible stream bed that is clean.

b. The collection of periphyton samples at the same established monitoring sites and transects as defined in Condition 26a The periphyton collection methods shall follow the protocols outlined in Appendix 3 of *"A periphyton monitoring plan for the Manawatu-Wanganui Region"* (Kilroy et al. 2008). Analysis of periphyton samples shall also follow the Biggs and Kilroy (2000) guidelines for chlorophyll a analysis.

Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 25-26 can be implemented.

Soil Sampling

27. In the month of **December 2012**, the consent holder shall undertake soil sampling at three separate areas. One sampling area shall be located in the Airport disposal area, one area shall be located in the Tundra disposal area and one are shall be located in an area not subject to wastewater irrigation (as a control area).

28. The consent holder shall take at least 9 cores from each area described in Condition 27 at varying depths as follows:

a. 3 cores at 0-10 cm depth;
b. 3 cores at 10-20 cm depth; and
c. 3 cores at 50-70 cm depth.

29. The soil samples required by Conditions 27 and 28 shall be analysed for the following:

a. pH;
b. phosphorus;
c. potassium;
d. magnesium; and
e. total nitrogen and base saturation.

Annual reporting

30. Annual data records and a report summarising the results for each year ending 1 April shall be forwarded to the Manawatu-Wanganui Regional Council's Environmental Protection Manager by **31 May** of each year of this consent, commencing 31 May 2012 and shall include but not be limited to the following:

a. The results and analysis of wastewater and water quality sampling required by Conditions 17-19;
b. A copy of the Operations and Management Plan and any subsequent updates required by Conditions 10 and 11;
c. A copy of the inflow and outflow records required by Conditions 13 and 14;
d. The results and analysis of macro-invertebrate and periphyton sampling required by conditions 21-26;
e. The results and analysis of soil sampling required by Conditions 27-29;

f. An overall assessment of effects on land and water quality in the receiving environment from the discharges authorised by this resource consent;
g. Details of any upgrades or maintenance already implemented or planned for the following 12 months;
h. Details of investigations into plant performance including inflows, outflows, effluent disposal system and treatment system;
i. Details of any changes to the operation of the plant and/or proposed upgrades resulting from investigations into plant performance and monitoring results; and
j. The records of any complaints received and details of measures undertaken in response to the complaint.

Review

31. The Manawatu-Wanganui Regional Council may, under section 128 of the Act, initiate a review of all conditions of this consent in **July 2012 and 2013,** for the purpose of reviewing the effectiveness of these conditions in avoiding or mitigating any adverse effects on the environment. The review of conditions shall allow for:

a. deletion or amendments to any conditions of this resource consent to ensure adverse effects are appropriately mitigated; or
b. addition of new conditions as necessary, to avoid, remedy or mitigate any unforeseen adverse effects on the environment; or
c. if necessary and appropriate, the adoption of the best practicable options to avoid, remedy or mitigate any adverse effects on the environment.

Leana Shirley
CONSENTS PLANNER

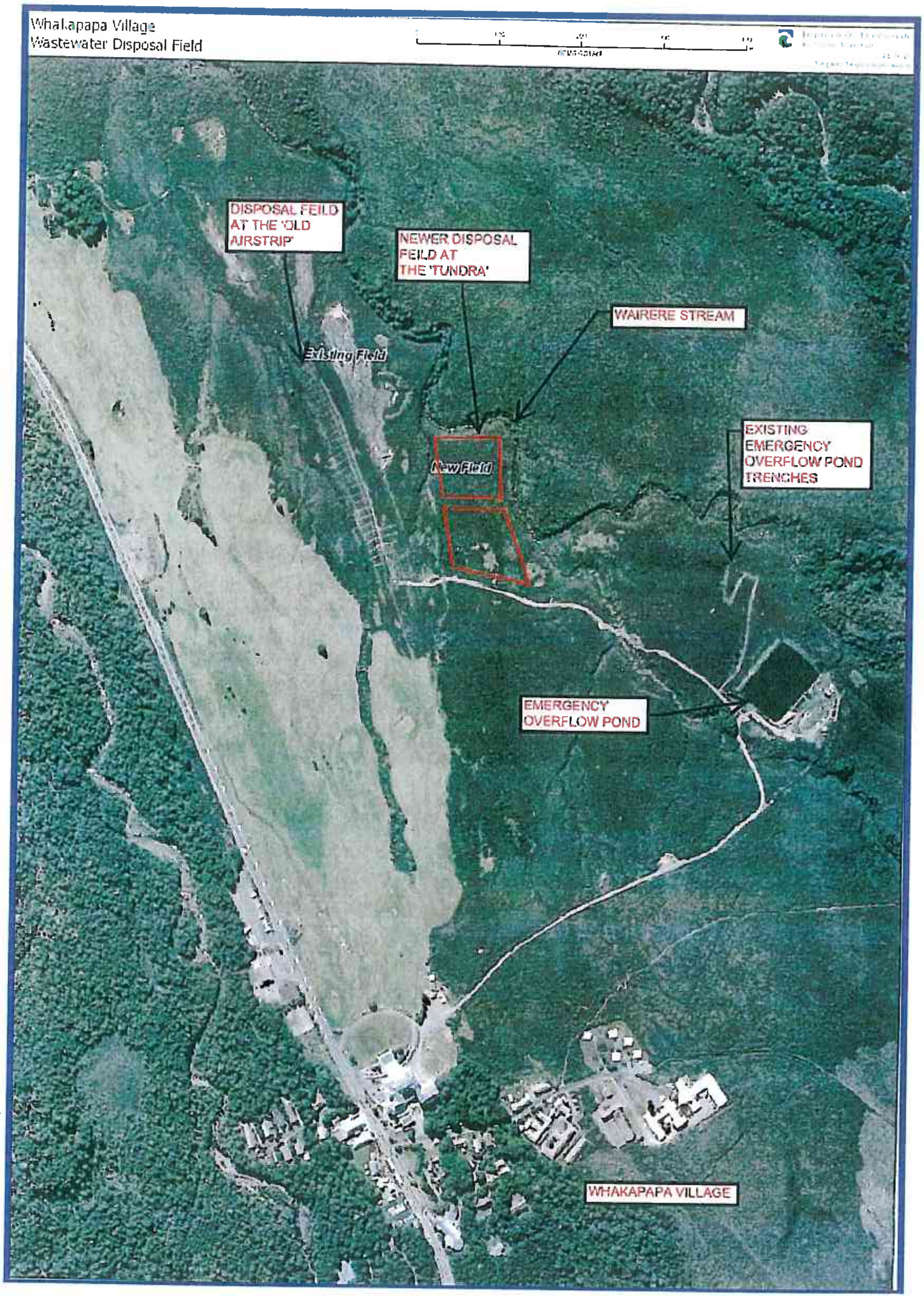
8. DECISION

For the reasons reported above, the Consents Manager of the Manawatu-Wanganui Regional Council (pursuant to delegated authority), grants resource consent by Department of Conservation under sections 104, 104B, 105, 107 and 108 of the Resource Management Act 1991 to discharge treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu for a term of 3 years expiring on **1 December 2014** and subject to conditions of consent in section 7 of this resource consent.

Phillip Hindrup
ACTING CONSENTS MANAGER

11 January 2012

Figure 7: Aerial plan showing the location of the "EOP', trenches and disposal fields



PLAN C105684A

N

PLAN C105864B

0 20 40 60 80 100 120 140 160 180 200 Metres

Consent Conditions for Discharge Permit 105684
Department of Conservation

General

1. The consent holder shall undertake the activity in general accordance with the consent application and its associated plans and documents first lodged with Manawatu-Wanganui Regional Council on 18 February 2011, and further information received on:

   a. 29 July 2011 via letter, being an amendment to the requested consent term and proposed activity.

   Where there may be contradiction or inconsistencies between the application and further information provided by the applicant, the most recent information applies. In addition, where there may be inconsistencies between information provided by the applicant and conditions of the resource consent, the conditions of the resource consent apply.

   Advice Note: Any change from the location, design concepts and parameters, implementation and/or operation may require a new resource consent or a change of consent conditions pursuant to section 127 of the Resource Management Act 1991.

2. The activities authorised by this discharge permit shall be restricted to:

   a. discharge of treated wastewater via subsurface dripper tubes to an area of land no less than 2.96 hectares; and
   b. the discharge of treated wastewater into land via a series of three infiltration trenches; and
   c. the discharge of treated wastewater to land through the base and sides of the unlined emergency overflow pond

   on land being legally described as Tongariro National Park at approximate map reference NZMS260 S19:296-201 / NZTopo50 BH34:196-585 as shown on the attached plan (Plan C105684A) attached to and forming part of this consent.

Land discharge restrictions

3. The maximum volume of treated wastewater (hereafter referred to as wastewater) authorised to be discharged into and onto land via subsurface dripper tubes and ground soakage (trenches) shall not exceed 700 cubic metres per day (700 m^3/day).

4. Subject to Condition 3, the average annual discharge of wastewater into and onto land shall not exceed 170 cubic metres per day (170 m^3/day).

5. The discharge of treated wastewater to land via subsurface irrigation shall not exceed a hydraulic loading rate of 1litre per hour per square metre of land (1 L/hr/m^2).

6. The consent holder shall ensure that only secondary or tertiary treated wastewater is discharged into the emergency overflow pond (old oxidation pond) when required during high flow (storm) events.

7. By **30 June 2014** the consent holder shall cease discharging treated wastewater from the emergency overflow pond (old oxidation pond) and all wastewater shall be discharged via the subsurface land application system.

8. The discharges into and onto land authorised by this consent shall comply with the following separation distances:

   a. 20 metres from bores, surface waterbodies and/or artificial watercourses; and
   b. 20 metres from any residential buildings, public places and amenity areas where people congregate, education facilities and public roads.

Advice note: Condition 8 applies to both the discharges to land via subsurface irrigation and the discharge via infiltration trenches.

Odour

9. The activities authorised by this consent shall not cause any objectionable odour to the extent where it causes an adverse effect beyond the bounds of the wastewater treatment plant and land disposal area site.

   Advice note: Odour will only be considered objectionable, after a Manawatu-Wanganui Regional Council officer has considered the Frequency, Intensity, Duration, Offensiveness and Location of the odour (FIDOL factors).

Operation and Maintenance Plan

10. By **30 April 2012**, the consent holder shall update the existing Operation and Maintenance Plan (titled *Whakapapa Wastewater Treatment Plant Operations Manual, June 2006*) and submit the updated Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager. The plan shall include but not be limited to:

    a. A description of the entire treatment and disposal facilities including plans showing the buildings, treatment facilities, distribution lines for land disposal and infiltration trenches;
    b. A description of the routine inspection and maintenance procedures to be undertaken at the treatment plant (i.e. the buffer pond, sedimentation basins, oxidation pond, filtration unit and UV sterilisation) and wastewater disposal area and procedures for the recording of all maintenance and repairs undertaken;
    c. Procedure(s) for the managing, recording and reporting of daily wastewater applications (rates and volumes) to the disposal area;
    d. An outline of the procedure for monitoring volumes and quality of wastewater inflow into the treatment plant and outflow to land disposal
    e. A description of how the irrigation (sub-surface dripper tube and infiltration trench) systems will be operated and managed;
    f. A description of the procedure(s) for the management of activated sludge and biosolids generated at the wastewater treatment plant including the dewatering and offsite disposal measures;
    g. Details on the frequency that the irrigation lines are flushed to prevent/minimise blockages and ensure wastewater is irrigated evenly;
    h. The management of odour from activities at the treatment plant;
    i. A description of procedures for the management of unforeseen emergency situations such as failures of pumps and mechanical parts at the plant, blockages in the reticulation system, pipeline ruptures and power outages;
    j. The maintenance of a daily weather register to record daily rainfall and wind direction;
    k. a list of names of appropriate contact people in the event of system malfunction, including contact telephone numbers; and
    l. the keeping of a complaints register to record any complaints received with regard to wastewater collection, reticulation, treatment and disposal (i.e. date, time, complainant, nature of complaint, what was done about it or what went wrong, who repaired it and how.

11. Should alterations to the Maintenance and Operations Plan be made as a result of changes to the treatment plant, land application area and/or wastewater scheme, the consent holder shall submit a revised copy of the Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager by **1 June** of each year.

12. The consent holder shall ensure that the wastewater treatment plant is operated in accordance with the Operation and Maintenance Plan at all times.

Recording

13. **By 1 March 2012,** the consent holder shall install and maintain, in a fully operational condition, flow meter(s) at the Wastewater Treatment Plant to accurately measure the volume of wastewater entering the plant and exiting the plant. The flow meters shall have a pulse counter output traceably calibrated to +/- 5 % or better.

14. The consent holder shall monitor the flow meters to keep an accurate record of the daily volumes entering the wastewater treatment plant and the volumes discharged to land via subsurface irrigation under this consent.

15. The consent holder shall keep an accurate daily record of the volume and treatment level of wastewater entering the emergency overflow pond and infiltration trenches. If no wastewater is discharged to the pond or trenches on any day, a 'nil' measurement shall be recorded.

    Advice note: To achieve compliance with conditions 14 and 15 the consent may need to install an additional flow meter at the outlet of the irrigation field pressure pump.

16. A copy of the records required by Conditions 14 and 15 shall be forwarded to Manawatu-Wanganui Regional Councils Environmental Protection Manager by **31 May** each year in the Annual monitoring report required by Condition 30 or upon request.

Monitoring Programme

<u>Wastewater and water quality sampling</u>

17. Commencing **1 January 2012**, the consent holder shall collect a monthly sample of the tertiary treated wastewater in the 'wet well' (after wastewater has been through UV treatment) prior to the wastewater being discharged to land. Monthly wastewater sampling shall continue until **1 January 2014**.

18. Commencing **1 January 2012**, the consent holder shall collect a monthly instream sample both upstream and downstream of the wastewater treatment plant in the unnamed tributary of the Wairere Stream and in the Wairere Stream at the sites below as shown on Plan C105684B attached to and forming part of this consent. Monthly stream sampling shall continue until **1 January 2014**.

19. The wastewater and instream sampling required by conditions 17 and 18 shall be analysed for the following:

    a. pH;
    b. Dissolved Oxygen;
    c. Dissolved Carbonaceous BOD_5;
    d. Total Suspended Solids;
    e. Dissolved Reactive Phosphorus;
    f. Dissolved inorganic nitrogen (i.e. sum of nitrate, nitrite and ammoniacal nitrogen);
    g. Total ammoniacal nitrogen; and
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20. All wastewater sample analysis required by conditions of this consent shall be undertaken by an independent laboratory accredited to IANZ.

<u>Macro-invertebrate sampling (water quality sampling)</u>

21. Commencing **August 2012,** the consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake macro-invertebrate sampling once between the months August to October (winter/spring) each year of this consent in both the unnamed tributary of the Wairere Stream and the Wairere Stream.

22. The macro-invertebrate sampling required by Condition 21 shall be undertaken following a period of at least three weeks without a significant flood event as an instantaneous river flow exceeding 9.063 m^3/second as recorded at the Whakapapa at Footbridge flow recording site operated by Genesis Energy). .

Advice note: Flow information at this site can be found visiting the Genesis Energy website http://www.genesisenergy.co.nz under the rivers, lakes and rainfall tab.

23. The macroinvertebrate sampling required by Condition 21 shall be undertaken at the following sites as shown on Plan C105684B:

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b. Unnamed tributary of the Wairere Stream downstream of the Whakapapa Village Wastewater Treatment Plan (point 2 on Plan C105864B);
c. Wairere Stream downstream of the unnamed tributary confluence (point 3 on Plan C105864B); and
d. Wairere Stream upstream of the Whakapapa Village Wastewater Treatment Plant (point 4 on Plan C105684B).

24. The macro-invertebrate sampling required by Condition 21 shall follow Protocols C3 (hard bottomed quantitative), P3 (full count with subsampling option) and QC3 (Quality control for full count with subsampling option) from the Ministry for the Environment's *"Protocols for sampling macro-invertebrates in wadeable streams"* (Stark et al. 2001). Sampling shall involve:

a. Collection of 5 replicate 0.1 m^2 Surber samples at random with a 20 m section of riffle habitat at each sampling site;
b. Full count of the macro-invertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macro-invertebrate Community Index (MCI); and
c. Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT individuals.

Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 21-24 can be implemented.

Periphyton and algae sampling (water quality sampling)

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a. A visual assessment of the percentage cover of both filamentous algae and algal mats (to the nearest 5%) at 5 points across each of four transects encompassing run habitat and extending across the width of the stream(s) at each sampling site. The visual monitoring methods shall follow the protocols outlined in Appendix 2 of "*A periphyton monitoring plan for the Manawatu-Wanganui Region*" (Kilroy et al. 2008). Reported estimates shall include:
   i. Percentage cover of visible stream bed by bacterial and/or fungal growths (sewage fungus) visible to the naked eye;
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   iii. Percentage cover of visible stream bed by diatoms or cyanobacteria mats more than 0.3 cm thick;

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b. The collection of periphyton samples at the same established monitoring sites and transects as defined in Condition 26a The periphyton collection methods shall follow the protocols outlined in Appendix 3 of *"A periphyton monitoring plan for the Manawatu-Wanganui Region"* (Kilroy et al. 2008). Analysis of periphyton samples shall also follow the Biggs and Kilroy (2000) guidelines for chlorophyll a analysis.

Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 25-26 can be implemented.

Soil Sampling

27. In the month of **December 2012**, the consent holder shall undertake soil sampling at three separate areas. One sampling area shall be located in the Airport disposal area, one area shall be located in the Tundra disposal area and one are shall be located in an area not subject to wastewater irrigation (as a control area).

28. The consent holder shall take at least 9 cores from each area described in Condition 27 at varying depths as follows:

a. 3 cores at 0-10 cm depth;
b. 3 cores at 10-20 cm depth; and
c. 3 cores at 50-70 cm depth.

29. The soil samples required by Conditions 27 and 28 shall be analysed for the following:

a. pH;
b. phosphorus;
c. potassium;
d. magnesium; and
e. total nitrogen and base saturation.

Annual reporting

30. Annual data records and a report summarising the results for each year ending 1 April shall be forwarded to the Manawatu-Wanganui Regional Council's Environmental Protection Manager by **31 May** of each year of this consent, commencing 31 May 2012 and shall include but not be limited to the following:

a. The results and analysis of wastewater and water quality sampling required by Conditions 17-19;
b. A copy of the Operations and Management Plan and any subsequent updates required by Conditions 10 and 11;
c. A copy of the inflow and outflow records required by Conditions 13 and 14;
d. The results and analysis of macro-invertebrate and periphyton sampling required by conditions 21-26;
e. The results and analysis of soil sampling required by Conditions 27-29;
f. An overall assessment of effects on land and water quality in the receiving environment from the discharges authorised by this resource consent;
g. Details of any upgrades or maintenance already implemented or planned for the following 12 months;
h. Details of investigations into plant performance including inflows, outflows, effluent disposal system and treatment system;
i. Details of any changes to the operation of the plant and/or proposed upgrades resulting from investigations into plant performance and monitoring results; and
j. The records of any complaints received and details of measures undertaken in response to the complaint.

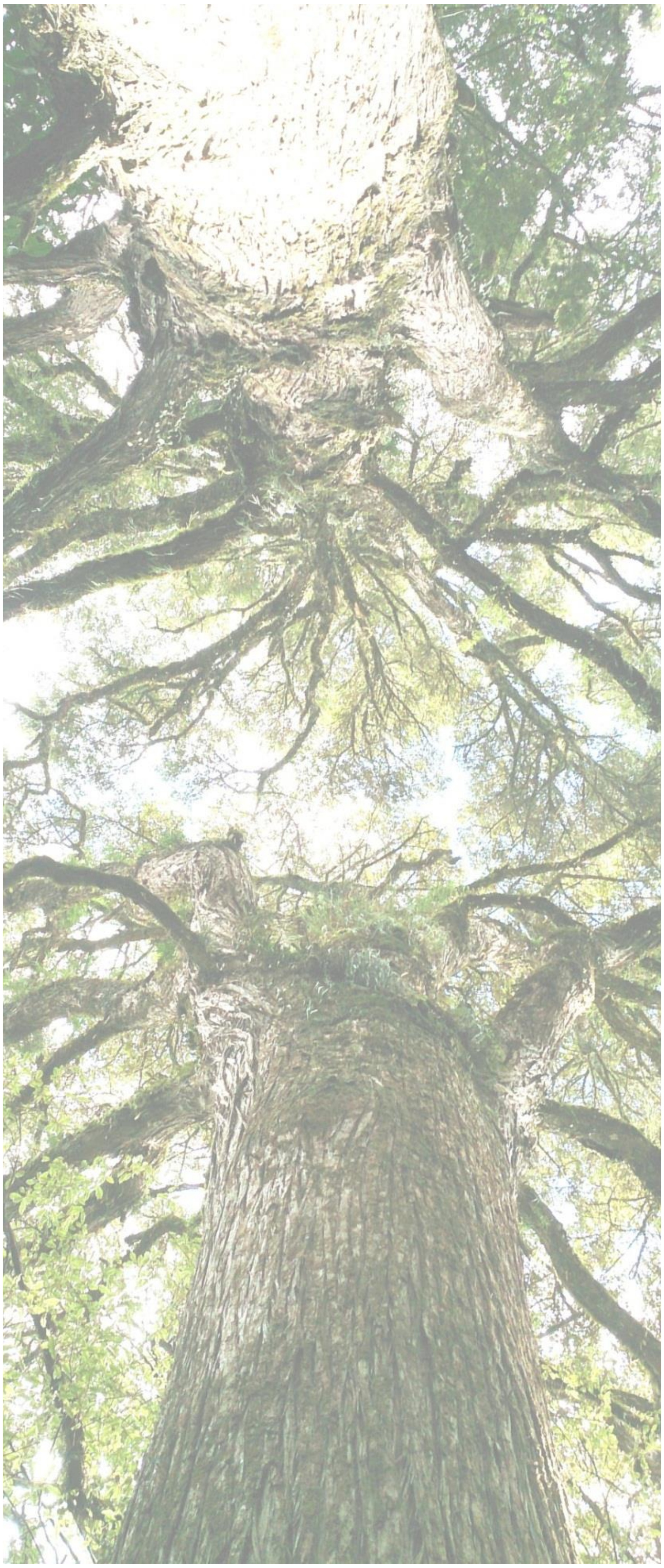
Review

31. The Manawatu-Wanganui Regional Council may, under section 128 of the Act, initiate a review of all conditions of this consent in **July 2012 and 2013,** for the purpose of reviewing the effectiveness of these conditions in avoiding or mitigating any adverse effects on the environment. The review of conditions shall allow for:

    a. deletion or amendments to any conditions of this resource consent to ensure adverse effects are appropriately mitigated; or
    b. addition of new conditions as necessary, to avoid, remedy or mitigate any unforeseen adverse effects on the environment; or
    c. if necessary and appropriate, the adoption of the best practicable options to avoid, remedy or mitigate any adverse effects on the environment.

APPENDIX 2

ECOLOGICAL ASSESSMENT - TERRESTRIAL



Whakapapa Waste Water Disposal Field: Ecological Assessment

Prepared for:
Department of Conservation, Central North Island Office, Taupo

Compiled by Nicholas Singers Ecological Solutions Ltd.

NSES Ltd report 1: 2016/17

Contents

Executive Summary

Potential Environmental Effects

The construction of waste water treatment wetland(s) at areas G (wetland 1) and A, B and C (wetland 2) will have near to minimal negative ecological impact on the current ecological values of the proposed sites. Effects over time are likely to be positive through replacing introduced dominant vegetation (heather and pasture grasses) with native dominant vegetation. Further because the wetland habitat created will be highly productive (e.g. primary and secondary ecosystem production), this should provide additional resources for native wildlife such as fernbird.

Assessments Undertaken

A site investigation was made and terrestrial plants were identified and described using the Recce method. All wildlife seen or heard were recorded. Ecologically suitable native plants for the development of a waste water treatment wetland have been identified.

Result of Assessment

Excluding area D, areas assessed are dominated by introduced plants especially heather and grasses and locally, in infiltration area A and B, by the native tall tussock, mountain toetoe. Areas G, A, B, C and the borrow pit north of infiltration area A, are most suitable for development into wastewater treatment wetlands being relatively flat and of low ecological value. Area D is less suitable because it has a higher cover of native species and also has a steeper slope than the other areas.

Suggested Approach for Effects Identified

As this proposal will have near to minimal negative ecological impact on the current ecological values of the proposed sites, development should proceed with minimal restrictions. However there is a large amount of mountain toetoe within infiltration areas A and B. Ideally this tussock should be harvested as a vegetation restoration resource if this area is utilised as a waste water treatment wetland.

1. Introduction

Tongariro National Park is an outstanding natural area with values that are unique within New Zealand (Department of Conservation 2006). This is recognised internationally with the Park having duel World heritage status for both natural and cultural heritage granted in 1990 and 1993 respectively. Administered under the National Parks Act (1980), the General Policy for National Parks (2005) and the Tongariro National Park Management Plan (2006–2016), the intention is to manage the Park to the highest possible environmental standards.

Having significant visitation, environmental impact from recreation is currently unavoidable and the disposal of waste water at Whakapapa epitomises this problem — arguably one of the greatest human environmental pressures the Park faces.

Disposal of waste water at Whakapapa is further complicated by infiltration of storm-water, high rainfall and the significant peaks and troughs in visitor numbers especially during the winter snow season when visitation is highest. This peak in effluent often occurs at a time when it is most difficult seasonally to effectively treat, due to cold winter conditions which are less favourable for microbial and plant growth. The consequence of this is that inadequately treated waste-water periodically reaches a tributary of the Wairere Stream when waste water flow exceeds the capacity of the treatment infrastructure (Department of Conservation 2016).

Aquanet Consulting Ltd (Aquanet) has conducted an assessment of the current effects of the discharge on freshwater quality and ecology (Aquanet, 2016). This report has concluded that the discharge currently resulted in increased growth of periphyton (although the One Plan targets may generally be met) and significant adverse effects on the macroinvertebrate communities of an unnamed tributary of the Wairere Stream. The report identifies SIN (Soluble Inorganic Nitrogen) as the key management target should reduce effects on periphyton and macroinvertebrates need to be reduced.

The proposed improvements to the waste water treatment process aim to remedy this situation through an adaptive management approach, implementing staged improvements and monitoring the performance of these in a step-wise manner.

- Stage 1 involves improvements to infrastructure such as reducing the amount of storm-water entering the treatment process, improved nitrification at the plant and the use of buffering tanks to store waste water during peak flow times, which would then gradually be fed back into the system in a more controlled manner. Monitoring of these improvements will occur and if they are shown to still be inadequate, Stage 2 will proceed.
- Stage 2 involves developing up to three waste water treatment wetlands and discharge of the treated wastewater to land.

The implementation of these stages will aim at reducing the amount of SIN reaching the streams, via improved nitrification at the plant and de-nitrification within the wetlands. The "success" of these stages will be assessed against in-stream "environmental outcomes".

Wetland 1 is planned to be developed in area G, the area located immediately downgradient of the wastewater treatment plant and will be approximately 2.4 Ha in size (Figure 1). If required, wetland 2 would be constructed in infiltration areas A, B and C and be approximately 2.6 Ha.

In determining the potential for each of these areas to be used for the construction of wetlands, consideration of existing ecological values, and the effects (negative or positive) the development of wastewater wetlands may have on these values, in the short, medium and long term. This ecological assessment forms part of this process.

Figure 1: Approximate boundaries of Whakapapa Village current waste water treatment fields (A–D) and area G. Treatment wetlands will be located in one or more of these areas.

2. Relevant Legislation

This ecological assessment has been undertaken in the context of the Tongariro National Park Management Plan and the Manawatu—Wanganui Regional Council's ONEplan, particularly Section 7 Indigenous biological diversity, landscape and historic heritage and Schedule F: Indigenous Biological Diversity.

The Tongariro National Park's management strategy strongly attempts to firstly prevent or where not possible, minimise environmental impacts from human activities. The following policies and objectives from the Tongariro National Park Management Plan are pertinent to this proposal and the disposal of waste water within the National Park.

4.1.7.1 Indigenous Plants

Policy 3 – Only indigenous plants which have been grown from seed or cuttings **collected in the Park and its vicinity should be used for revegetation** or landscaping…"

4.1.17 Waste Discharges, Contaminants and Noise

Objective

a To protect Tongariro National Park and its environs in their natural state

c To minimise the waste generated within the Park, in line with the strategic approach of local authorities

Policies

1 All effluent in Whakapapa and Iwikau villages … will be reticulated and discharged through an **approved** land-based sewage treatment plant located in Whakapapa Village
2 Fuel and sewage spills onto land or into watercourses constitute serious pollution…

4.3.2.3 Building, Structures and Utility Services

Objective

a To protect the values of Tongariro National Park through appropriate design and siting of permitted infrastructure

Policies

12 The department will work with agencies with statutory responsibility for administering legislation relating to buildings, structures, and utility services to ensure **best practice and minimise environmental impacts**
13 The highest standards of assessment, design and implementation for permitted infrastructure will be adopted

The ONEplan is the Manawatu–Wanganui Regional Councils Regional Policy Statement and regional plan. Section 7 Indigenous biological diversity, landscape and historic heritage contain a range of objectives and policies pertinent to this proposal. Schedule F: Indigenous Biological Diversity is a component of Part II — the Regional Plan of the Manawatu—Wanganui Region that identifies rare, threatened or at-risk habitats. Assessment of ecological values compared to Schedule F was undertaken as these rare, threatened or at-risk habitats should be avoided from development.

3. Ecological values of the waste water field

An ecological assessment of the land within and adjoining the Whakapapa waste water treatment site was undertaken. Specifically this assessed the current infiltration fields and another area (Area G) which may be suitable to be developed into a waste water treatment wetland. An ecological survey was undertaken in July 2014 and vegetation was qualitatively sampled and described using the approach of The Recce Method (Hurst & Allen 2007) to assess plant composition and cover. Indigenous fauna were recorded when seen or observed. This ecological assessment was first compiled into a preliminary report (Singers 2014) which was later revised (current report) considering the final proposal within the Resource Consent Renewal and other supporting documents (Department of Conservation 2016).

3.1 Ecological setting and Landscape History

Whakapapa Village has a cool sub-alpine climate with a high rainfall (2914mm average), and is situated at 1119 m above sea level (Atkinson 1981). Frosts are frequent and can occur in all months of the year and the area experiences a short growing season (Scott 1977). Rainfall events are often intense resulting in significant leaching of soil nutrients. Outside of summer, precipitation regularly falls as sleet, hail and snow.

The natural vegetation pattern has been modified, largely due to human induced fires, and the village is situated on the historic fire boundary (Silvester 2009). More recently weed invasion, particularly by heather (*Calluna vulgaris*) has occurred throughout the areas of low stature vegetation.

Prior to this ecological modification the natural vegetation would have been forest dominated by mountain beech (*Fuscospora cliffortioides*) with occasional mountain totara (*Podocarpus cunninghamii*), pauhautea (*Libocedrus bidwillii*) and alpine celery pine (*Phyllocladus alpinus*) and a wide range of sub-canopy shrubs and ferns. Human induced fires to the north of Chateau Tongariro and the Bruce Road reduced the forest to low stature red tussock grassland, shrubland (Silvester 2009). With the Park's legal protection, fire suppression has allowed much of the Park to develop into shrubland and scrub.

The Whakapapa Village Sewerage Treatment area, including the location of the current infiltration fields is entirely situated in the area which was burnt, though is surrounded by small areas of mountain beech forest and successional (indigenous dominant) scrub. Part of the area has also been used for other purposes in the past, including as an airstrip for light planes and as a piggery. This historic use has significantly impacted on vegetation and soil of both areas.

3.2 Infiltration fields A, B, C and the borrow pit,

Infiltration fields A, B, C are situated north of the Whakapapa Golf Course and occur on a gradually sloping (2–3°) terrace of the Mt Ruapehu ring-plain (Figure 1). Within almost the entire length of these areas a historic light plane airstrip was present which was likely used last in the 1950's (Paul Green, pers.com, ex Tongariro-Taupo Conservator). The airstrip was approximately 15–20m wide and probably the full length of A and B infiltration fields. It is likely that the airstrip would have been dominated by low stature introduced pasture grasses, perhaps similar to the current state of the Whakapapa Golf course. When use of the airstrip ceased the vegetation was allowed to naturally regenerate, while most of the vegetation adjoining the airstrip would have been dominated by red tussock grassland.

The current vegetation state is strongly relative to its past use and modification and is dominated by two introduced species, Yorkshire fog grass (*Holcus lanatus*) and heather (Figure 2). On much of the former air strip a lush grassland of 10–20cm height is present of abundant Yorkshire fog grass and occasional creeping bent (*Agrostis stolonifera*), soft rush (*Juncus effusus*) and locally abundant mountain toetoe (*Austroderia fulvida*), especially at the lower portion of area A and area B (Figure 3). Other species occurring here include occasional red tussock (*Chionochloa rubra* subsp. *rubra*) and holy grass (*Heirochloe redolens*), both native grasses, and tall fescue (*Schedonorus phoenix*) and heather which are introduced species. There is a sharp line between the exotic grassland areas, which is likely the former edge of the airstrip and areas either side which probably were once red tussock grassland. In these areas heather and locally manuka (*Leptospermum scoparium*) now dominate the vegetation, forming a shrubland of approximately 60–160cm height. Other less common species occurring here include; red tussock, mountain toetoe, Mt Ruapehu hebe (*Hebe venustula*), inaka (*Dracophyllum longifolium* var. *longifolium*), bog pine (*Halocarpus bidwillii*), silver tussock (*Poa cita*) and alpine celery pine (*Phyllocladus alpinus*).

At the time of survey the majority of infiltration area A was saturated and grassland areas were heavily grazed by rabbits and hares with abundant pellets throughout. One change that appears to be occurring is that mountain toetoe appears to be is rapidly increasing in abundance with numerous young plants present, likely a consequence of saturation and eutrophication.

Figure 2: Infiltration field A, Yorkshire fog grassland (green grass) with heather on margins

Figure 3: Infiltration field A–B, mountain toetoe

North of infiltration area A, the burrow pit area appears is a highly modified area where pumice appears to have been quarried from it — most probably to flatten and improve the drainage of the airstrip and or the Whakapapa Golf course (Figure 1). This area is now dominated by raw pumice and a low cover of heather and occasional red tussock.

These areas are all potentially suitable for developing into waste water treatment wetlands because.

i. The areas have a low gradient slope and therefore water would travel slowly through it. Soil removal within the borrow pit has also created a depression which could be easily enhanced for creating a waste water treatment wetland.
ii. Has very low ecological value being dominated by heather and exotic grass species,
iii. Limited excavation would be required to maintain water within a defined area.

3.3 Infiltration field D

Apart from the construction of an underground infiltration field this area appears to have had limited past development pressure, though the original forest vegetation would have been destroyed through fire. The vegetation is native dominant and is representative of similar seral vegetation outside of the Whakapapa Amenity Area, recovering from fire (Figure 4). It has also recovered well from the construction of the pipe lines for the infiltration field. Red tussock and heather each occupy 20–30% cover with lesser proportions of holy grass, Mt. Ruapehu hebe and bog pine. Other species present include inaka, silver tussock, manuka, koromiko (*Hebe stricta*), mountain tauhinau (*Ozothamnus vauvilliersii*), mountain flax (*Phormium cookianum* subsp. *cookianum*), mountain toetoe, alpine celery pine and Strathmore weed (*Pimelea prostrata*).

Figure 4: Infiltration field D looking towards Chateau Tongariro. Holy grass (fore ground), red tussock (orange), heather (red) and Mt Ruapehu hebe (yellow-green)

To determine whether this vegetation type conforms to the At Risk habitat type “Indigenous tussockland below the tree line” defined in Schedule F of the Oneplan, the cover of all tussock species and all shrubs/ scrub were pooled independently. The Oneplan doesn’t qualitatively or quantitatively describe the characteristics which are required to be met in order for an area to be called Tussockland. As a surrogate Atkinson’s (1985) – Table 9 “Diagnostic criteria for terrestrial vegetation structural classes” for tussockland was used to inform this determination. Tussocks, as defined by Atkinson, occupied between 30-45% cover while shrubs/ scrub, including heather approximately 52% — shrubs and scrub having a higher cover than tussocks. Importantly, unlike natural cold air inversion basins such as National Park wetland/frost-flat where extreme frost restricts tree growth, tussock cover is more permanent. This site however does not meet this abiotic characteristic, which would be expected for the habitat “Indigenous tussockland below the tree line”. The site is clearly successional and it is likely within as little as 20–30 years dense shrubland/scrub of manuka, alpine celery pine and bog pine scrub will likely develop here without fire or other major disturbance. Consequently, it is my opinion that while this site still has a moderate abundance of tussock species, it does not conform to the at-risk habitat type “Indigenous tussockland below the tree line”.

This area is least suitable to develop into a waste water treatment wetland because it has the highest abundance of native plants, is regenerating towards native scrub and has a higher slope than other areas.

3.4 Area G

Area G occurs down slope from the Whakapapa Sewerage oxidation pond and is not part of the infiltration fields, though is potential a location where a treatment wetland could be built. Part of the area was previously used as a piggery, likely in the 1950’s or earlier (Paul Green pers.com, ex Tongariro-Taupo Conservator) and old silver pine posts and some wire are still present and may demarcate this enclosure. The area occurs on a gradually sloping (2–3°) terrace of the Mt Ruapehu ring-plain (Figure 1).

Figure 5: Infiltration field G, exotic grassland (brown) and heather (red)

Figure 6: Infiltration field G, Yorkshire fog grassland (green grass) and soft rush (light brown)

The vegetation is highly modified with most of the area being dominated by heather and areas of exotic grassland (Figures 5 & 6). Heather is the dominant plant and occupies 60–70% cover with smaller areas of exotic grassland of Yorkshire fog, creeping bent, chewing's fescue (*Festuca rubra* subsp. *commutata*), soft rush, buttercup (*Ranunculus bulbosus*) and areas of holy grass. Other less common species which occur here include inaka, manuka, cutty grass (*Carex coriacea*), bog pine, red tussock, silver tussock and *Pittosporum anomalum*. Though not rare or threatened the abundance of *P. anomalum* is notable because it is relatively common here, though generally uncommon throughout Tongariro National Park.

Area G is suitable to develop into a wastewater treatment wetland because it;

iv. has a low gradient slope and therefore water would travel slowly through it;
v. is close to the treatment plant,
vi. is has very low ecological value being dominated by heather and exotic grass species,
vii. limited excavation would be required to maintain water within a defined area, and
viii. is less obvious to Whakapapa village as topographically it is situated within a lower lying area.

3.5 Indigenous fauna

During the rapid ecological survey a limited variety of indigenous fauna were observed, including North Island fern bird (*Bowdleria punctata* subsp. *vealeae*), the Australasian harrier (*Circus approximans*) and Paradise shelducks (*Tadorna variegata*).

The subspecies of the North Island fernbird which has recently been classified as declining (Robertson et.al 2013), though Tongariro National Park has a very large population which is most likely stable. Multiple observations were made of fernbird in all areas surveyed, indicative of several individuals occurring here.

3.6 Plants to be used within the waste water treatment wetlands

Tongariro National Park contains a large area of wetland habitat though most is dominated by bog and fen wetland types of low natural fertility. Waste water treatment wetlands are high in nutrients and conversely use swamp species which perform well in these high nutrient conditions. Swamp wetlands are present within the Tongariro Ecological Region at the lower extent of the volcanic ring plains, such as within the Lake Rotoaira basin. Site limitations especially temperature is also an important factor which will determine what species will grow at Whakapapa and perform well in these considerations.

The Tongariro National Park Management Plan policy for the use of plants within revegetation sites is clear and requires the use of locally sourced plants — purposefully to ensure the long term integrity of the Park's ecosystems and habitats. Species to be used therefore need to be firstly climatically suitable, ecological suitable for the use in a treatment wetland, as well as being present within the National Park or its vicinity. Consequently, these three factors restrict what species can be used in the wetland. Appropriate species do however qualify given these factors including swamp species such as purei (*Carex secta*), *Carex virgata*, marsh clubrush (*Schoenoplectus tabermontani*), giant spiked sedge (*Eleocharis sphaceolata*), harakeke (*Phorium tenax*) and mountain toetoe (*Austroderia fulvida*). Propagation material of these species will be collected from the vicinity of the Park from ecological suitable locations. There is also a large amount of mountain toetoe already growing within infiltration site A which could easily be transplanted into a wetland.

Revegetation of waste water treatment wetlands using these species will create a novel habitat type which is not currently present within the Park, though similar swamp habitats occur in the Park's vicinity.

4. Summary of Ecological Values

The ecological values of the infiltration fields A–C, the borrow pit and area G have been significantly compromised by past development and are dominated by exotic species, especially Yorkshire fog grass and heather. Utilisation of areas A–C for the waste water disposal has probably already greatly increased soil fertility and soil moisture which appears to have resulted in a proliferation of species associated with wetlands such as Yorkshire fog grass, soft rush and mountain toetoe. In contrast, area D is native dominant and is representative of similar areas outside of the amenity area undergoing vegetation succession following fire. Actively regenerating, its ecological values will likely improve as heather is over-topped by indigenous scrub species such as manuka, inaka, alpine celery pine and bog pine.

Given their ecological condition all areas do not conform to a rare, threatened or at-risk habitat type as defined by Schedule F of the Horizons Regional Councils Oneplan.

In my opinion areas A–C, the borrow pit area and G are the most suitable locations for the development of waste water treatment wetlands because;

i. Vegetation present is highly modified,
ii. The land is of a shallow gradient and natural down-hill movement of waste water through the wetland could be specifically incorporated into the design

Wetlands are abundant within the western side of Tongariro National Park, though are dominated by low to moderately fertile bog and fen habitats (Singers 2009). While a constructed wetland(s) would be somewhat unique in its composition within the Park, it has the potential to improve the ecological values of area's A–C, the borrow pit and G, especially if designed to be in-keeping with landforms and natural wetland forms present locally. It is likely that there would be natural invasion of any treatment wetlands developed by a range of wetland species present in the general vicinity, thus over time any wetland could provide additional habitat for suitable species.

The current vegetation of areas A–C, the borrow pit and G is dominated by heather and Yorkshire fog which is of limited habitat value for wildlife species locally. Fernbird are perhaps the most numerous native bird present and while some loss of habitat will occur during the construction phase, the treatment wetland habitat created will be highly suitable and potentially more productive habitat for them, with a greater abundance of invertebrates.

Paradise shelduck, mallard and grey duck are present and use wetland habitats locally. It is highly likely that these species would use any wetland created for both nesting and seasonal foraging especially when invertebrates and seed are abundant.

Conclusions

The construction of waste water treatment wetland(s) at areas A, B, C, the borrow pit and area G will have near to minimal ecological impact on the current ecological values of the proposed sites. In addition to its use for disposing and treatment of waste water, over time any wetland dominated by highly productive swamp type plants could actually become more beneficial habitat through providing additional resources for a range of wildlife and plants.

Wetland design should however consider the landscape and attempt to be in-keeping with natural wetlands locally. To achieve this amenity planting of large wetland plants such as harakeke and toetoe as well as local terrestrial plants such as manuka and mountain toatoa around the perimeter of any constructed wetland should be undertaken.

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APPENDIX 3

ENGINEERING REPORT - VEOLIA

Conceptual upgrade options assessment relating to Resource Consent application

Whakapapa WWTP

March 2017

Executive Summary

The Whakapapa Waste Water Treatment Plant (WWTP) is operating under an expired Resource Consent. As part of the application for a new Resource Consent an assessment was made of the plants' shortcomings and the options for upgrade of the plant and the associated wastewater scheme. As part of this assessment several engineering reports of similar nature are peer-reviewed. Options from these reports as well as new options are considered and preferred options are selected.

The current waste water scheme mainly comprises the villages of Whakapapa and Iwikau. Although some pump stations form part of the network a large part is gravity reticulated to the WWTP. The process steps through which the water is treated are: a coarse bar screen, a Pasveer ditch with two paddle aerators, two clarifiers, tertiary treatment filtration and UV disinfection. Part of the treated effluent is pumped into a subsurface irrigation field of capacity lower than the average waste water flow to the plant. The other part of the effluent runs into a facultative pond from where it overflows into soakage trenches. From these trenches the water eventually drains to the Wairere tributary, the main receiving water body of which the ecological conditions are at the centre of the envisaged Resource Consent.

Both hydraulic loading as well as contaminant loading onto the WWTP is highly variable. This is mostly due to the waste water catchment being a tourist area with its highest visitor peak during the ski season. In order to capture the various loadings onto the plant 4 different profiles are established; Low Season, Summer, Winter Regular and Winter Peak. The latter entails the heaviest contaminant loading onto the plant. Nevertheless the WWTP removes cBOD well under almost all circumstances. Removal of suspended solids is erratic as well as the plants disinfection capacity. These latter two might be related. Removal of nitrogen is poor. Removal of phosphorous cannot be assessed as influent information on phosphorous is unavailable.

Flow and contaminant data are available for the influent to the plant. The dataset for flow is small. Nevertheless, a design basis for a plant upgrade is established based on available data and engineered data. For this purpose an analysis was made of the 4 profiles. As a design basis Winter Peak concentrations were used combined with a hybrid of Winter Regular and Winter Peak flow rates. The reason for the flow hybrid lies in the cap on skiers on the mountain and therefore the limit to growth of peak flows. The network and tertiary treatment pond can buffer the instantaneous peak loads such that every situation can be coped with.

With respect to the WWTP's potential treatment capability a gap analysis is made for every main parameter. The outcomes are summarised as follows:

- Suspended solids removal could be better if the hydraulic overloading of the plant could be minimised. Thereto Inflow and Infiltration must be combatted and buffering capacity in the network must be improved. The tertiary filters should be overhauled and potentially augmented for better operability. Sludge quality control must be improved;
- cBOD removal is already satisfactory. It must be noted that currently most cBOD is removed aerobically. If it were removed as part of the denitrification process, which is common in Biological Nitrogen Removal processes, this would save on energy and improve nitrogen removal performance. The current design of the plant does not allow this however;
- Complete nitrogen removal is not possible under the design load of the plant. Biological nitrogen removal consists of two steps; nitrification and denitrification which are to be carried out in that order. For full nitrification the plant seems too small. This automatically means that denitrification cannot be accommodated on top of that. For nitrogen removal the waste water does not carry sufficient alkalinity. An external carbon source may also be required for full dentrification;
- It is not likely that phosphorous removal at the plant has achieved its maximum attainable capacity; for biological phosphorous removal not enough biological sludge can be kept, assisted chemical removal is not installed. Given the high background phosphorous concentrations in the effluent receiving environment an optimised phosphorous removal process may not be needed;

- E-coli removal or disinfection is currently not optimal, but it is expected that once the tertiary filters are overhauled (as part of the TSS removal improvement), the plant's disinfection ability will also improve.

As a result of the gap analysis the various options for upgrading the plant are identified and evaluated. For each of the gaps the preferred options for WWTP upgrade are listed and worked into a staged approach. Reasons for the staging of the upgrades are:

- Uncertainty in the design basis for upgrades; Limited flow information with respect to both the reticulated waste water as well as the receiving water body lies at the basis of some of the suggested upgrades;
- Adaptive management; the ultimate goal of the plant upgrade is to meet in-stream environmental outcomes for the water body that the treated effluent is discharged to. Given the high cost associated with some of the upgrades, the implementation of later stage activities should only be implemented if effects on the receiving environment remain too high after implementation of the earlier stage upgrades;
- The physical difficulty to implement all upgrades at the same time on an operational facility.

The two stages of upgrading the plant and network are:

Stage 1

This stage is aimed at improving plant operability, collection of data, compulsory upgrades and improvements on nitrogen removal. It comprises:

- Combatting inflow and infiltration plus generating more buffer capacity in the network [in progress at date of writing];
- Installation of automated data collection and communication between various sites plus additional measures for improved collection of data on flows and loads;
- Construction of a new switchboard and control centre at the WWTP in order to accommodate the future motors and instruments;
- The tertiary filters will be overhauled as part of stage 1 as well as the internal sludge management and disposal system [nearing completion at date of writing];
- Installation of a semi-natural wetland system. This is a commitment made by the Department of Conservation. The system will be installed mainly for social-cultural reasons, but is understood to be designed for denitrification duties.
- The wetland being aimed at denitrification raises the need for improved nitrification at the WWTP site. If the initial stage 1 improvements do not generate the desired nitrification level, a dedicated fixed film nitrification process will be installed at the WWTP. This will then also entail influent screening and a grit trap at the plants' inlet.

During and after stage 1 the combination of the nitrification capacity of the WWTP and the denitrification capacity of the wetland will be assessed in practice. After this stage the upgrade approach will be partially adaptive.

Stage 2

After upgrade stage 1 it will become clear whether additional denitrification capacity and/or alkalinity supply is required for meeting effluent standards. This may then lead to denitrification capacity installed at the plant at stage 2, as well as some chemical storage and dosing facilities. If chemical phosphorous removal is considered required, this will be installed as part of stage 2. Lastly at this point the composition and quantity of waste sludge is finally certain for which a sludge dewatering facility can be built.

Contents

List of tables

List of acronyms

ADWF	Average Dry Weather Flow
AOTC	Actual Oxygen Transfer Capacity
BNR	Biological Nutrient Removal
BOD	Biological Oxygen Demand
cBOD	carbonaceous Biological Oxygen Demand
CFU	Colony Forming Units (for micro-organisms)
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
D(R)P	Dissolved (Reactive) Phosphorous
F/M	Food to Mass ratio
I&I	Inflow and Infiltration
MLSS	Mixed Liquor Suspended Solids
NC	Normally Closed (for valves)
NO	Normally Open (for valves)
NH_4-N	Nitrogen related to ammonia
NO_3-N	Nitrogen related to nitrates
PDWF	Peak Dry Weather Flow
PWWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
SCADA	Supervisory Control And Data Acquisition (System)
SOTC	Specific Oxygen Transfer Capacity
TKN	Total Kjeldahl Nitrogen
TIN, SIN	Total Inorganic Nitrogen (equal to) Soluble Inorganic Nitrogen
TN	Total Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
TTP	Tertiary Treatment Pond
TWAS	Thickened Waste Activated Sludge
UV	Ultra Violet (disinfection)
VSD	Variable Speed Drive
WAS	Waste Activated Sludge
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant

1 INTRODUCTION

The Whakapapa Wastewater Treatment Plant (WWTP) is located within Tongariro National Park. Since the 1940s the Whakapapa Village has been serviced by a reticulated wastewater system and the treated effluent was discharged directly to water. In 2004, primarily due to cultural concerns, Iwikau Village and Whakapapa Ski Area were connected to the Whakapapa Village wastewater system. A significant upgrade of the plant was undertaken in time for the 2005 winter season, following which the treated wastewater was discharged to land via subsurface dripper fields.

The current treatment and disposal system has been monitored closely for the last four years with good results for suspended solids, *E. coli*, dissolved oxygen, phosphorus and pH. Nitrogen is high in winter months due to peak flows and cold temperatures. However the treatment plant and irrigation fields have suffered from a number of operational problems including lack of hydraulic capacity and 'plugging'. This has been "solved" by opening up joints in the irrigation lines leading to overland flow making its way to the unnamed tributary to the Wairere Stream.

Since July 2015, the management of the WWTP has been transferred over to Ruapehu District Council. Veolia are contracted to carry out the day to day maintenance and management of the WWTP. Since July 2015 a comprehensive review of the state and performance of the reticulation network and wastewater plant has been undertaken.

The existing Resource Consent [no. 105684] for operating the plant and discharging treated wastewater was due to expire on 1 December 2014. A consent application [2014-145AP1] was lodged on 21 August 2014 by Cheal Consultants Limited. It contained improvement suggestions to the wastewater treatment plant to improve performance in regards to nitrogen reduction and management of peak flows. It also included a commitment to decommission the existing drip irrigation and trenches and commission a new wetland discharge, with any overland flow directed to the unnamed tributary. This consent application [2014-145AP1] was considered by the Regional Council to fall short on a number of subjects.

This report forms part of a new resource consent application package to be lodged with the Regional Council.

A key role in this consent application is played by the quality the discharged effluent will need to comply with. One must consider what the potential or actual effects of the discharge are on the receiving environment, in this situation the Wairere Stream and its unnamed tributary. In a recent study it was concluded that reducing the inorganic nitrogen (ammoniacal, nitrate- and nitrite-nitrogen) inputs from the discharge into the streams may be required in the future.[i]

Historically the management of the WWTP site has been lacking in data collection. The gaps in the data and the range and costs of the required modifications mean that a staged approach is suggested for capital and operational improvements.

This report also considers engineering options to provide further nitrification and de-nitrification at the plant. Given the high costs associated with these options, the proposal put forward in the application is to implement these of the combination of Pasveer Ditch and wetland.

In summary, the purpose of this document is to:

- Identify a set of proposed effluent quality standards that is attainable from the WWTP;
- Identify key upgrades that are required to improve the day-to-day performance of the plant.
- Define a staged approach for capital and operational improvements. The improvements that relate to nutrient removal are recommended to be implemented on the basis of adaptive management. Only if after the implementation of certain upgrades the effects on the receiving environment remain too high, then additional upgrades should be progressed;
- Provide costing for the various upgrades and options.

The upgrades previously suggested by MWH and Cheal are in the following documents are considered and peer-reviewed in the process sections of this report:

- Whakapapa Wastewater Treatment Plant Process Modelling Nitrogen Reduction Options; MWH; 2015 [v]
- Issues and Options Report, section 2.4, MWH, 2014 [xii]
- Whakapapa Wastewater Treatment Plant Summary of upgrade options, MWH, 2015 [xiii]
- Application for Resource Consent for Wastewater, sections 6.3 and 6.4, Cheal, 2014 [xiv]

References in [ ] are the labels used in the List of References at the back of this report.

The scope of this report excludes matters pertaining to the new proposed wetland and decommissioning of existing drip irrigation facilities.

2 WHAKAPAPA WASTEWATER SCHEME

The Whakapapa wastewater scheme comprises the villages of Whakapapa and Iwikau as well as waste water supplies from sports clubs up the mountain. These last supplies are very concentrated because no reticulated water supply is present there. The maps on the two following pages outline the wastewater scheme.

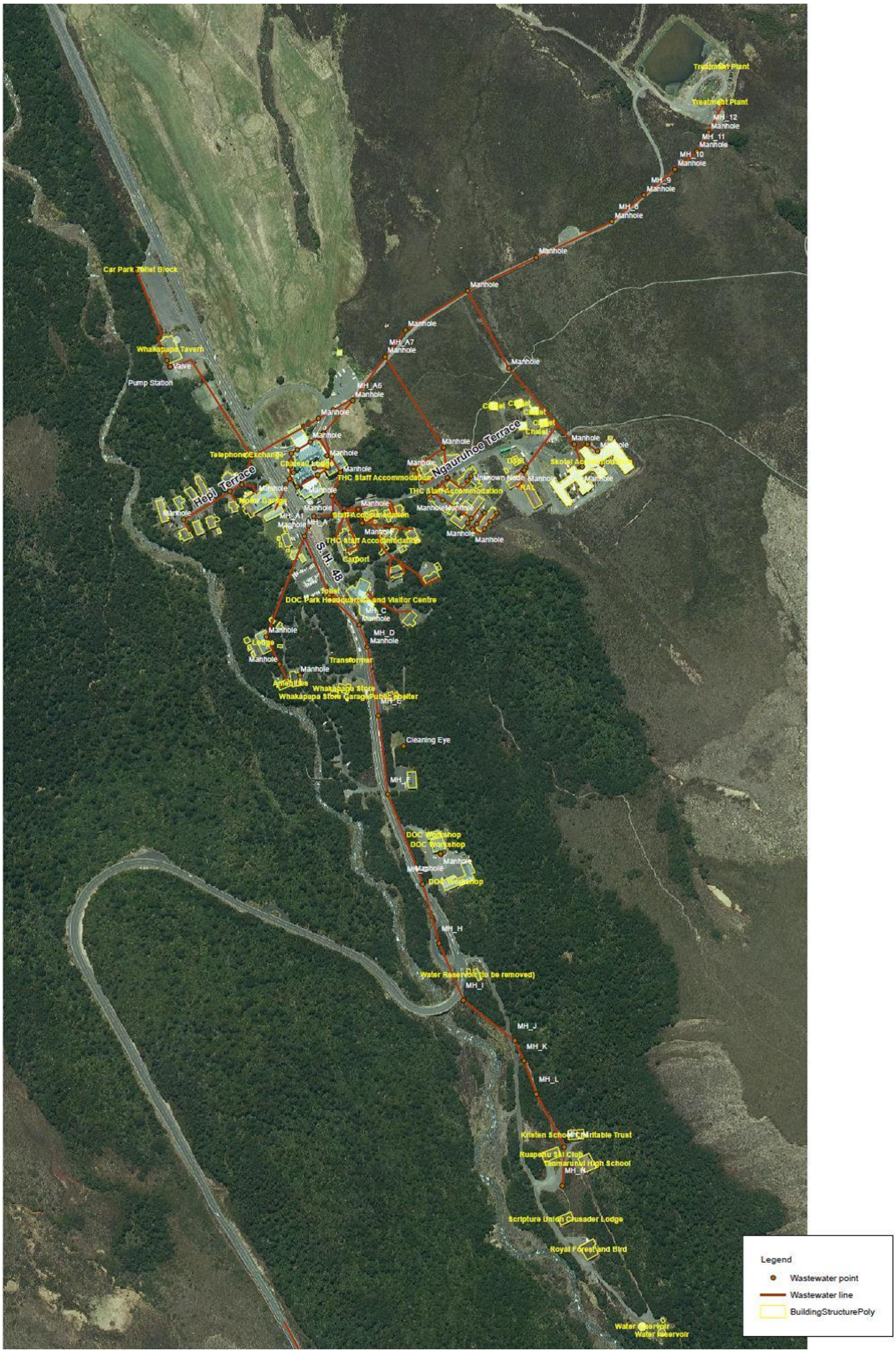


Figure 1 Whakapapa wastewater scheme; Whakapapa part[ii]

Veolia

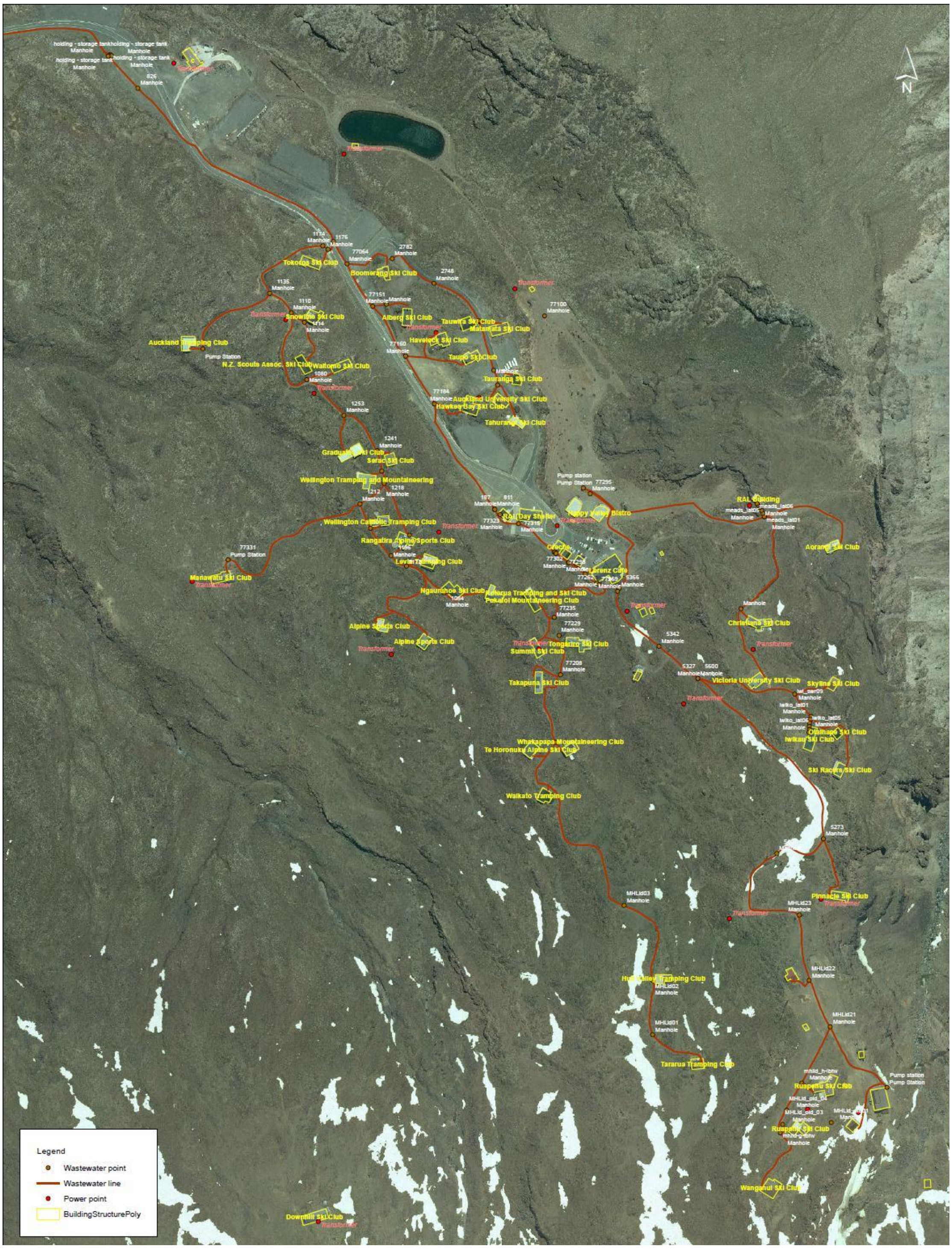


Figure 2 Whakapapa wastewater scheme; Iwikau part

At the bottom of the Iwikau part of the wastewater scheme which is at the top of Figure 2, there is an in-line storage tank. It is currently being converted to be used for storage. Its capacity is $335m^{3}$[iii].

3 EXISTING PLANT CHARACTERISTICS

The Whakapapa Wastewater Treatment Plant consists of a bar screen to remove gross solids prior to wastewater entering the Pasveer Ditch, clarifiers, a pumping station to pump the secondary treated effluent through the tertiary treatment filtration and UV disinfection process and a further pumping station to pump the tertiary treated effluent to sub-surface infiltration on nearby land for final effluent disposal.

Surplus activated sludge is as of March 2017 thickened in a Thickened Waste Activated Sludge (TWAS) tank. Thickened sludge is disposed of to the Turangi WWTP.

A schematic representation of the process is given in Figure 3.

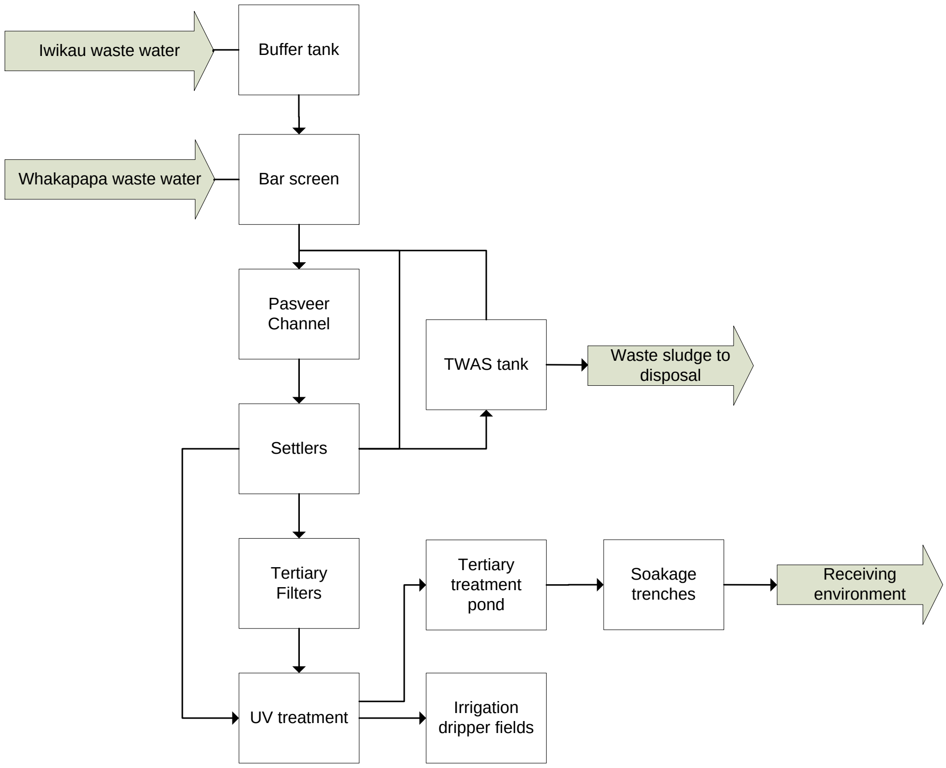


Figure 3 Block flow diagram of Whakapapa WWTP

Figure 4 Bar screen

Figure 5 Cage rotor inside Pasveer Ditch

Waste water is received in a small chamber containing a 50mm bar screen. Return activated sludge (RAS) from the clarifiers is also returned to this point. The mixture of raw wastewater from the sewer and return activated sludge (microorganisms that are able to metabolise and break down the pollutants in the wastewater) is received in the Pasveer Ditch. The contents of the Pasveer Ditch (called mixed liquor) is continuously pumped around by two cage rotors maintaining the necessary velocity for the sludge to not settle out. The two cage rotors also provide for the transfer of atmospheric oxygen, required by the microorganisms carrying out the contamination breakdown process. The rotors can be run continuously or on a timer system. Timer sequence operation will depend on variations in load. As the load increases and the measured DO levels drop the timers controlling the rotors are manually adjusted to keep the DO level within the required parameters.

Rag rakes protruding down into the Pasveer Ditch in front of the rotors catch gross solids that have made it into the Ditch. These rakes are cleaned periodically to remove the solids from the system. Mixed liquor from the Pasveer Ditch constantly flows under gravity through the flow splitting box which distributes flow evenly to the two clarifiers. These clarifiers can be individually isolated which is done during low flow periods.

Figure 6 Clarifier

Figure 7 Flow measuring chamber with V-notch weir flow meter

Figure 8 Flow transmitter

The clarifiers are used to separate the activated sludge flocs (solids) from the liquid (effluent). The activated sludge is denser than water and settles to the bottom of the tank under gravity while the clarified effluent overflows the weir, through the flow measuring chamber and into the tertiary treatment unit pumping wet well. The clarification tanks are in the form of a hopper and have adjustable weirs. By raising or lowering the weirs through a total vertical movement of about 15 centimetres the level in the Pasveer Ditch and the clarifiers can be raised or lowered thus increasing or decreasing retention time.

The clarified effluent from the clarifiers is collected in the tertiary treatment pumping wet well, from where it is pumped through the sand filters. These filters “polish” the effluent (remove suspended solids carried over from the clarifiers) before it passes through the ultraviolet (UV) disinfection unit. Polishing the effluent maximises the efficacy of the UV disinfection process and the following subsurface infiltration.

Figure 9 Tertiary filters

Figure 10 UV disinfection

The effluent from the tertiary treatment process passes through a coarse safeguarding screen, then collects in the infiltration field pumping wet well, from where it is pumped through a flow meter and out to the infiltration fields. The infiltration fields consist of 4 fields of sub surface dripper line, each able to be dosed independently by operating control valves. Two out of 4 fields are plugged such that close to no flow can go through, which has reduced the disposal capacity down to a maximum of 3.2 l/s.

For the occasions that flow through the plant is in excess of what the infiltration fields can cope with (which is often), the secondary or tertiary treated effluent will overflow into the tertiary treatment pond (TTP). The liquid effluent is retained in the pond for a period depending on the effluent flow into the pond and rainfall. It functions as a facultative treatment pond. The pond contents eventually drain to infiltration trenches in the land downhill of the pond. From these trenches the water eventually drains to the Wairere tributary.

Figure 11 Tertiary Treatment pond

Figure 12 RAS pumps

The activated sludge that has settled to the bottom of the clarifiers is normally returned to the head of the plant by means of return activated sludge pumps. Two pumps are present. They are typically operated as one per clarifier (normal configuration). The sludge inventory in the plant normally grows due to the contaminant load received. Periodically sludge has to be wasted from the system to keep the correct balance between food (the substrate coming into the system) and mass (the microorganisms breaking down that substrate).

Figure 13 TWAS tank

Figure 14 Re-aeration tank

The RAS pumps discharge can be diverted to the TWAS tank to waste it from the system (waste activated sludge, WAS). When sludge is being wasted, it has a polymer dosed into it to help with the dewatering process. In the TWAS tank it undergoes gravity thickening. Supernatant is periodically decvanted off back to the Pasveer Ditch. The thickened sludge is collected and sent to the Turangi WWTP.

The re-aeration tank is originally designed as an intermediate step between the RAS pumps and the return point in the Pasveer Ditch. The microorganisms in the sludge require oxygen to thrive and decay (endogenous respiration) and oxygen to metabolise the contaminants in the wastewater (exogenous respiration). The separate re-aeration tank is included to separate the endogenous respiration from the exogenous respiration and thereby allow a more efficient oxygen transfer for this part. The re-aeration tank is currently in the process of being restored to its original duty.

4 CURRENT PLANT PERFORMANCE

In order to understand what upgrades the WWTP requires it is necessary to understand the process design basis for upgrading. In other words; we must understand how much wastewater containing how much contamination the WWTP is receiving and how well the treatment currently works.

4.1 Flow information

The first problem that is faced with regards to the Whakapapa WWTP is the lack of reliable flow data. The WWTP is equipped with three flow meters, one between the clarifiers and the tertiary filters (flow meter A), one before the drip irrigation fields (flow meter B) and one at the outlet of the tertiary treatment pond (flow meter C). Flow meter A normally passes all of the plant flow. In their 2014 report[iv] MWH have indicated that this V-notch flowmeter reads unreliably. These observations are confirmed by Veolia and therefore the flow instrument was replaced in June 2016. It is not possible to recalculate the actual flow data from what was recorded prior to June 2016, because of the absence of a linear correlation.

In theory flow meters B and C should total up to the same amount as flow meter A, but they hardly ever do. Flow meter B is suspected to record too much on occasions due to the irrigation pump passing air slugs. Flow meter C is positioned at the outlet of the tertiary treatment pond, so effects of evaporation, rainfall, surface run-off and groundwater seepage are all influencing its reading.

The methodology taken towards flow data assessment is the following: Reliable Whakapapa Water Treatment Plant (WTP) production data exists since July 2015. WWTP flow information is only available since June 2016. Earlier information is ignored; numbers are most likely too high. From 15 June 2016 to 31 January 2017 the totalised values of flow meter A at the WWTP are compared with the sums of flow meters B and C and the maximum is taken in order to be conservative. These maximum WWTP values are compared with WTP production data. On days without rain the amount of water leaving the WTP appears very comparable to that received by the WWTP. The general term for this type of flow is Average Dry Weather Flow (ADWF).

Relationships are then sought for days with many skiers on the mountain or days with rain (both skiers and rain produce wastewater that does not relate to the WTP). WTP data is thereby taken as the basis for WWTP inflow, but upward corrections are made for skiers and rain. The results of this analysis are as follows:

Table 1: Plant hydraulic loading though tourist periods

Period	WTP flow (m^3/d)	Corrected for rainfall (m^3/d)	Corrected for skiers (m^3/d)
Summer (January-March)	179	237	237
Winter (July-October)	203	228	228

Notes:

- There seems to be no significant statistic relationship between waste water flow and skiers on the mountain.

4.2 Historic plant load information

The amount of contaminant (load) received by the plant is not directly measured but calculated multiplying concentration data with flow data.

Various documentation exists that reports plant flow and loading data:

- The nitrogen reduction options report by MWH in 2015[v]. MWH used Biowin for modelling WWTP performance. Flow data were used from November 2013 to November 2014.
- The report by DCM Process Control in 2014 characterising the influent to the WWTP[vi]

There are some comments to be made about the MWH nitrogen reduction options report:

- Actual flow data from October 2013 to November 2014 were used. The flow rates do not seem to be corrected for a faulty flow instrument. The flow data from the MWH report are in line with the plant flow rates from the daily operating spreadsheet, thus probably too high.
- MWH have taken the approach of developing 6 different dry weather flow profiles for Base, Shoulder and Peak season and within those for weekdays and weekends. They did this based on actual concentration monitoring during September and October 2014. It could be questioned how 2 months worth of data can be applied with certainty to a full year, but otherwise this was a useful approach at the time. For future forecasting a different approach is needed, because the tourist seasons have changed in the Whakapapa area with a notable upturn in summer visitors.
- The way that MWH have calculated infiltration flow and storm flows is based on the same dataset as how average dry weather flows (ADWF) were calculated. Although the details of the calculations are not made available, it seems like infiltration and storm flows may have been taken into account twice. This adds to the suspicions that flow figures that are used are likely overestimates.
- The DCM report was used as input to the MWH report. The DCM report is based on continuous monitoring of parameters and calibrating them by a certified laboratory. This method is probably as reliable as possible. The contaminant concentration profiles presented in this report are very useful to determine a design basis. The contaminant concentrations also differ with the season. 4 different concentration profiles were developed for NH_4-N and 2 for TSS and COD.
- In summary; the concentration data are likely to be correct for at least September and October. The deduction of 6 concentration profiles from this and assuming how they apply throughout the rest of the year is an approach as good as any other. Most likely the flows assumed for MWH's Biowin model are too high. It is possible that they are overestimated by a fixed percentage, but there is insufficient information to definitely conclude this.

4.3 Current plant loading profiles

Given the tourist nature of the WWTP catchment the plant loading is highly variable. The concentration information from the Process Modelling Nitrogen Reduction Options Report by MWH[v] was used to determine the plant loading. This report defines four different concentration profiles for TSS, COD and ammonia. We will call them A, B, C and D (and not use the names that MWH used for them as to avoid confusion). Profile A represents the lowest concentrations, which apply when little tourists are in the area (because tourists in the case of Whakapapa generate concentrated waste water) and D represents the highest.

- Profile A is applied for the entire of the low season;
- Profile B is applied for the summer season. The concentrations in profile B resemble best the averages in undiluted municipal waste water. This is an assumption by Veolia that deviates from the MHW approach. In summer there is less rain, hence less dilution as per Profile A;
- Profile C is applied for the ski season minus the peak days. A high proportion of the waste water is generated in Iwikau huts which have more dilution water available than the ski huts up the mountain;
- Profile D is applied for the peak skiing days when many people are up the mountain generating concentrated waste water. As mentioned in section 4.1 no significant statistical relationship could be found between skiers and waste water *flow rate*, so we have assumed here that skiers translate to *concentrations* only. 35 peak skiing days were selected. This number is explained below Table 8 in 5.2;

- All profiles are used in combination with Average Dry Weather Flows. Rain water normally dilutes flow and does not contribute much to plant load (with the exception of some TSS which will be ignored here).

The various plant loading profiles were evaluated for composition and frequency of occurrence. Average dry weather flow rates have been used for calculation. The result is presented in Table 2.

Table 2: Plant loading profiles vs occurence

Profile	Hydraulic load (m^3/day)	TSS load (kg/day)	COD load (kg/day)	NH4-N load (kg/day)	Occur-rence (days/y)	Occur rence (%)	Cum. occur-rence
A (low season)	188	35.8	79.5	6.2	155	42%	42%
B (summer)	179	34.0	75.6	8.2	90	25%	67%
C (winter regular)	193	60.2	122.2	11.4	85	23%	90%
D (winter peak)	213	66.4	134.8	31.8	35	10%	100%
Weighted ADWF	189	43.9	93.6	10.3			
Total					365		

The plant loading is presented on a per day basis because this is the common way of designing a biological treatment process. A well-sized plant will have a biomass inventory that can absorb peaks of BOD and nitrogen throughout the day due to the buffering capacity of the biomass and the buffering capacity of the process volume itself. The biological process will be the key step in removing contaminants from the wastewater and as such the starting point for a plant upgrade design.

4.4 Plant removal performance

The plant loading profile principle seems a sensible way of also evaluating what the plant can remove under the various circumstances. Available seasonal information with regards to plant outlet concentrations was grouped into one of the 4 profiles and evaluated. It was assumed that sampling was only done on weekdays. Hence removal data are not present for the weekend loadings. The results are presented in Table 3.

Table 3: Plant average inlet and outlet loads and removal percentages

Profile	TSS inlet (kg/day)	TSS outlet (kg/day)	TSS removal (%)	NH4-N inlet (kg/day)	NH4-N outlet (kg/day)	TIN outlet (kg/day)	N removal (%) based on NH4-N in	N removal (%) based on TN in	cBOD inlet (kg/day)	cBOD outlet (kg/day)	cBOD removal (%)
A (low season)	35.8	6.0	83%	6.2	1.0	2.8	55%	72%	36.1	1.3	96%
B (summer)	34.0	4.5	87%	8.2	1.5	2.9	65%	78%	34.4	0.6	98%
C (winter regular)	60.2	3.9	94%	11.4	5.8	7.5	34%	59%	55.5	0.8	99%
D (winter peak)	66.4	34.3	48%	31.8	10.9	14.1	56%	72%	61.3	1.4	98%

Notes to Table 3:

1. cBOD is displayed instead of COD. Whilst COD is a more accurate parameter, BOD is often measured as this is the parameter with the ecological impact. The ratio of COD/cBOD at the WWTP inlet is assumed 2.2 which is a common ratio for municipal wastewater.
2. TIN in outlet was first calculated based on NH_4-N. Not all TIN originates from NH_4 however. The figures in the next column are based on the assumption that total nitrogen in the inlet is larger than ammoniacal nitrogen by ~60%. This assumption is made based on a set of 8 analyses made in a winter period in 2014[vi] This percentage needs further substantiation prior to finalisation of plant design.
3. Profile D (winter peak) removal performance is looking more rosy than it probably is. Effluent sampling has traditionally never occurred on weekend days while many peak skiing days are weekend days.

The removal data from Table 3 are repeated in Table 4 below expressed as concentrations for ease of understanding. Removal percentages are not repeated as they are the same.

Table 4: Plant average inlet and outlet concentrations

Profile	TSS inlet (mg/l)	TSS outlet (mg/l)	NH4-N inlet (mg/l)	NH4-N outlet (mg/l)	TIN outlet (mg/l)	cBOD inlet (mg/l)	cBOD outlet (mg/l)
A (low season)	190.1	31.8	32.7	5.5	14.8	192.0	7.2
B (summer)	180.3	25.3	46.0	8.1	16.1	192.0	3.3
C (winter regular)	320.3	20.3	59.2	30.1	38.9	287.4	4.1
D (winter peak)	353.3	161.0	149.0	51.1	66.1	287.4	6.7

Conclusions from Table 3 and Table 4 are:

1. cBOD removal by the Whakapapa WWTP is good under all circumstances;
2. TSS removal is reasonably good, but there are individual sample data showing erratic effluent figures up to 1400 mg/l. Removal of TSS seems largely independent of flow profile. It is known that the tertiary filters are often bypassed due to operational problems. It is likely that the TSS removal has more to do with filter bypassing than with plant inlet loading. With properly operating tertiary filters removal percentages can be much better than those currently achieved;
3. Nitrogen removal varies between not so good and very poor. It can be clearly seen that nitrogen in the effluent gets worse when the plant loading goes up. This has both to do with the available oxygen taken up by BOD removal in favour of nitrogen removal as well as with the lower temperatures under which elevated loading occurs. Nitrification runs much slower at low temperatures. Looking at individual samples there are very few cases where the TIN concentrations are low. This confirms the concern stated by MWH[v] that nitrification and denitrification are hard to achieve in the same Pasveer Ditch.

Outlet data on dissolved reactive phosphorous and *E. coli* are presented in Table 5. No corresponding inlet data are available, so removal percentages cannot be presented.

Table 5: Plant outlet data on DRP and *E. coli*

Profile	Dissolved Reactive Phosphorous outlet (kg/day)	E-coli outlet (Log[CFU/100ml])
A (low season)	0.5	2.8
B (summer)	0.7	2.9
C (winter regular)	0.8	3.4
D (winter peak)	1.2	3.6

Concerning *E. coli* removal; this is highly dependent on the TSS removal. TSS in the effluent suppresses UV transmissivity and makes disinfection less efficient. There is currently no reason to assume that the limited removal of *E. coli* is primarily due to an underperforming UV system. Once the TSS removal issue is solved, the UV system must be looked at in terms of ability to deliver the required dose rate and absence of short-circuiting. Therefore *E. coli* performance is not considered a starting point for the WWTP upgrade.

It is unknown how much phosphorous is removed in the WWTP due to lack of sampling data. Phosphorous can normally be partially removed biologically in a Biological Nutrient Removal (BNR) system. If the biological removal does not suffice, a chemical dosing can enhance the phosphorous removal performance. The addressing of phosphorous removal is not considered a priority for the WWTP upgrade given the high background concentrations in the receiving environment.

5 CONCEPTUAL REMOVAL REQUIREMENTS

For the determination of removal requirements, we must look at a Design Basis for plant design, i.e. how much contaminant and how much water is received.

5.1 Parameters used for WWTP design

The design of the various steps in a wastewater treatment plant are based on a combination of contaminant loads and hydraulic flow rates. The following is an overview of the various (possible) unit operations in combination with their most important design parameter.

Table 6: Main parameters behind WWTP design

Unit operation	Main design parameter	Secondary design parameters
Screening	hydraulic peak flow	rag load
Degritting	hydraulic peak flow	grit load
Primary settling/filtration	hydraulic peak flow	TSS load
Secondary biological treatment	BOD/COD removal requirement, nitrogen removal requirement	Temperature, flow rate
Secondary clarification	hydraulic peak flow	MLSS expected from biological treatment
Intermediate pumping	hydraulic peak flow	dynamic pump head
Tertiary filtration	hydraulic peak flow	TSS expected from clarifiers
UV disinfection	UV transmissivity (strongly related to filtration performance)	hydraulic peak flow
Aluminium salt dosing	phosphorous load	
Sludge treatment	biological treatment design	wetcake disposal cost

Table 6 is included here for two reasons:

1. For general understanding on how WWTP's (or upgrades thereof) are designed; and
2. To indicate how important reliable flow data are.

The last item, flow data, is also used to calculate BOD/COD, nitrogen and TSS loads.

5.2 Projected hydraulic flow rates

Reference is made again to Table 2, which provides 4 different dry weather flow profiles for low season, summer, winter and winter peak days. So far, only historical flow and loading data has been considered. Growth forecast needs to be taken into account for future proofing purposes. The Department of Conservation[vii] has indicated the following growth forecast figures:

Table 7: Growth forecast for the Whakapapa waste water catchment for 2025

Period	Skifield visitor increment	DOC visitor increment	Day visitors increment	Night visitors increment	Waste water flow increment (m^3/d)
Summer	278	798	538	538	102
Winter	963	-	866	96	49

The wastewater flow increment in Table 7 is based on night visitors generating 150 litres of wastewater per day and day visitors generating 40 litres of wastewater per day based on the same estimates as in the MWH report[v]. Veolia believes this is conservative.

The flow increments in Table 7 are added to the hydraulic loads in Table 2 to determine design hydraulic plant load. This is done in Table 8 below. Design load onto the plant is determined differently for summer and winter tourist periods:

Summer is an uninterrupted period of 3 months during which buffering capacity in the network is not used (this buffering capacity equals the Iwikau buffer tank which is located upstream of where the summer waste water is generated). Winter on the other hand has flow profiles alternating between “winter regular” and “winter peak”, thus a higher amplitude in flow rate. Forecast visitor increases are more likely to come onto the account of winter regular days: Winter peak flow rates are not likely to grow as much because of the cap on ski passes. Also buffer capacity in the network will be used to flatten out some of the hydraulic peaks. Therefore it seems incorrect to use “winter peak” solely for design basis. As a best estimate a weighted average flow rate between “winter regular” and “winter peak” is used for winter.

The PDWF (design flow) is 33% higher than the calculated future ADWF. This mark-up generally captures up to the 90th percentile of measured flows within the various profiles. The 90th percentile is deemed adequate for load design given that anything over the 90th percentile is likely storm water and hence not contributing to plant loading.

Table 8: Hydraulic plant loads for design and consent purpose

Profile	**Future ADWF (m^3/day)**	**PDWF for load design (m^3/day)$^{note\ 1}$**	**For consent (m^3/day)$^{note\ 2}$**
A (low season)	188		
B (summer)	281	373	
C (winter regular)	242	334	
D (winter peak)	262		
Annual mean	231	353	530
95th percentile			765
Absolute maximum			995

Notes to Table 8:

1. The weighting between winter peak and winter regular is determined as follows:
    - The ski season usually lasts around 120 days.
    - The sum of School holidays and Blue Bird days (falling outside of school holidays) is around 35 days. Data over the last 6 years show an average of 35 days with in excess of 2000 skiers on the mountain
    - Therefore the weighting factor for “winter peak” is 35 days. The remained of 85 days is considered “winter regular”
2. The column “for consent” takes into account once in 30 years 24 hour maximum rain loads as forecasted by the High Intensity Rainfall Data System. Contaminant loads do not go up significantly under these circumstances, but the plant must process the storm water.

In all Table 8 presents a conservative approach, which compensates for the uncertainty introduced of the WWTP dataset not even covering a complete year.

5.3 Establishment of a Design Basis

The WWTP design basis is now determined by using the flow data from Table 8 multiplied with concentrations from Table 4. Despite plant peak flow rates being higher in summer, the winter contaminant loading is determining the design of the biological treatment. The winter weighted average figure from Table 8 is multiplied with loading profile D. It seems prudent to not weigh concentration profiles C and D as is done for flow profile; visitor growth will mostly translate into concentrated waste water because the number of overnight visitors can barely go up.

Table 9: Plant influent specification for design

Parameter	Unit of measurement	Design value	Notes
Average dry weather flow rate	m^3/d	231	
Peak dry weather flow rate (winter)	m^3/d	334	
Peak dry weather flow rate (summer)	m^3/d	373	
Peak wet weather flow rate	l/s	11.5	Note 1
Temperature	°C	≥6.3	10^{th} percentile upon winter peak profile
Total suspended solids	kg/d	104.1	
Chemical oxygen demand	kg/d as O_2	211.2	COD/cBOD is assumed 2.2
Ammonia nitrogen	kg/d as N	49.8	
Total nitrogen	kg/d as N	79.6	Note 2
Total phosphorous	kg/d as P	3.3	Note 3
E-coli	CFU/100ml	10^6	Note 4
Alkalinity	kg/d as $CaCO_3$	167.3	Note 5

Notes:

1. Whilst the plant contaminant loading is designed for a peak dry weather situation, it is prudent to design the plant for hydraulic flows that reflect the peak wet weather situation. The peak wet weather flow rate is assumed to equal the maximum flow as per consent. This then leads to a peaking factor (compared to ADWF) of 4.3 which is fair for a network that has moderate inflow and infiltration;
2. It is assumed that total nitrogen is 60% higher than ammonia nitrogen[vi] which must be confirmed prior to finalisation of plant design; and
3. No information on influent phosphorous concentrations or loads could be found. A typical concentration of 10 mg/l was estimated. This is based on the fact that the measured concentrations for COD, TSS and ammonia are all in the range between “medium strength” and “high strength” domestic wastewater.[viii] The value for total phosphorous was interpolated accordingly.
4. *E. coli* or faecal coliforms are not usually recorded as a load, but rather as a concentration. The mentioned value is an interpolation along the same lines as the one for phosphorous.
5. Alkalinity is based on worst case measured ratio between alkalinity and nitrogen as per the DCM report[vi].

5.4 Establishment of an effluent specification

This section provides information on expected effluent quality, and limits that may be used as resource consent conditions. It should be noted that these effluent limits are set on the basis of assumed prudent investment in upgrade of the plant and they are not set based on rigorous assessment of the assimilative capacity of the receiving environment to receive these loads.

For each parameter a design target is proposed which should be attainable under normal steady flow and load circumstances. These design targets are considered suitable to use as a long-term median concentration limit, using the statistical framework defined in the New Zealand municipal wastewater monitoring guidelines (no more than 8 out of 12 consecutive samples exceeding the median limit).

The nature of the wastewater catchment is however such that considerable load changes can occur. A biological plant always needs some time to adapt to changes even if it is sized for the larger loadings. The effluent concentration will at times exceed the design value in response to transient conditions. This is mostly due to the fact that living organisms have to do the job. To provide an upper limit for the effluent concentration, a 90^{th} percentile concentration is suggested for each parameter, to be used in conjunction with the median values discussed above. This value is higher than the design target by a margin that is reflective of the plants response to transient conditions.

All relevant plant effluent parameters are discussed below:

- Flow rate: From an engineer's perspective it does not make sense to specify a maximum to the effluent flow rate; what is received by the plant must leave it in one way or another. Influent will not disappear and discharge via the regular outfall point(s) is preferred over any other type of discharge. If the main aim of a maximum discharge flow is to set a limit on contaminant loads (obtained by multiplying concentration and flow) then it makes more sense to directly set effluent load limits. It was chosen not to do that here, because concentration limits are quite common in resource consents as well as plant design specifications;
- Temperature: Does normally not appear in an effluent specification;
- Total suspended solids: Veolia Experience indicates that a well-functioning BNR plant with tertiary filtration should be able to produce under 15 mg/l of TSS. If the tertiary filtration must be bypassed but the clarification stage works fine, below 25mg/l should be attainable under normal circumstances. In transient conditions the TSS value should stay under 35 mg/l;
- Five-day carbonaceous biochemical oxygen demand: $cBOD_5$ is a parameter that has lower accuracy and repeatability of measurement than COD, but between the two it is the parameter with the ecological impact. A BNR plant with tertiary filtration and UV disinfection should be able to produce under 10mg/l as is shown by the current performance of the plant. With the tertiary filter bypassed or under transient conditions, lower than 20mg/l is normally attainable;
- Nitrogen: In the Horizons One Plan, the nitrogen effluent parameter to be monitored is soluble inorganic nitrogen (SIN). This is in practice equal to total inorganic nitrogen (TIN), the sum of ammonia nitrogen, nitrate and nitrate. The attainable effluent concentration in TIN is independent of tertiary treatment working or not (as all nitrogen is dissolved), but it is highly dependent on temperature. With the right BNR design at a temperature of 6.3°C, under 8mg/l can be attained. With higher temperatures, better nitrification can be achieved and thus lower TIN values. The higher the recycle rate between nitrification and denitrification zones, the better the nitrogen removal. The current Pasveer Ditch has a very good recycle rate. An important note that has to be made is that nitrification requires alkalinity and denitrification requires a cBOD source. There should be enough of both in the wastewater or otherwise these must be dosed. The available analysis data indicates that levels of both are insufficient. Further information is also contained within section 6.3. Nitrification bacteria are slow growers especially at lower temperatures, which is exactly when the load changes occur. A 90^{th} percentile value of 20 mg/l is proposed, to provide for transient conditions;

- Dissolved reactive phosphorous: biological phosphorous removal is highly dependent on what phosphorous levels are received in combination with BOD or COD levels. Based on the current influent specification it can be expected that 2-3mg/l of phosphorous is taken up by the microorganisms. This leaves another 7-8mg/l to potentially be removed otherwise. In cases where biological phosphorous removal does not suffice, it can be chemically enhanced through iron or aluminium salt dosing or both. The dissolved reactive phosphorous concentration downstream of a well-designed properly working tertiary filtration step is under 1.0mg/l. Advanced technologies like membrane filtration can bring this figure further down to around 0.1mg/l. It is noted that phosphorus treatment is discussed here but does not appear to be a priority in terms of dealing with in-stream effects of the discharge;
- *E. coli*: A biological plant with well-designed, well-functioning tertiary filtration and UV disinfection should be able to produce under 100CFU/100ml, the log of that is 2. During the few days per year that the Tertiary Treatment Pond is envisaged to play an active role in the treatment process, sampling should be done from the back of the TTP or wetland. In such case, the disinfection performance deteriorates because of inputs from birds and other wildlife.

The following table is included as a preliminary set of effluent quality standards based on the considerations above.

Table 10: Plant effluent quality standards for design based on plant influent specification

Parameter	Unit of measurement	Design target (median value , not to be exceeded on more than 8 out of 12 consecutive monthly samples)	Suggested 90th percentile value (not to be exceeded on more than 3 out of 12 consecutive monthly samples)	Notes
Total Suspended Solids	mg/l	15	35	
Carbonaceous Biological Oxygen Demand	mg/l as O_2	10	20	
Total Inorganic Nitrogen	mg/l as N	8	20	Influent temperature ≥7°C
Dissolved Reactive Phosphorous	mg/l as P	1.0	5.0	Applicable only if phosphorus treatment is required
E-coli	CFU/100ml	10^2	10^3	

The values listed as design target in Table 10 may well be considered as the limit to an annual median. The combination of Table 9 and Table 10 form the design basis for the plant upgrade design.

Table 11 here below is included to indicate what removal percentages are associated with the design target and suggested consent values in Table 10.

Table 11: Expected removal of contaminants based on plant influent specification for design

Parameter	Unit of measure-ment	Plant inlet concentration	Removal for design target (median value)	Removal for suggested 90th percentile value	Notes
Total Suspended Solids	mg/l	312	95%	89%	
Carbonaceous Biological Oxygen Demand	mg/l as O_2	632	98%	97%	
Total Nitrogen	mg/l as N	238	97%	92%	
Total Phosphorous	mg/l as P	10	90%	50%	In filtered effluent the values for TP and DRP will not differ much.
E-coli	CFU/100ml	10^6	4 log	3 log	

In the following chapter the shortcomings of the current plant set-up will be compared to what is required for this design basis by going through the various parameters.

6 EVALUATION OF PROCESS SHORTCOMINGS

The parameters in Table 10 are all based on a well-designed well-functioning BNR plant design which the Whakapapa WWTP is currently not. Every parameter and its target design value will be evaluated against the current plant layout and process limitations will be identified. The process limitations all refer to a specific step in the WWTP process. After this so-called gap analysis improvement options will be evaluated in Section 7.

6.1 Total suspended solids reduction

The TSS leaving a biological treatment plant is usually unrelated to the TSS entering the plant. The TSS entering the plant mostly separates out, hydrolyses and gets captured in biological floc. The TSS leaving the plant is mostly biological floc only containing a minor amount of the influent TSS. Biological floc is light and has the potential to wash over the clarifier launders under certain circumstances. Tertiary filtration is designed primarily to filter out small amounts of TSS and thus reduce the effluent TSS concentration. In order to achieve this there are limitations to what a tertiary filter can treat in terms of flow and solids loading.

6.1.1 Hydraulic capabilities of the filters

The three filters are 0.9m in diameter, so have 0.64m^2 superficial area each. Assuming that these filters are filled with filter sand with a low uniformity coefficient they should be able to treat 1.8 l/s each with peaks up to 2.7l/s. The total is then much lower than the instantaneous peak flow in Table 9. Somewhat coarser media like hydroanthracite or filter coal would allow higher flow rates up to 4.1 l/s. According to Table 9, 3.8 l/s per filter would be required as a hydraulic peak flow. This is possible when the filters are upgraded with coarse media. Otherwise filter capacity would need to be augmented.

The pump feeding the tertiary filters is reported to pump 4.8l/s.[iv] It is suspected that MWH has not calculated this rate correctly though. In their report they make a subtraction where an addition would have been required. The corrected value would then be 12.2 l/s which is in line with the pump curve and Veolia's own observations. This feed flow rate translates to a flow per filter of 4.1 l/s. This is aggressive assuming they are sand filled and explains the high filter pressures often observed.

Higher flows currently bypass the filters and the UV system and run into the Tertiary Treatment pond from which there is no route back to the treatment plant. These flows obviously do not get solids removal treatment (or active disinfection).

Hydraulic overloading of the plant has to do with:

- Genuine high flows due to many tourists visiting Whakapapa and Iwikau; and
- Inflow and Infiltration.

Whilst I&I can never be totally eliminated there are very obvious signs of excessive I&I in the Whakapapa wastewater network.[ix] MWH have suggested a programme to reduce I&I[x]. The reduction of I&I will not just improve the performance of the filters, it will also improve performance of the clarifiers, the biological treatment and reduce the design capacity of any other equipment to be newly installed.

Genuine high flows (plus the part of I&I that will be left after the programme has been carried out) can be treated in two ways:

1. Design the plant to cope with it immediately; or
2. Design buffer capacity.

Because of existing assets the latter way might be the more economical. In Section 7 the options for buffering high flows are discussed.

6.1.2 Solids loading of the filters

On high TSS concentrations the tertiary filters have shown to block up easily. The normal response to a blocked filter is a backwash. The main issue with the Whakapapa filters is that each filter is backwashed with the effluent from the other two. This is a clever way to eliminate the need for a system comprising a backwash pump and tank, but it is a risky set-up on a plant with limited instrumentation and automation. It is simply not functioning when all filters are blocked up. It is impossible to backwash one blocked up filter with two other blocked up filters, so a stalemate position is reached. The concept only functions if filter loadings are normal, both hydraulically as well as in terms of load. The key issue is that hydraulic overloads often coincide with solids overloads. This happens when the clarifiers cannot fulfil their settling duty due to high flows.

The relatively quick blocking up of the tertiary filtration in combination with a flow that the filters should easily handle indicates that both:

- The filter media might not be correct for the duty; and
- The underdrain system seems underdesigned when compared with the feed pump.

Indeed according to anecdotal evidence two of the three filters have even “exploded” due to a high differential pressure. Therefore it is recommended to eventually overhaul the filters with the aim of taking away these operational hazards.

In summary the shortcomings of the filters are:

- An almost certain design issue with regards to the media and filter underdrains;
- No operational recovery mechanism in case of blockage of all filters; and
- A possible capacity issue.

If the capacity issue is confirmed there may be more economic ways to augment capacity than based on proceeding with the current filters. Therefore the addressing of the design and blockage issues are better postponed until the capacity issue is confirmed or not.

6.1.3 Loading of the clarifiers

The treatment step preceding the tertiary filters are the clarifiers. If they work properly the number of filter issues will also come down significantly. The clarifier design was checked on the basis of both hydraulic as well as solids loading rate.

The clarifiers have a surface area of $18m^2$ each and are very shallow with 2 metres and no side wall depth at all. They have a feed well that dissipates inlet energy. Provided sludge characteristics are all in the normal range, an upflow rate of 1.0m/h is the maximum loading for such clarifiers, making the maximum instantaneous plant flow $36m^3/h$ or 10 l/s. Then under that circumstance this upflow rate should only persist for very limited time. The plant design inlet flow rate is 11.5l/s according to Table 9. For this situation more clarification capacity would be required. Alternatively inflow can be buffered. For long duration high flow rates (which will realistically only occur when I&I contributes largely) flow buffering in combination with a temporary high clarifier loading will not suffice.

On the peak dry weather flow situation $373m^3/d$ comes into the plant. If the peaks are buffered out the average plant flow would be $15.5m^3/h$. Distributed over the two clarifiers this gives 0.43m/h which is a more healthy upflow rate.

The clarifier solids loading depends on the amount of mixed liquor processed. During the peak period the plant runs on maximum 5.0g/l MLSS. If the RAS rate is 100% of the plant flow which is quite common, the clarifier solids loading associated with a plant flow of $15.5m^3/h$ would be $4.3kg/m^2/h$. The figures in literature around recommended clarifier solids loading rate assume clarifiers of at least 3.5m side wall depth, good flocculation zones and a stable sludge. Under these circumstances 5-8 $kg/m^2/h$ is recommended[viii]. Lack of side wall depth makes the Whakapapa clarifiers susceptible to disturbances. It is hard to say what the recommended solids loading rate is under the specific Whakapapa circumstances and it is better to draw conclusions from experience. The peak period 5.0g/l MLSS has proven to work well on the clarifiers as long as no hydraulic overloading occurs.

In the future the WWTP may have to work with longer sludge retention times than it currently does. This has to do with the shift of BOD removal from the aerobic to the anoxic phase (refer 6.2) and the lower sludge production that this entails (which is good from the perspective of sludge processing and disposal). Older sludge behaves differently in a clarifier than relatively young sludge. This is worth noting although it may not lead to issues.

It could be cautiously concluded that clarifier loading is not a high priority concern.

6.1.4 Biomass quality control

Even if the clarifiers operate all within their design criteria, their effluent can still be poor. This mostly has to do with the quality of the sludge. Healthy sludge consists of a good blend of various micro-organisms. It is easy to get the wrong blend. Many causes exist for poor sludge quality. The most important are:

- Aeration issues
- High septic loads
- Wrong RAS rates

Aeration is discussed in the next section. High septic loads are things that must be dealt with. It is known that these occur. Luckily the high septic loads usually come as part of the diurnal peaks. If these peaks can be buffered the septic loads are buffered too. Refer to 7.2 Buffering of high flows.

Wrong RAS rates is considered a shortcoming, but can be easily solved. It is discussed in 7.6.

6.2 cBOD removal

The process volume for BOD reduction is $238m^3$[v]. The MLSS value that is usually maintained in peak time is around 4.0g/l. This means that 952 kg of MLSS is present. It is assumed that 80% of this is biologically active, hence MLVSS. This would then mean that the sludge loading for the plant design load is 0.10 kgBOD/kgMLVSS/d. This equals low loading according Veolia experience. It has to be mentioned that Pasveer Ditches are mostly designed with loadings similar to extended aeration facilities because of the relatively low treatment efficiency. Compared to this design basis the current WWTP would be at its maximum load for BOD (and not allow for the nitrogen that is supposed to be reduced simultaneously). The cBOD treatment has been satisfactory so far. The odd outlier on BOD performance does not warrant a separate study into process shortcomings with regards to this parameter, but it is noted that the BOD process volume is on the small side.

The aeration capacity installed consists of two paddle aerators of different size. The small aerator just after the raw water inlet has a power draw of 1.5kW and allegedly a Specific Oxygen Transfer Capacity (SOTC) of 1.8 kgO_2/kWh. The large aerator at the other side of the ditch has a power draw of 3.0kW and allegedly the same SOTC of 1.8 kgO_2/kWh. This makes the total SOTC 8.1 kg O_2/h or 194 kg O_2/d. The Actual Oxygen Transfer Capacity (AOTC) is always lower than SOTC due to efficiency loss related to waste water. Based on above SOTC the AOTC would approximately be 128 kg O_2/d.

A calculation was made for BOD removal alone in the current Pasveer Ditch based on the design plant load. The total required oxygen capacity based on these circumstances is 142 kg O_2/d. The current machines would in theory not be far off this requirement. However it was observed that during tourist periods (both summer and winter) the aerators struggle to maintain a healthy oxygen concentration in the Pasveer Ditch and a rancid smell develops. Two valid explanations can be thought of:

- The BOD load is not evenly spread over the day; the instantaneous oxygen demand is higher than the daily average;
- The aerators do not actually transfer as much as 128 kg O2/d.

The note must be made that BOD can also be removed in conjunction with nitrate (on the basis that there is nitrate, i.e. the nitrification step must work, see next section). This type of BOD removal does not require aeration. The ratio of BOD to total nitrogen in the current design basis is such that in theory all BOD could be removed anoxically, i.e. without aeration.

If BOD/N spot ratios change, which they do and if nitrification would work well, then only a small amount of aeration is required for which the current paddle aerators are likely good enough.

The purpose of the re-aeration tank is stabilisation of the aerobic bacteria which would otherwise have to occur in the Pasveer Ditch. As the Pasveer Ditch is fairly small for its purpose this re-aeration tank is a welcome addition for transfer of oxygen into the aerobic sludge. This promotes sludge retention time, endogenous respiration and thereby the development of the correct bacteria for the job and it reduces odour. The tank is approximately 37m^3 of capacity. Based on the tank capacity a RAS flow equal to the plant inlet flow would have a residence time of about 2 hours. This is within the range of what re-aeration tanks are normally designed for.

The oxygen transfer capacity in the re-aeration tank is unknown.

6.3 Nitrogen Removal

The only practical way to remove nitrogen is biologically. Biological nitrogen removal in regular municipal treatment plants roughly consists of nitrification and denitrification. Both processes primarily rely on microbial activity, and are required (in that order) to remove inorganic nitrogen from the waste stream. Upon nitrification ammonia nitrogen and organic nitrogen get converted into nitrites and nitrates in an oxidation process. This requires a certain combination of sludge age, temperature and DO concentration. Figure 15 indicates the boundaries for nitrification to be effective. It shows that the lower the temperature, the more difficult it is to nitrify. At a design temperature of 6.3 degrees a sludge age of at least 17 days is recommended. Sludge age is determined by the amount produced (and thus also wasted) per day. Sludge production rate is mostly determined by BOD removal. Due to the BOD load onto the plant the sludge production at the design capacity is estimated at 110kg/day. If this were combined with a sludge age of 17 days the inventory of sludge would equal to some 1.9 tonnes. The current Pasveer Ditch has a volume of 238m^3[v]. 1.9 tonnes of sludge translates to an MLSS value of 7.9g/l. This is impossible to maintain; the solids concentration into the clarifiers would be too high and they would not work at all.

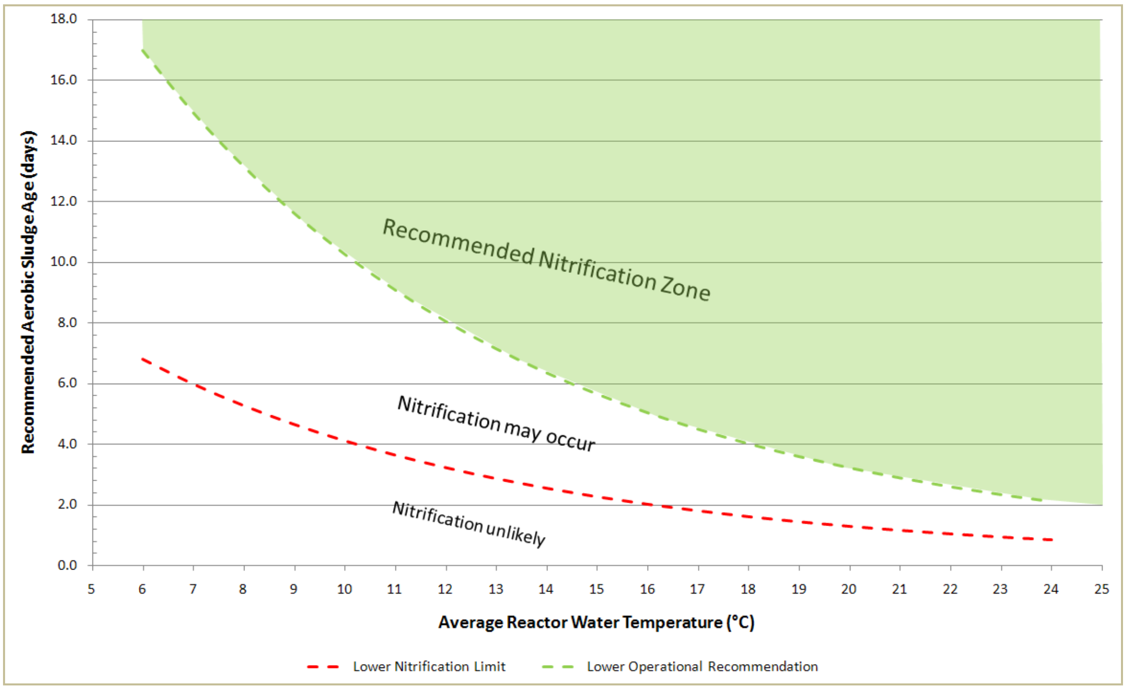


Figure 15 Nitrification pre-requisites[xi]

The conclusion from the above is that based on design conditions the capacity of the Pasveer Ditch seems too small to allow simultaneous nitrification and BOD removal. Solutions to the problem must be sought either in:

- Increasing the total treatment volume, a doubling would be required
- Separating the nitrification and denitrification. Either the nitrification or denitrification could go into a separate reactor.

For nitrification alkalinity is required. For every gram of Kjeldahl nitrogen removed, 7 grams of $CaCO_3$ alkalinity is also removed. If the alkalinity is not available the nitrification stops. The sampling data from the DCM report [vi] show an average alkalinity/TKN ratio of 3.1 with a variability between 2.1 and 4.1. The good news is that a well-functioning denitrification can alleviate the issue. For every gram of denitrified nitrogen 3.6 gram of alkalinity (as $CaCO_3$) is returned. If the denitrified wastewater is allowed to exchange alkalinity with the raw wastewater, the ratio of 7 can theoretically drop to 3.4. This would only be possible with a full backmix, which defeats the other purposes of wastewater treatment, so it is better to work with a ratio between 3.4 and 7. In either case this means that alkalinity is another factor preventing good nitrification in the Whakapapa WWTP. Lime, caustic soda or soda ash is typically dosed for alkalinity supply.

Denitrification is the process where nitrites and nitrates get converted into gaseous nitrogen. Any nitrogen load that is not first converted to nitrites and nitrates cannot be denitrified, meaning to say that this reaction sits low in the sequence of treatment steps. Denitrification rate is dependent only of temperature and BOD loading rate and it has as a prerequisite that oxygen concentration is below 0.2mg/l. Denitrification is often carried out as a first step in the biological process with a recirculation of nitrified water. The upfront position guarantees a high concentration of BOD which is rate determining for the denitrification. The recirculation rate depends of the ultimate nitrogen reduction that must be achieved. The current set-up in a continuously recirculating Pasveer ditch guarantees a very high recirculation rate.

The level to which nitrites and nitrates will be removed depends on the ratio of BOD/TN in the influent. The ratio in the current design basis in Table 9 is 2.1 where 4 is the minimum. Under all the other plant loading profiles (low season through to winter peak) this ratio is lower than 4 meaning that full nitrogen removal will always require an additional dose of a chemical like acetic acid or methanol (other carbon sources like ethanol and molasses have also been used). In Table 9 the values of BOD are estimated based on COD levels, the TN levels are based on limited sampling, so there is an uncertainty about the ratio.

Denitrification behaviour of the current plant was evaluated by subtracting outlet TIN and outlet ammonia values. The results of that exercise show that:

- When nitrification was good, denitrification was usually bad, except from two exceptions in warm months;
- When nitrification was not good, denitrification was much better, but still not great.
- Full nitrification/denitrification of incoming wastewater has only been achieved on occasions during low season (i.e. only a fraction of the design load) under warm weather circumstances.

This shows again that nitrification and denitrification are hard to achieve in the same small reactor volume especially when it is well mixed. The current ditch is too short to allow a high nitrifying DO level at one end and an anoxic level (below 0.2mg/l DO) at another end. If the volume were to be increased, the ditch would need to be much longer in order to achieve good zoning. Also with phasing of the DO regime a good total nitrogen removal result cannot be obtained because then an even larger volume will be required for the full process to work.

Denitrification and BOD removal in the same volume is a better combination. In first place the denitrification stage needs BOD. About 2.1 g of BOD is needed per g of NO_3-N reduced. When taking into account the sum of nitrogen absorbed in the sludge and remaining after the process, still 160kg BOD is required for denitrification. This would mean that the full incoming BOD load is needed for denitrification plus an external carbon source. Whatever BOD can be used for denitrification does not require aeration, thereby saving on power. The aeration capacity in the Pasveer ditch is currently insufficient so it makes a good space for simultaneous BOD removal and denitrification.

If the current design basis is confirmed a facility for an external carbon source must be foreseen. For effective use of this chemical and more consistent effluent results a small post-denitrification reactor between Pasveer Ditch and clarifiers is the preferred approach.

6.4 Phosphorous removal

Currently it is unknown how much phosphorous is received by the plant. It has been assumed in Table 9 that 10 mg/l as Total Phosphorous is received being in line with other concentrations between medium and high strength domestic waste water. The biological uptake capacity depends on the removal of BOD and the sludge residence time (as this affects the sludge uptake quantity). Between 2-3mg/l of phosphorous is assumed to be currently taken up by the sludge. This leaves another 7-8 mg/l of phosphorous of which a small amount might precipitate and be filtered off. Indeed the dissolved reactive phosphorous level that is of interest to Horizons One Plan will be lower than the total phosphorous level but not by a large margin. It must be assumed that chemical phosphorous removal will be required. Obviously such facilities are not currently installed so must feature on the list of plant shortcomings.

A factor that does not improve phosphorous removal (and to a lesser extent nitrogen removal) is leaving waste activated sludge idle for a long time. Sludge that has biologically taken up phosphorous is known to release it upon getting anaerobic. This is exactly what is suspected to happen in the re-aeration tank when not aerated. Currently WAS is left thickening in this tank and supernatant is periodically pumped back to the Pasveer ditch. No analysis data is available, but it is suspected that the supernatant stream is rich in phosphorous.

A similar situation occurs if sludge were stored for periodic thickening or dewatering in a dedicated tank. It will release phosphorous. The returned centrate or filtrate will be high in phosphorous and could shock-load the plant if released unbalanced. For balancing purposes the return liquid should be released to the Pasveer ditch downstream of the take-off point to the clarifiers (i.e. opposite to where the return pipe is now)

Permanently aerating sludge that biologically holds phosphorous is not a good alternative either. This starves the phosphate accumulating organisms of acetate which can only be generated under anaerobic conditions. Alternating anaerobic and aerobic conditions is the best way to capture phosphorous biologically.

6.5 E-coli removal

The monitoring of E-coli in the plant effluent and in the tributary to the Wairere Stream, which ultimately receives the plant effluent, shows erratic levels. This will have to do with the different flow paths towards the Wairere Stream that the plant effluent can take, but also with tertiary filter performance. In section 6.1 the shortcomings of these filters are evaluated. It is expected that once the filter performance improves the E-coli removal will too. Nevertheless the UV machine must be checked for its appropriate design and current lamp intensities, dose rates must be evaluated and permanent UVT monitoring should be installed. It is not expected that the UV machine needs replacement or augmentation.

6.6 Summary of current process shortcomings

The conclusions from this chapter are summarised as follows:

1. High flows to the plant cannot be buffered [solution almost complete at time of writing];
2. Inflow and Infiltration makes the high flows unmanageable [solution almost complete at time of writing];
3. The clarifiers are occasionally overloaded. Peak flows, even excluding I&I, are hard to process or will create upsets resulting in wash-out of solids which impact on the tertiary filters;
4. The tertiary filters need an escape route from a fouled position [solution almost complete at time of writing];
5. The tertiary filters need an overhaul from hazard and operability point of view [solution almost complete at time of writing];
6. The tertiary filters might need augmentation;
7. The nitrification step must be separated from the BOD removal and denitrification. The total reactor volume is too small and the DO profile cannot be varied sufficiently to carry out both processes in the same volume;
8. Insufficient alkalinity is present in the wastewater and must be dosed for nitrification to significantly progress towards completion;
9. The capacity of the aerators is insufficient for either BOD removal or nitrification, but when BOD removal and denitrification are combined in the current Pasveer ditch the paddle aerators can have a future, be it on an intermittent basis;
10. For full denitrification on the current design basis an external carbon source is required. In order to deploy this chemical efficiently a post-denitrification reactor is required;
11. For a substantial removal of phosphorous a chemical dosing will be needed in combination with a good tertiary filtration step;
12. The re-aeration tank should re-assume its aeration duty on intermittent basis so that sludge is conditioned well before either return to the Pasveer ditch or for dewatering. That obviously prompts the need for another waste sludge solution [solution almost complete at time of writing]; and
13. Too little information is available about the actual plant loadings and flow profiles during peak periods to make accurate design decisions pertaining to nutrient removal [being addressed at time of writing].

7 IMPROVEMENT OPTIONS ANALYSIS

In the previous chapter the limitations to the WWTP process have been linked to the various steps in the process. In this chapter these steps in the process are considered one by one and upgrade options are considered.

7.1 Inflow & Infiltration

The inflow and infiltration issues relating to the Whakapapa sewerage scheme can be summarised as follows from the MWH 2014 report[iv]:

- Infiltration into old and poorly maintained sewers;
- Displaced joints in sewers;
- Gully traps flush with or lower than ground level collecting storm water;
- Drain pipes from roof directed into gully traps; and
- The odd cross-connection.

Inflow and Infiltration should be one of the first issues to be addressed. It is the root cause of many of the capacity problems around the plant. Various sources of I&I exist so also various solutions must be explored in parallel. Refer to Table 12 for the options.

Table 12: Upgrade options for inflow and infiltration

Option	Originator	Benefits	Drawbacks
Lining leaking pipes	Various	More economical than replacement	Reduction of pipe capacity
"Bursting" leaking pipes	Ruapehu District Council	Pipe capacity stays equal or increases	More costly than slip lining. Only to be done if pipe is undersized or technically depreciated. Not practiced before in Ruapehu District
Raising Gully traps	MHW[ix]	Done at cost of property owners	
Diverting storm water pipes away from gully traps	MWH[ix]	Done at cost of property owners	
Repair pipes that leak locally (including leaking joints)	Veolia	Economical way to combat a significant part of the issue	Initial cost
Undertake works to control storm water around the treatment plant site	Cheal[xiv]		There is a small potential for storm water to enter the Tertiary treatment Pond. Otherwise there is no possibility for significant amounts of overland stormwater to enter the treatment plant site.

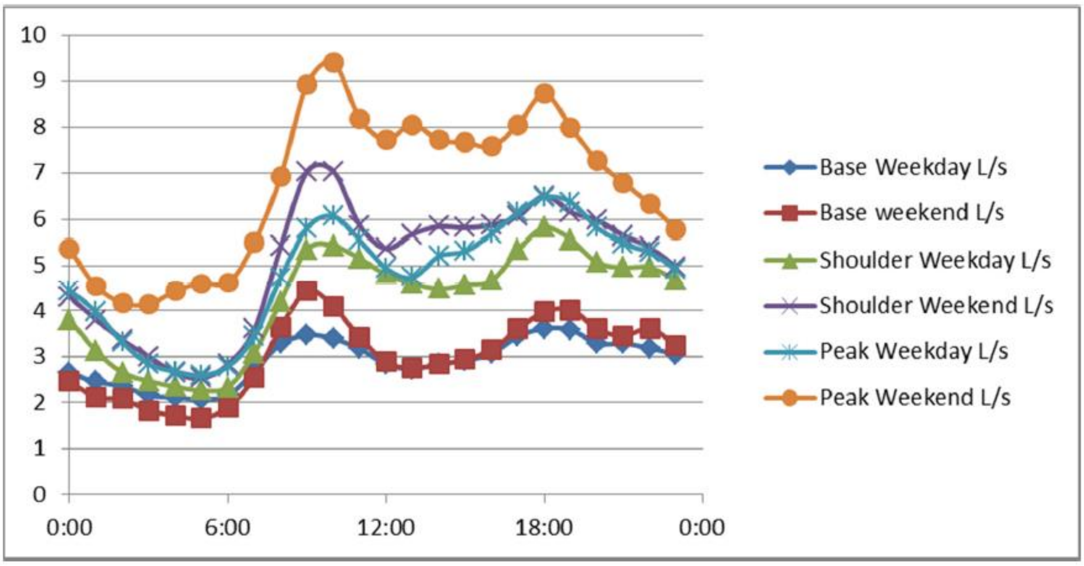
Option	Originator	Benefits	Drawbacks
Preferred options	Further investigation of the condition of the wastewater pipe infrastructure is required in order to understand if lining or bursting (if pipes undersized) will economically assist combatting inflow and infiltration into the network. [has commenced] Raising gully traps and diverting storm water pipes to be carried out in parallel. Repair pipes that leak locally (including leaking joints) in a comprehensive way.		

Quick improvement is expected by raising gully traps and diverting storm water pipes. The repair or replacement of sewer pipes is more expensive and generally will take place over a longer period of time.

7.2 Buffering of high flows

Once I&I issues have at least been partially resolved, there will still be diurnal peaks in the flow profile towards the plant. These are shown within Figure 16. Also it will never be possible to completely solve I&I, so wet weather peaks will remain (but smaller than the current ones).

Figure 16 Modelled diurnal profiles (adopted from source v)



Parts of the plant, such as the clarifiers and tertiary filters suffer when handling the design peak flow of 11.5 l/s. Instead of augmenting these, buffering of peak flows should be considered.

According to the Issues and Options Report of MWH[xii], the wastewater flow coming from Iwikau, or stated in another way, from upstream of the inline wastewater storage tank is roughly 50% under peak dry weather flow conditions. If this information is correct it creates an opportunity for beneficial use of this tank.

Table 13: Upgrade options for buffering of high flows

Option	Originator	Benefits	Drawbacks
Use tertiary treatment pond as flow equalisation basin. Thereto de-sludge the pond, line it with synthetic liner, install a plant bypass, install a return pump station.	Cheal[xiv]	Large stormwater capacity Full treatment of high flows	High construction cost Ongoing pumping cost
Install bypass from inlet works to disposal area	MWH[xiii]	Most economic solution to high inlet flows	This will result in a lesser degree of treatment and potentially a breach of resource consent conditions.
Convert the Iwikau inline waste water tank to allow actual buffering during the diurnal peaks	Veolia	Full treatment of high flows Existing tank. Needs relatively little investment for considerable result. Iwikau contributes around half of the inflow, so half of the peak can be shaved (if it does not last too long).	If tank is too small an extra solution must be found.
Use tertiary treatment pond as active treatment back-up for extraordinarily high plant loads	Veolia	Existing pond. No modifications required. Due to size very suitable for extensive treatment	Deterioration of coliform numbers in treated effluent.
Preferred option	Fit out the Iwikau buffer tank for flow buffering. Thereto put a flow control valve in the tank discharge and control from SCADA. Overflow of tank to bypass flow control. [almost complete at time of writing] If the tank proves too small for the occasional plant peak load, construct an overflow from the clarifier flow splitter towards the tertiary treatment pond.		

The Iwikau buffer tank will allow holding the peak dry weather flow from Iwikau for more than 24 hours. This is substantial capacity. It will effectively allow trapping the diurnal peaks from Iwikau and releasing them overnight as to balance the plant loading. This would be a very effective way of reducing plant upsets.

In the case that the Iwikau buffer tank is too small to hold the occasional short term load, or when the peak originates from downstream this tank, the tertiary treatment pond can absorb and treat the overload. Two types of overload exist in terms of a short term peak:

- A diurnal peak is so high that treatment problems occur. This will occur as a short term very high flow combined with a high nitrogen load. The treatment problems will manifest themselves in the nitrification treatment as well as in the clarification and tertiary filtration. In this case an overflow from the clarifier flow splitter into the tertiary treatment pond will lead to immediate relief on the clarification and filtration systems as well as an injection of mixed liquor into the pond. The mixed liquor will hold nitrifying bacteria as well as some untreated ammoniacal nitrogen. The pond will at this point be high in oxygen because high diurnal peaks in Whakapapa are due to high tourist influx. This always coincides with sunny weather. The sun promotes the algae cycle in the pond thereby creating an oxygen-rich environment. The combination of oxygen, ammoniacal nitrogen, nitrifying bacteria and the vast volume of the pond will see to the desired degradation of nitrogen to nitrites and nitrates. Anoxic zones in the wetland constructed downstream of the pond will see to the degradation of nitrites and nitrates aided by the naturally available carbon source.

- The second overload is related to high rainfall. Contaminant loads will be low in such case as there will not be many visitors during such weather. The wastewater in such case is very lean and does not need much treatment. Under these circumstances it is better to not overflow from the clarifier flow splitter, because mixed liquor is likely not needed for additional treatment. It is better to overflow from Pump Station 1. This overflow already exists and no additional construction is required. It has to be noted that this functionality works provided the tertiary filtration is upgraded (refer to 7.9) and functions properly. The tertiary treatment pond in this case serves as a settler for the suspended solids that have been washed over and a natural disinfection system, powered by solar UV light.

The aforementioned scenarios imply that the Tertiary Treatment Pond should be kept operational at least for the period that the design basis is not yet fully understood. It also means that at least one of the effluent sampling stations should be located at the tertiary treatment pond outlet.

7.3 Pre-treatment

Pre-treatment, being the removal of gross solids and grit, is not currently understood to be an area of great concern. When implementing solution dedicated reactor for nitrogen removal (which is a fixed biofilm process, refer to 7.5) the pre-treatment will turn into a considerable concern, because any fixed film process has the potential to catch rag. Moreover the lack of pre-treatment is responsible for the quick RAS pump wear and many plugging issues.

Table 14: Upgrade options for pre-treatment

Option	Originator	Benefits	Drawbacks
Do nothing	Veolia	No initial cost	Ongoing ragging and grit issues. Impossibility to have an effective nitrification treatment
Construct new inlet works with automatic screening facility with compactor and bagging of screenings	MWH[xiii] Veolia	Elimination of screenings and rag will extend lifetime of equipment, prevent a lot of plugging issues and save a lot on labour cost.	Initial cost, maintenance cost
Construct a grit chamber as part of the new inlet works	Veolia MWH[xiii]	Elimination of grit will extend lifetime of equipment and save on maintenance cost. Combining it with the screen will offer a synergy advantage. Permits electromagnetic (thus very accurate) flow measurement.	Initial cost, maintenance cost
Preferred option	Although currently there is no direct reason to install pre-treatment as a priority, any suitable nitrogen treatment option will require it. Construct an automatic screening facility and, because of the synergy advantages, a grit chamber at the same time. Install electromagnetic flow measurement.		

7.4 BOD treatment

The level of BOD treatment is not a current concern. Especially when nitrification works well, BOD should be removed as part of the denitrification process. In case of varying BOD/TN ratios the paddle aerators may still be needed, but their oxygen transfer capacity will most likely suffice. Prior to these conclusions some upgrade options for improvement of BOD removal capacity were suggested. They are listed in Table 15.

Table 15: Upgrade options for BOD treatment

Option	Originator	Benefits	Drawbacks
Do nothing	Veolia	No cost involved	Renewed consideration might be required later
Raise the level of the Pasveer ditch including raising the rotors and motors	Cheal[xiv]	On the eye an easy way to get a small gain in treatment capacity	There is currently hardly any freeboard left in the Pasveer ditch so there is no easy way of doing this. The volumetric removal requirement cannot be met by this measure
Install primary treatment as to eliminate 40% of BOD and 55% of TSS prior to secondary treatment	Veolia	Fast way of reducing plant load	BOD is required for denitrification. Removing it upstream generates the need to add more artificial carbon source.
Monitor performance of WWTP without using re-aeration tank	MWH[xiii]	Re-aeration tank can be used as temporary sludge storage/thickening tank	Re-aeration tank currently used as sludge storage/thickening vessel. Restoring its intentional duty frees up Pasveer Ditch aeration capacity which is dearly needed.
Preferred option	Do nothing. The upgrade of the nitrification step will have such an impact that BOD treatment will likely not be an issue. The BOD performance should be assessed during stage 2 of the upgrade to confirm that it is adequate to meet resource consent requirements.		

7.5 Nitrogen treatment

The lack of nitrogen treatment is the most important shortcoming from the perspective of the probable demands in the new resource consent. It was concluded in section 6.3 that the volume of the current Pasveer Ditch seems insufficient to accommodate the amount of sludge that would be required for complete nitrification under design conditions. It was also concluded that nitrification and denitrification in the same volume is challenging. For these reasons the first focus in this section is to separate nitrification treatment from the other biological treatment. The second step is to do this in a way that does not require a process volume equal to or larger than the existing Pasveer ditch. The third step focuses on the lack of alkalinity for the nitrification to complete. The fourth and last step is to focus on the BOD/N ratio that does not allow full denitrification. For clarity the four steps are split out into four different tables.

Table 16: Upgrade options for nitrification treatment

Option	Originator	Benefits	Drawbacks
Increase aeration capacity by changing rotor immersion depth or other means	Cheal[xiv]	On the eye an easy way to get a small gain in treatment capacity	The volumetric removal requirement cannot be met by this measure. In winter time the plant will still struggle to maintain nitrifying bacteria
Cover the ditch to prevent heat loss	Cheal[xiv]	Sensible idea for keeping some of the heat inside during winter time.	Oxygen depletion will take place under the cover thereby jeopardising the high oxygen need. Fresh air will always be required for aeration Maintenance under the cover will get more complicated
Modify control of aerators to allow simultaneous nitrification and denitrification. Enable large rotor to operate at an adjustable DO setpoint while the small rotor operates continuously	MWH[xiii]	Economic solution in case it works	The Pasveer ditch is too small to accommodate parallel BOD removal, nitrification and denitrification for the design plant flow. So this will not work
Install heating system to heat the wastewater in the Pasveer ditch to at least 10°C	MWH[v]	At 10°C nitrification will work faster than at the current design temperature	Opex considerations for heating wastewater appear to make this suggestion unfavourable. Note that municipal sewage is always generated at temperatures high enough for treatment. It seems more logical to prevent the sewage from cooling down too much rather than heating it up again.
Changing the aeration mechanism to one that adds heat rather than dissipates heat	Cheal[xiv]	At more elevated temperatures nitrification will work better	Such systems are unknown to Veolia. Laws of physics prescribe that adiabatic compression will be followed by expansion. At the same time heating will be followed by cooling.
Install a dedicated nitrification tank on a loop to the Pasveer ditch	Veolia	Nitrification can be separated from denitrification which is the only way that both processes can work	Initial cost

Option	Originator	Benefits	Drawbacks
Use the Pasveer ditch as nitrification only facility and install denitrification/BOD removal separately (wetland may provide de-nitrification)	Veolia	Less new tanks to be built Use of existing infrastructure	The sludge inventory required in the Pasveer ditch could not be clarified in a normal way and would need a membrane plant.
Try to achieve as much as possible nitrification in the Pasveer ditch. Install denitrification separately	Department of Conservation	Can start immediately No Capex involved Large save in expenditure if it works Use of existing infrastructure	BOD available for denitrification will all be consumed, adding to sludge production Larger consumption of alkalinity
Preferred option	In the short term, use the Pasveer ditch to try and provide at least partial nitrification, assuming the wetland will provide de-nitrification [has commenced] Should the above solution prove insufficient, install a dedicated nitrification tank on a loop to the Pasveer ditch.		

In a first instance, the Pasveer ditch may be used to provide a degree of nitrification of the wastewater prior to its discharge through the constructed wetland. Whilst the Pasveer Ditch may not be able to provide full nitrification, this approach presents the advantage of using existing infrastructure, gathering more information and the ability to be implemented immediately at minimal cost.

An external nitrification tank is considered to provide the most reliable nitrification outcome.

Nitrifying bacteria are sensitive and they grow slowly. The nitrogen loads onto the Whakapapa WWTP are highly variable. It will not be possible to breed up enough biomass prior to a peak day unless many weeks in advance artificial nitrogen loading is started by means of urea dosing. Then still events can occur that make the bacteria wash out or become inactivated. By far the best solution to housing nitrifying bacteria is immobilising them so they cannot go away. The generic name for this is fixed film activated sludge process. The immobilisation has as an extra advantage that the reactor volume can be significantly smaller than when a suspended growth process were to be selected. Two varieties of fixed film exist; fixed packing or suspended packing. Within these varieties multiple companies provide process designs and the required equipment. Table 17 lists the various options.

Table 17: Upgrade options for nitrification in a fixed film process

Option	Originator	Benefits	Drawbacks
Fixed bed Ringlace™ process	Veolia (not a Veolia process)	Ringlace can be placed inside an existing tank	It requires spiral roll diffused bubble aeration so the Pasveer ditch is unsuitable. Varying BOD loads disturb the process.
Fixed bed biorotor	Veolia	Developed for small scale plants	Sensitive to freezing over in winter. Attracts flies and mosquitos in summer. Needs screening at plant inlet

Option	Originator	Benefits	Drawbacks
Upflow submerged attached growth process	Veolia	Very efficient process on a small area	Complicated design with backwashing requirement. Requires pre-treatment and primary treatment.
Moving Bed Bioreactor	Veolia	Simple and robust design in a small area. Present in New Zealand	Needs separate tank with screen at outlet Needs screening at plant inlet
Preferred option	Moving bed Bioreactor as nitrification reactor. Preliminarily the Veolia Hybas process will be assumed for sizing and cost calculation. This is an economic and robust process specifically developed for this particular purpose.		

With the climatic conditions and varying waste water load of Whakapapa a solution is required which offers large operational flexibility. These criteria are best met by a moving bed bioreactor.

It was noted in section 6.3 that the wastewater generally holds too little alkalinity for good nitrification. In such cases alkalinity must be dosed. Various possibilities exist which are listed in Table 18.

Table 18: Upgrade options for alkalinity supply

Option	Originator	Benefits	Drawbacks
Do nothing	Veolia	No cost	TIN levels at the plant outlet can still go up to 80mg/l.
Caustic soda dosing	Veolia	Easy to handle chemical	Concentrated caustic soda congeals under 15°C
Lime dosing	Veolia	Economic choice from operations perspective	Difficult to handle chemical that has reputation for plugging dosing lines. Requires lot of attention
Soda ash dosing	Veolia	Economic choice from operations perspective Known to operators as also used in Taumarunui	Initial cost Ongoing cost
Preferred option	Soda ash dosing. More information on alkalinity and TKN levels would be helpful for appropriate sizing of this facility.		

Soda ash is the chemical that offers the best operability for the Whakapapa situation.

Once all nitrogen in the wastewater is nitrified, i.e. converted to nitrite and nitrate it still reports as TIN in the effluent. Denitrification is required for which BOD is needed. There is BOD in the wastewater, but under none of the loading profiles summarised in Table 2 there is enough BOD for full denitrification. If full denitrification is required an external carbon source is dosed. This usually acetic acid or methanol. The choice between either of these can be postponed and dosing equipment can even be designed such that it can take either of the 2. Dosing of this carbon source in the Pasveer ditch will lead to an inefficient use of the chemical; a part of it will be oxidised aerobically. This costs double money, because not only the chemical is ineffectively used, also the waste sludge amount increases. The standard solution to such problem is a post-denitrification stage. This is an unaerated tank (or series of tanks) physically in between the main biological process and the clarifiers. The carbon source is dosed at the front. The more or less plug flow regime ensures the most efficient use of the chemical. Options are listed in Table 19.

Table 19: Upgrade options for denitrification treatment

Option	Originator	Benefits	Drawbacks
Do nothing	Veolia	No cost	TIN levels at the plant outlet can still go up to 80mg/l. Post-denit inadvertently occurring in clarifiers leading to sludge bulking and poor effluent
Dose carbon source in Pasveer ditch	Veolia	Cheaper than separate tank	Inefficient use of carbon source leading to high consumption and more sludge to be processed
Install a dedicated post-denitrification tank between Pasveer ditch and clarifiers. Dose carbon source just upstream.	Veolia	The efficiency of carbon dose is much higher in a plug flow type arrangement like a post-denit tank than a continuously mixed arrangement	Initial cost
Execute post-denit as a moving bed bioreactor	Veolia	More compact than regular post-denit	Cost benefit not obvious
Install wetland designed for denitrification	Department of Conservation	DoC has committed to installation of a wetland for denitrification Wetland uses atmospheric CO_2 as carbon source which is more economic than carbon source dosing	No obvious location for effluent quality sampling. Deterioration of coliform numbers in treated effluent. Very long start-up period , so performance cannot be evaluated on the short term
Preferred option	Install a wetland designed for denitrification. Should the above solution prove insufficient, install a dedicated post-denit tank with two serial compartments, mixers and carbon source dosing followed by a small aeration tank.		

The Department of Conservation has committed to installation of a wetland for social cultural reasons. There is no additional cost involved in designing this for denitrification. The carbon source used for denitrification is provided by decayed biomass. Before biomass decays it will first have to go through an entire growth cycle. This is why the performance of a wetland can only be measured after several years. If the wetland proves to provide insufficient or erratic levels of denitrification then a dedicated denitrification process at the WWTP will be needed.

The inefficiency of carbon dosing in the Pasveer Ditch will likely within a period of a few years mount up to the cost of a dedicated post-denitrification tank. This separate tank is for reasons of residence time distribution (and thus treatment efficiency) best split in successive compartments. The small aeration tank (15 minutes residence time) at the back is needed for 2 reasons:

1. Any overdosed carbon source will report as BOD in the effluent. It can be removed in this aerated tank; and
2. Denitrification must stop before the clarifiers or they will suffer from rising sludge and thus deteriorated effluent.

Due to the uncertainties in design data it is recommended to assess the plant performance once the combination of external nitrification and denitrification in the Pasveer ditch is operational. It may reveal that the denitrification that occurs in the ditch is better than design data indicates. This will push out the timeframe for meeting ultimate effluent TIN data, but it will lead to a better-designed plant in the long term.

7.6 Phosphorous treatment

Better sludge management (refer 7.12) will provide for better biological uptake of phosphorous. Should enhanced phosphorous removal be required from Resource Consent perspective, the options available are as shown in Table 20.

Table 20: Upgrade options for phosphorous removal

Option	Originator	Benefits	Drawbacks
Install a dedicated biological phosphorous removal process	Veolia	Less chemical cost	Many dedicated tanks and complex process control required in order to make it work. Hardly feasible for small plant. Still additional chemical removal needed
Use ferric chloride dosing for phosphate precipitation	Veolia	Renowned phosphorous removal process	Ferric chloride must be imported into NZ and is very expensive
Use aluminium sulphate dosing for phosphate precipitation	Veolia	Renowned phosphorous removal process	Initial cost, operating cost
Use lime dosing for phosphate precipitation	Veolia	Cheap chemical	Nasty chemical to handle. Effluent pH can easily go out of specification Substantial increase in sludge production
Preferred option	Install aluminium sulphate (alum) dosing for phosphate precipitation. The other options are more complex, more expensive or both.		

The location for installation of the alum dosing is important. Preferably the precipitate is captured inside the floc so the clarifiers will catch the phosphorous precipitate. Any carry-over precipitate is then filtered off on the tertiary filters. If it is dosed before the biological process, the alkalinity will get negatively affected by the acidic alum and also the biological uptake may become less. Therefore the alum is best dosed just after the post-denit facility. A manually controlled dose line to the inlet of the filters might be worth the (small) extra investment as to allow polishing of the effluent. Dose rate is best flow proportional with a cap for wet weather flows.

7.7 Biomass quality control

If the amount of return activated sludge is high compared to the amount of substrate (i.e. low influent flows) the so-called filamentous bacteria are favoured. These bacteria are often responsible for sludge bulking and clarifier wash-overs. Therefore in most plants, even the small ones, RAS pumps have variable frequency control. The flow of RAS is varied with the flow into the plant. In larger plants there is a sophisticated control of RAS rate over influent rate, but as a first approach it works well to have a RAS rate equalling the influent rate.

Small plants usually have a large percentual variation in flow. If RAS rates are taken down the chances are there that the sludge turns septic. This is adverse for the process.

The presence of the re-aeration tank makes the solution here slightly less straightforward, yet more robust, see options analysis in Table 21.

Table 21: Upgrade options for biomass quality control

Option	Originator	Benefits	Drawbacks
Fit RAS pumps with variable speed control. Flow meter on RAS line.	MWH[xiii] Veolia	Better control of F/M ratio and thus sludge characteristics. Power savings.	Initial cost
Use Re-aeration tank as intended (but re-aerating intermittently) as to allow endogenous respiration separate from BOD oxidation	Veolia	This will alleviate the aerator duty and thus create a more robust environment for BOD removal in the Pasveer Ditch. It will also create a selector environment when RAS meets raw waste water thereby reducing the chances on bulking sludge.	Another tank may be needed for sludge storage (refer Table 25)
Install extra return pump in re-aeration tank. Allow returning sludge to ditch while in parallel discharging waste activated sludge to a sludge treatment solution	Veolia	No extra waste sludge storage tank needed. Waste sludge is stabilised so less odourous and pathoghenic.	Initial cost
Preferred option	All of the above in parallel. Reinstatement of the re-aeration tank allows sludge quality control. It should remain full which is something the RAS pumps will control. Return of sludge to the Pasveer ditch as well as wasting of sludge can be done by one set of pumps.		

7.8 Clarification

Based upon available data it is unsure if there is an issue with the clarification equipment. It is considered likely that once the I&I issues are resolved, flow is sufficiently buffered and biomass quality is under control, the clarifiers will achieve operational requirements. Table 22 is included nevertheless.

Table 22: Upgrade options for clarification

Option	Originator	Benefits	Drawbacks
Do nothing	Veolia	No cost involved	Action might be required later
Increase the capacity of the clarifiers	Cheal[xiv]	Less likely to get a sludge wash out with all negative consequences	Might not be needed if flow control measures are implemented
Preferred option	Do nothing. The current 36m^2 of sedimentation surface allows for some 700m^3/d loading. The flow data available so far indicate that the clarifiers should be able to cope if everything else works well. The words "do nothing" by the way do not mean implying to stop MLSS and SVI testing. These tests are very important to monitor the sludge characteristics and to anticipate on clarification problems.		

7.9 Tertiary filtration

The majority of the process shortcomings with regards to suspended solids removal and E-coli removal find their root cause in the underperforming tertiary filtration. Various shortcomings have been identified in section 6.1. The following upgrade options have been listed:

Table 23: Upgrade options for tertiary filtration

Option	Originator	Benefits	Drawbacks
Bypass filters when flows exceed 720 m^3/day or solids are carried over from clarifiers.	MWH[xiii]	Lower risk of plugging filters	Risk of breaching TSS and *E.coli* requirement in resource consent. Solution not addressing the root cause
Install a backwash facility using filtered effluent with potable water as a back–up.	Veolia	This creates a way out of a plant upset where all 3 filters are blocked	Initial cost
Install maintenance access hatch onto filters.	Veolia	This eliminates the need to deconstruct the building and lift filters out for maintenance once they are plugged. Lower maintenance downtime and cost expected.	Initial cost
Investigate quality of filter media and replace if needed.	Veolia	In case of correct filter media grading they should not plug that easily. Increase of capacity expected.	Initial cost
Install a VSD on the filter feed pump. Keep a capital spare filter feed pump.	Veolia	More benign filter flows, more operational continuity, less blockages, lower hazards, leaner bypasses if any.	Initial cost (a spare non-connected VSD was identified in the filter shed. It might be intended for this pump)
Investigate quality of underdrain system, pressure rating and replace parts if needed.	Veolia	Reportedly filters have “exploded” on previous overloading events. This indicates erroneous pressure design and a significant health & safety concern.	Initial cost
Install turbidity analysers on the common filter feed and filter outlet.	Veolia MWH[xiii]	Information on the correct functioning of the filters can be gathered. Conclusions about any automatic diversion can be better substantiated. Allows automatic shutdown of dripper field pump.	Initial cost
Preferred option	All suggested options in parallel except for the filter bypass. Considerable synergy advantages are present when executed in parallel. Operability of these filters is a serious concern. [project nearly finished at time of writing]		

7.10 UV treatment

Veolia considers it likely that the UV equipment might be capable of doing what it is intended to do once the upstream performance items have been addressed.

It is recognised that there is little instrumentation around the UV treatment. A relationship between poor disinfection and low UV transmissivity can currently not be established.

Table 24: Upgrade options for UV treatment

Option	Originator	Benefits	Drawbacks
Do nothing	Veolia	No cost	No means of verifying the good working of the UV machine. More action might be required later
Upgrade UV treatment unit.	MWH[xiii]	Effluent coliform requirements will be easier to attain under degraded circumstances.	Solution not addressing the root cause. If the root cause were solved first the UV unit might prove of sufficient capacity
Install a UVT instrument	Veolia	It will be possible to verify the good working of the UV machine or its replacement machine if any.	Initial cost.
Verify the design of the unit, install new lamps, sleeves, UVT instrument	Veolia	A general overhaul seems more economic than a replacement	Initial cost
Preferred option	Do nothing except verifying design, good functioning of the unit and installing a UVT instrument until results from all upgrades upstream of the UV unit have been completed and performance outcomes are known. If improvements in effluent TSS do not improve E-Coli reduction an additional audit is required.		

7.11 Wetland and decommissioning of disposal fields

The scope of this report excludes matters pertaining to the DoC commitment to establish a wetland and decommission the existing disposal fields. It is recognised that a wetland can provide a degree of treatment, including de-nitrification and final polishing of the treated waste water.

7.12 Sludge handling

The choice for the ultimate sludge handling solution is probably one of the last decisions to be taken. This will depend on:

- The amount of sludge to be ultimately generated. There is always an uncertainty in this, but the uncertainty in the design basis makes it worse.
- The future disposal cost. There is currently a very economic outlet which might not be sustainable.

A temporary assumption towards a solution will help planning for the rest of the upgrade. Refer to below table.

Table 25: Upgrade options for sludge handling

Option	Originator	Benefits	Drawbacks
Installation of a roof over the sludge dewatering pad	Cheal[xiv]	Geobags will not collect rainwater which then would negate their duty	A total review of the sludge dewatering methodology is recommended due to considerable health and safety concerns with ongoing 'reuse' of geobags.
Install thickened WAS tank	Ruapehu District Council	Duties of sludge thickening + storage are separated from the duty of sludge conditioning for optimised waste water treatment	There may not be a use for the tank once the ultimate sludge dewatering solution is implemented.
Install a sludge thickening facility, like gravity belt filter or dissolved air flotation	Veolia	More economical than a dewatering facility. Dewatering facility of smaller size can be built at end of pipe later if cost justified.	Not as a high a concentration can be attained as from a dewatering facility
Install a mechanical sludge dewatering facility	Veolia	The cost of sludge transport and disposal will come down.	Initial cost may not pay itself back quickly given the very low current cost for transport and disposal.
Install a mobile sludge dewatering facility	Veolia	The facility can be shared with other sites	Sludge storage is required. No other sites in the Ruapehu District currently have continuous sludge wasting.
Preferred option	Include a thickened WAS tank as part of the RAS and WAS management system. [completed] Postpone ultimate dewatering decision until more data available on waste sludge loads and future disposal cost. Assume for now a gravity belt filter fed from the re-aeration tank with covered storage of dewatered sludge. Return belt filtrate to Ditch past the take-off to the clarifiers.		

Frequent dewatering is the best way of not losing phosphorous captured inside the sludge back to the process. But as sludge dewatering cannot practically continue 7 days per week, 24 hours per day, the waste sludge needs some form of storage. It is practical to maintain the re-aeration tank as an aerated buffer and waste from there. The re-aeration tank will then upon this upgrade have a dual duty in re-aerating the return activated sludge as well as creating buffer for waste activated sludge. In doing so no extra tank is needed and no odour suppression/treatment system needs to be included. The current polymer dosing system can be modified as to have a flow proportional dose into the feed line towards the thickening equipment.

The re-aeration tank is best intermittently aerated for two reasons:

1. Exposing the raw water to RAS with a relatively high DO content makes the aerobic BOD removal process start. This is not desired; all available BOD should initially be used for denitrification as any demand must be supplemented with external carbon source; and
2. Sludge releases phosphorous when it is left anaerobic, but also when it is left aerobic for too long.

The re-aeration tank and its pump become a vital piece of equipment. As such an extra pump is proposed. VSD's on the pumps are proposed in order to regulate the RAS flow with the incoming waste water flow. This is a standard way of ensuring the right food to mass ratio in the biological process thereby favouring conditions for the right bacteria and a settlable floc.

As long as the final sludge solution is not implemented the re-aeration tank cannot combine duties of sludge conditioning as well as sludge thickening prior to disposal as per the current outlet. For that reason a thickened WAS tank is best implemented early on at least as a temporary solution.

It is noted that the re-aeration tank blower is a non-spared piece of equipment. A capital spare blower is suggested such that a blower failure can be corrected the same day. (It might be shared with a spare backwash blower for the tertiary filters) An installed spare may not be needed because the process will not fail immediately with un-aerated sludge.

7.13 Process Monitoring

Table 26: Upgrade options for process monitoring

Option	Originator	Benefits	Drawbacks
Construct new inlet works with a flume and a more accurate and more accessible flow meter.	MWH[xiii]	It will be possible to more accurately measure flow into the plant which is mandatory for understanding the operation.	A flume is one way of measuring flow. In case grit removal is installed an electromagnetic flowmeter is preferred because of higher accuracy and lower cost
Replace the flow instrument in the clarifier outlet	Veolia	Information can be gathered around flows. Better informed decisions can be made on upgrades in a later stage	Initial cost
Installation of further process monitoring equipment	All parties	Information can be gathered around flows and loads. Design basis for the plant upgrade can be established with more accuracy.	Initial cost
Increase automation of the treatment plant monitoring and operations including a SCADA system. Install remote SCADA system on laptop, with alarms to cell phone.	All parties	Information can be gathered around flows, loads and common operational problems. Problems can be addressed before they escalate.	Initial cost
Continue current periodic sampling and analysis for SVI and MLSS. Augment monitoring program with appropriate parameters for a BNR plant.	Veolia	A close eye can be kept on the daily performance, especially nitrification, denitrification and phosphorous removal. Dose rates can be optimised based on changed influent.	Operating cost (Repair cost and/or penalties when monitoring not implemented will likely be higher)

Undertake annual audits of the plant and disposal operations by a suitably experienced expert	Cheal[xiv] Veolia	Process optimisation is a requirement in the first stage in order to make the most of the upgraded plant. It will be money well spent.	Initial cost
Preferred option	Replace flow measurement in the plant outlet. [completed] Install a SCADA system + communications to enable remote plant control. Install flow measurement at the plant inlet post the degritting facility. Install flow, level, pressure and quality instrumentation in strategic locations. Purchase lab equipment for on-site monitoring of nitrogen and phosphorous removal performance. [completed] Increase frequency and type of sampling during peak periods. [ongoing] Undertake annual audits of the plant and disposal operations by a suitably experienced expert.		

7.14 Plant Documentation

Only two base options could be identified for managing plant documentation. They are presented in Table 27.

Table 27: Upgrade options for plant documentation

Option	Originator	Benefits	Drawbacks
Update the Operations and Maintenance Manual as a result of the upgrade	Cheal[xiv] Veolia	The background behind the plant operation is clear for all. Continuation of a high standard operation and maintenance is guaranteed	Initial cost
Do nothing	Veolia	No cost	The risk of maloperation is unacceptable
Preferred option	Update the Operations and Maintenance Manual after every stage of the upgrade		

8 COST ESTIMATE OF PREFERRED IMPROVEMENT OPTIONS

The improvement requirements and costs are directly linked to the (currently unknown) outcome of the resource consent application. The information presented in sections 7 and 8 is therefore indicative only for the purposes of enabling understanding of the potential requirements and cost implications arising from the DoC resource consent application.

The preferred improvements as identified in section 7 are listed in below table with a ±30% capex cost estimate. Costs are exclusive of GST but inclusive of project design, management and contractor margin and a 20% contingency. Any land acquisition, building and earthwork consent requirements are excluded.

The annual Operational cost is presented as well and estimated based on:

- A weighted average of the current flow profiles (since growth has not occurred yet)
- Manhour rates as per Contract 1039 between Ruapehu District Council and Veolia

- Power cost at a flat rate of $0.14/kWh
- Cost of maintenance amounting to 1.5% of the initial purchase cost (mechanical equipment and instruments only)
- Other consumables as per contract arrangements of Contract 1039 between Ruapehu District Council and Veolia

Table 28: Cost estimate of improvement measures

Improvement measure	Improve-ment Stage	Capex estimate ±30%	Annual Opex estimate ±30%	Notes
Replacement of flow instrument in clarifier outlet	1	$4,000	$30	Completed
Trial complete nitrification in Pasveer ditch	1	N/A	negligible	Completed. Results indicate that this is not possible.
Improved sampling regime during winter period	1	N/A	$6,000	Inlet and outlet concentrations of typical waste water parameters
Measures aimed at reducing inflow & infiltration	1	$180,000	N/A	Separate budget estimate is submitted
Fitting out the Iwikau buffer tank for flow buffering	1	$198,000	$3,800	Flow control valve + bypass, overflow line, mixing facilities, tank vent, power supply, switchboard, level instrument. Excludes communications. [nearing completion]
Lab equipment for on-site monitoring of nitrogen and phosphorous.	1	$21,000	$7,000	Hach-Lange spectrophotometer, SVI test device, additional lab equipment [completed]
Installation of communications facilities at various sites	1	$414,000	$2,000	Lump Sum Turn Key supply for sites: WWTP Iwikau buffer tank 5 Wastewater pump stations New switchboard for 1 pump station
Installation of SCADA at WWTP site	1	$90,000	$8,000	Includes GSM modem, alarm paging software, temperature instrument on plant inlet and 2 turbidity instruments on clarifiers and filters

Improvement measure	Improve-ment Stage	Capex estimate ±30%	Annual Opex estimate ±30%	Notes
New switchboard at WWTP site with sufficient capacity for new motors and instruments	1	$612,000	$4,000	Includes new building for switchboard, blowers and soda ash dosing. Includes new PLC & panel, provisions for all new motors and instrumentation for the later stage. Includes new instrument air compressors + pressure instrument. Excludes upgrade of power supply to plant (if needed).
Measures around RAS & WAS: • VSD and flow instruments on all RAS and re-aeration pumps • Extra return pump • Spare blower • Instrumentation • Thickened WAS tank	1	$97,000	$4,000	Includes new re-aeration pump, VSD on all re-aeration and RAS pumps, flow instruments with level controller, WAS flow control arrangement, spare blower, pressure & level instrument. Thickened WAS tank allows re-aeration tank to re-assume its duties. [Thickened WAS tank installed]
Tertiary filter backwash facility	1	$66,000	$500	Backwash water tank on concrete pad plus valves, Backwash pump, new automated valves & pipework. Pressure instrument on outlet. [nearing completion]
Filter upgrade	1	$76,000	$200	Maintenance hatch, new media, new underdrains, turbidity analysers, VSD on feed pump. Capital spare feed pump. Note that should filters prove too small, this scope will change significantly. [nearing completion]
UVT instrument	1	$35,000	$0	Installation and commissioning Power saving estimated to offset maintenance cost

Improvement measure	Improve-ment Stage	Capex estimate ±30%	Annual Opex estimate ±30%	Notes
Installation of screening and grit trap at WWTP + electromagnetic flow instrument	1	$228,000	-$9,000	Includes level sensor, hardstand and bins.
Installation of MBBR nitrification tank including pumps, blowers, instrumentation & valves.	1	$1,101,000	$15,000	Also includes flowmakers in Ditch, all internals and media, guard rails for nitrification tank, VSDs, 2 pressure instruments, 2 DO instruments and level instrument. Includes process guarantee. Cost of this measure will be significantly impacted by design load.
Installation of bunded Soda ash dosing system and reception facilities for alkalinity supply	2	$162,000	$9,000	To be installed indoors. Includes pH instrument in nitrification tank, level instrument in dosing tank, safety shower
Installation of post-denit tank including mixers, bypass and bunded carbon dosing + reception facilities	2	$386,000	$24,000	Includes small post-aeration tank with aeration grid, new flow splitter, guard rails for tanks, roofed, fenced & bunded chemical hardstand, forklift for IBC's
Installation of bunded alum dosing and reception facilities for phosphorous treatment	2	$51,000	$15,000	
Sludge thickening facility in small building	2	$187,000	$1,200	Includes flow instrument, flow control manifold, shed over bunded area, electrical fit-out. Cost of this measure will be impacted by correct flow data

Notes

1. All improvement measures will include an update of O&M documentation;
2. Costs for items relating to the wetland and decommissioning of the existing disposal fields are excluded from the scope of this report.

9 CONCLUSION

Reliable data on WWTP influent flow is only available since mid-2016. The design basis for plant upgrade is based on less than a years' actual flow data and for the rest "data-engineered" from WTP production. The reported concentrations, also before 2016, at the plant inlet are believed to be correct. Plant loading is calculated through flow multiplied by concentrations. As such the design basis is not very solid yet. Conservative assumptions have been made about growth (conservative in the sense that considerable growth is forecasted) which give some certainty that the design will not be undersized. The nature of the catchment generates a wastewater, which has an unfavourable ratio of nutrients to carbonaceous material, especially under the more elevated loading conditions. This prompts the need for various chemical dosing facilities.

Since effluent concentrations are likely to feature in the resource consent a lot of the conclusions on contaminant removal will be valid irrespective of accuracy of the design basis. In concept therefore many of the listed improvements identified in this report will be required. The question will then only be a matter of equipment sizing. In order to size the equipment appropriately a larger dataset is required, particularly on flow.

The uncertainty concerning design basis prompts for an upgrade best executed in 2 stages. The first stage is a multiple year program which initially contains elements that are not design basis related. DOC have indicated that a wetland will be constructed as a stage 1 activity. Once this wetland is constructed it will be possible to assess its impact on the receiving environment after which additional measures can be implemented as/if required. After running the facility a number of years into stage 1 more certainty is obtained on the design basis especially with regards to the biological treatment. As the last part of stage 1 the biological treatment can be upgraded with a nitrification facility of the correct size.

By monitoring of the effects of the completed stage 1 it will become clear how well the wetland performs and which of any chemical additions need to be made to the treatment for its optimisation. Also it will become clear whether enhanced denitrification at the WWTP site is needed.

The waste sludge treatment is also better deferred. Reasons are:

- Actual sludge production always varies compared to the calculated production;
- The current, very cost effective means of sludge disposal is likely to change due to increasing landfilling cost;
- There is little relationship between sludge treatment and plant effluent quality.

By postponing the upgrade of the sludge treatment (or part thereof) to stage 2 ultimately the best-informed decision can be made. In order to return the re-aeration tank to its design duty, which is re-aerating the sludge, a thickened WAS tank will be built as part of stage1.

With regards to treated effluent sampling the following is concluded:

- In case the use of the dripper fields will be continued, effluent sampling must occur from the Screen chamber or pump station that is feeding these dripper fields;
- In case the dripper fields cannot take up all of the treated water, which is often the case, effluent sampling must also occur from the outlet end of the Tertiary Treatment Pond or, once constructed, the outlet of the wetland.

The below table summarises the cost per stage of upgrade. Some of the expense may not have to be made.

Table 29: Cost estimate of improvement measures

Improvement Stage	Cost estimate ±30% (incl 20% contingency, ex GST)
1	(wetland and dripper field works excluded) $3,122,000
2	$786,000

10 RECOMMENDATIONS

A 2-staged upgrade is recommended. The first stage initially comprises of compulsory upgrades that improve plant operability and data collection. During this stage, which will take several years, information will be collected such that informed decisions can be made for the last part of stage 1. At the end of stage 1 the plant will have achieved a significant improvement of nitrogen removal from the wastewater.

Stage 2 is more around fine-tuning of the plant performance and operability; It is expected that stage 1 will address some problems that will affect the decisions for stage 2. A better assessment of what is required additionally can be made after the stepwise process changes. If at the end of stage 1 the design basis for plant upgrade must be changed then some or all of stage 2 actions may not need implementation at all. A P&ID drawing that schematically indicates the upgrades to the plant is contained in Appendix A. The different stages of the upgrade are displayed in different colours.

The proposed staging is as follows:

10.1 Stage 1

- Replace flow instrument in clarifier outlet [completed];
- Trial complete nitrification in Pasveer ditch [completed];
- Improved sampling regime during peak periods [ongoing];
- Measures aimed at reducing inflow & infiltration [has commenced];
- Fitting out the Iwikau buffer tank for flow buffering [nearing completion];
- Lab equipment for on-site monitoring of nitrogen and phosphorous.
- Installation of communications facilities at various sites [has commenced];
- Installation of SCADA at WWTP site;
- Upgrade of switchboard at WWTP site with sufficient capacity for new motors and instruments;
- Measures around RAS and WAS including thickened WAS tank [partially completed];
- Tertiary filter backwash facility [nearing completion];
- Filter upgrade [nearing completion];
- UVT instrument;
- Installation of wetland. DoC have indicated that they will construct a wetland with denitrification duties. [design complete]

The effects of the wetland on the ecology of the downstream environment will be monitored and analysed prior to continuing with the last part of stage 1 which comprises of:

- Installation of screening and grit trap at WWTP + electromagnetic flow instrument (depending on the need for a dedicated nitrification process);
- Installation of MBBR nitrification tank including pumps, blowers, instrumentation & valves (depending on the success of trialling full nitrification in the Pasveer ditch);

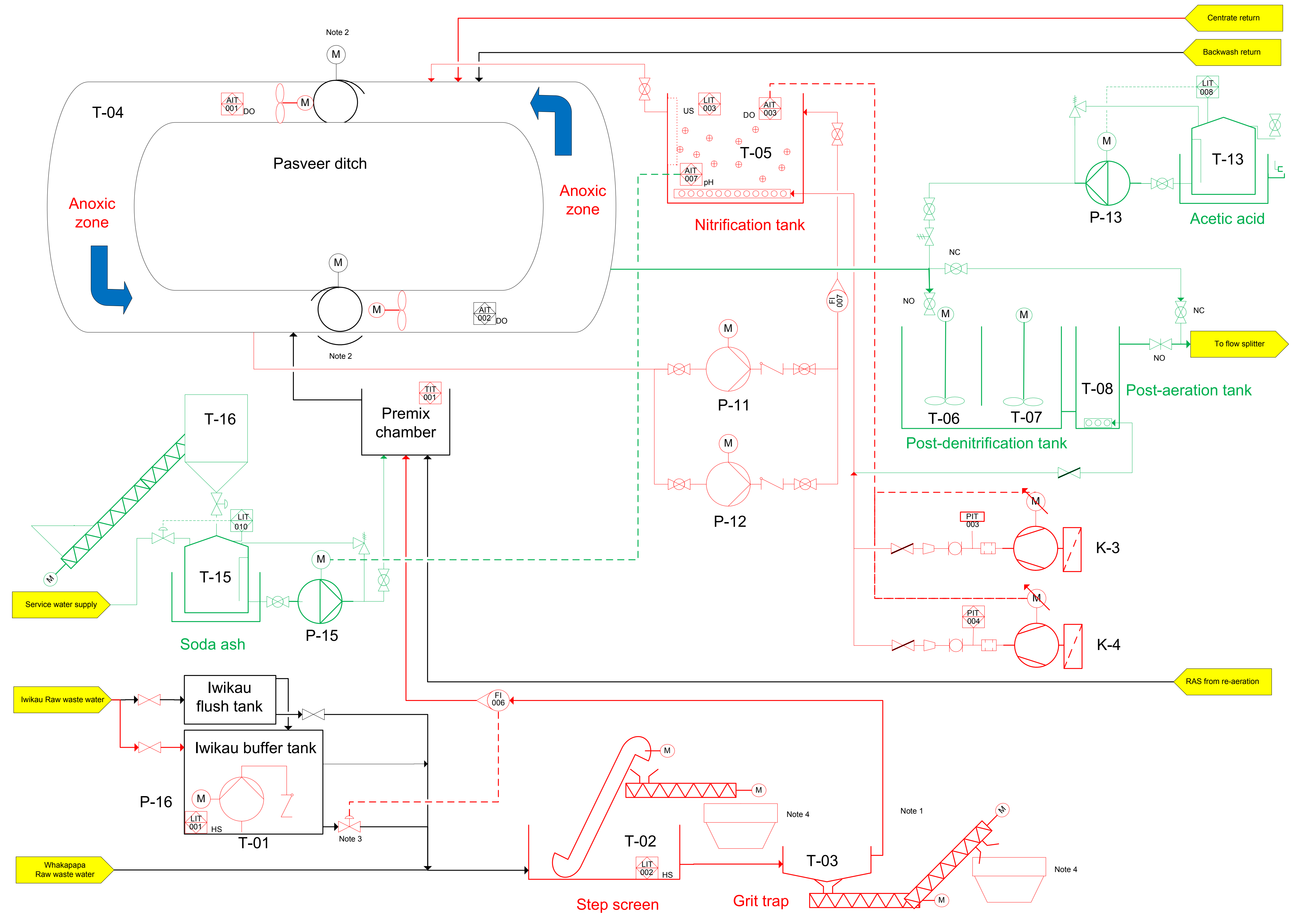
During the monitoring of the early stage 1 effects it will become clear what additional measures are required from the perspective of the receiving environment, so the WWTP design basis can be adjusted if needed.

10.2 Stage 2

At this point it will be identified to what extent additional denitrification must be installed if any. That will also clarify the ultimate amount of sludge produced. Any change in sludge disposal cost will be known at this point which then enables a proper business case to be done. Additionally the need for chemical enhancement of the biological process will be clear.

- Installation of bunded Soda ash dosing system and reception facilities for alkalinity supply (depending on the need therefore);
- Installation of post-denit tank including mixers, bypass and bunded carbon dosing + reception facilities (depending on success of wetland);
- Installation of bunded alum dosing and reception facilities for phosphorous treatment (depending on the need therefore);
- Sludge thickening facility in small building (depending on previous process changes and resulting sludge production);
- More clarification capacity (depending on success of filter upgrade).

APPENDIX A - PIPING & INSTRUMENTATION DIAGRAM INDICATING WHAKAPAPA WWTP UPGRADES



NOTES:

General: Working revision. Not all valves identified. Not all pipe size and class identified.

Coloured items are proposed new:

Red: Stage 1

Green: Stage 2

1. Flow instrument to be electromagnetic in case of grit trap installed. Else flume type.
2. Paddle aerators normally not running since anoxic conditions desired. New flowmakers see to maintaining 0.3m/s velocity.
3. Flow from Iwikau throttled based on plant inflow in order to flatten out peaks. Based on timers prior to stage 2.
4. Screenings bin and grit bin levels to be visually monitored.

MANAGER		
DESIGN	NdH	07/02/16
DESIGN CHECK	PD	19/02/16
DRAWN	NdH	13/06/16
DRAWN CHECK		
SIGNATURES		DATE

DRAWING No.	TITLE	CODE	DATE	DESCRIPTION	DRN	DRCK	DES	DSCK	MGR
REFERENCE DRAWINGS		REVISIONS & ISSUES							

A1

VEOLIA WATER

A.C.N. 069 471 334

Whakapapa
Waste Water Treatment Plant P&ID
Pre-treatment and Biological treatment
SHEET 1 of 3

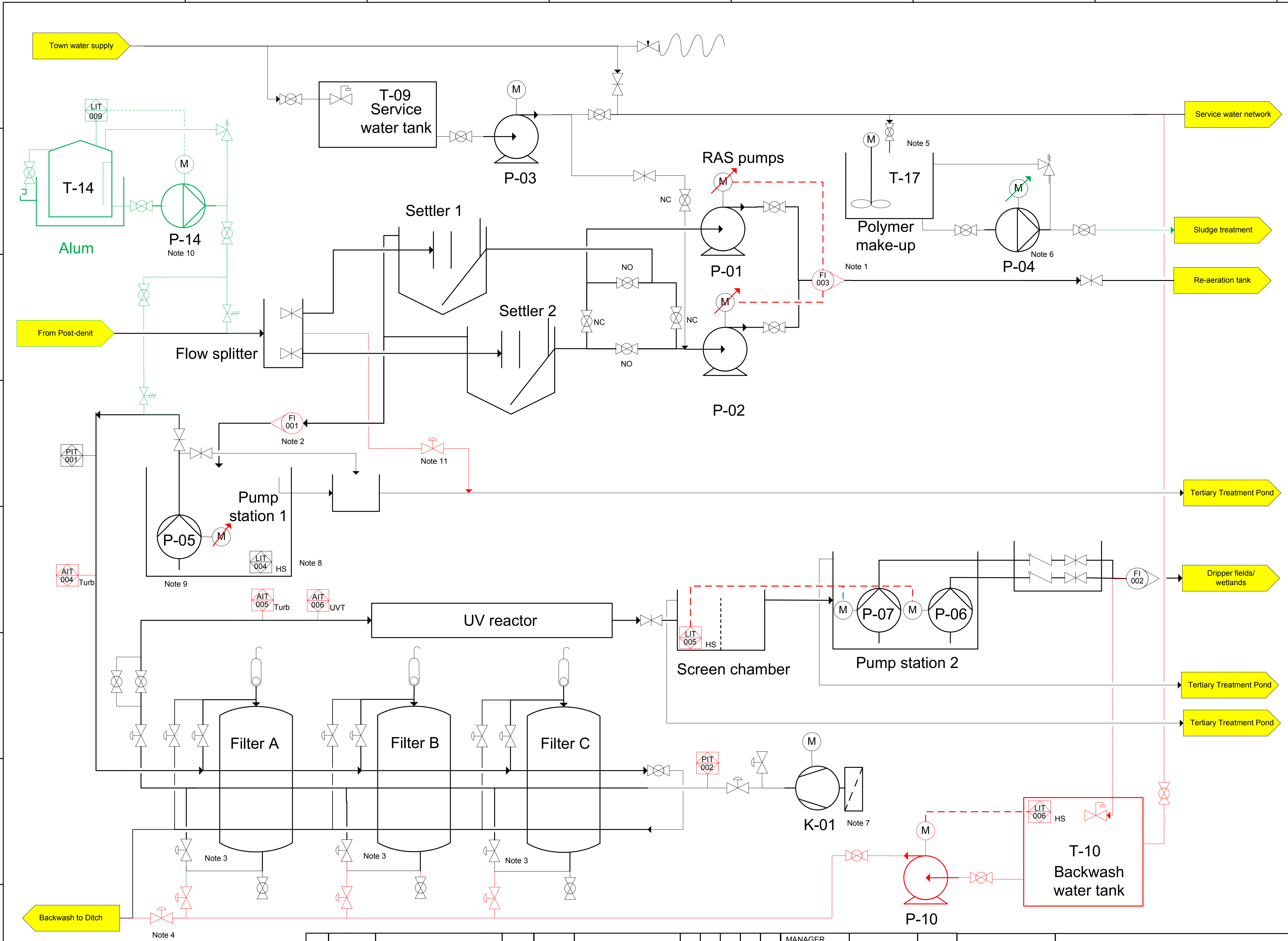
Scale: NOT TO SCALE

CAD DWG =

Project no =

Drawing number: RES- 15007-01

Revision: 3



NOTES:

General: Working revision. Not all valves identified. Not all pipe size and class identified.

Coloured items are proposed new:
Red: Stage 1
Green: Stage 2

The valves and instruments that do not have a dedicated control line to or from them are all controlled by the filter sequencer.

1. RAS pumps controlled by re-aeration tank level unless tank bypassed
2. Flow instrument to be replaced
3. Rearrange outlet valves, overhaul underdrains and create maintenance hatch
4. Valve for filter drain prior to air scour
5. Polymer tank level to be visually monitored
6. Speed controlled by WAS flow
7. Keep capital spare blower and filter
8. One reusable HS level transmitter should be available, but its location is uncertain
9. Keep capital spare pump
10. Alum dosing flow paced
11. Overflow to TTP in case of very high flow and nitrogen load

											MANAGER		
											DESIGN	NdH	07/02/16
											DESIGN CHECK	PD	19/02/16
											DRAWN	NdH	13/06/16
A1	DRAWING No.	TITLE	CODE	DATE	DESCRIPTION	DRN	DRCK	DES	DSCK	MGR	DRAWN CHECK		
	REFERENCE DRAWINGS		REVISIONS & ISSUES								SIGNATURES		DATE

VEOLIA WATER

A.C.N. 069 471 334

Whakapapa
Waste Water Treatment Plant P&ID
Tertiary treatment
SHEET 2 of 3

Scale: NOT TO SCALE

CAD DWG =

Project no =

Drawing number: RES- 15007-01

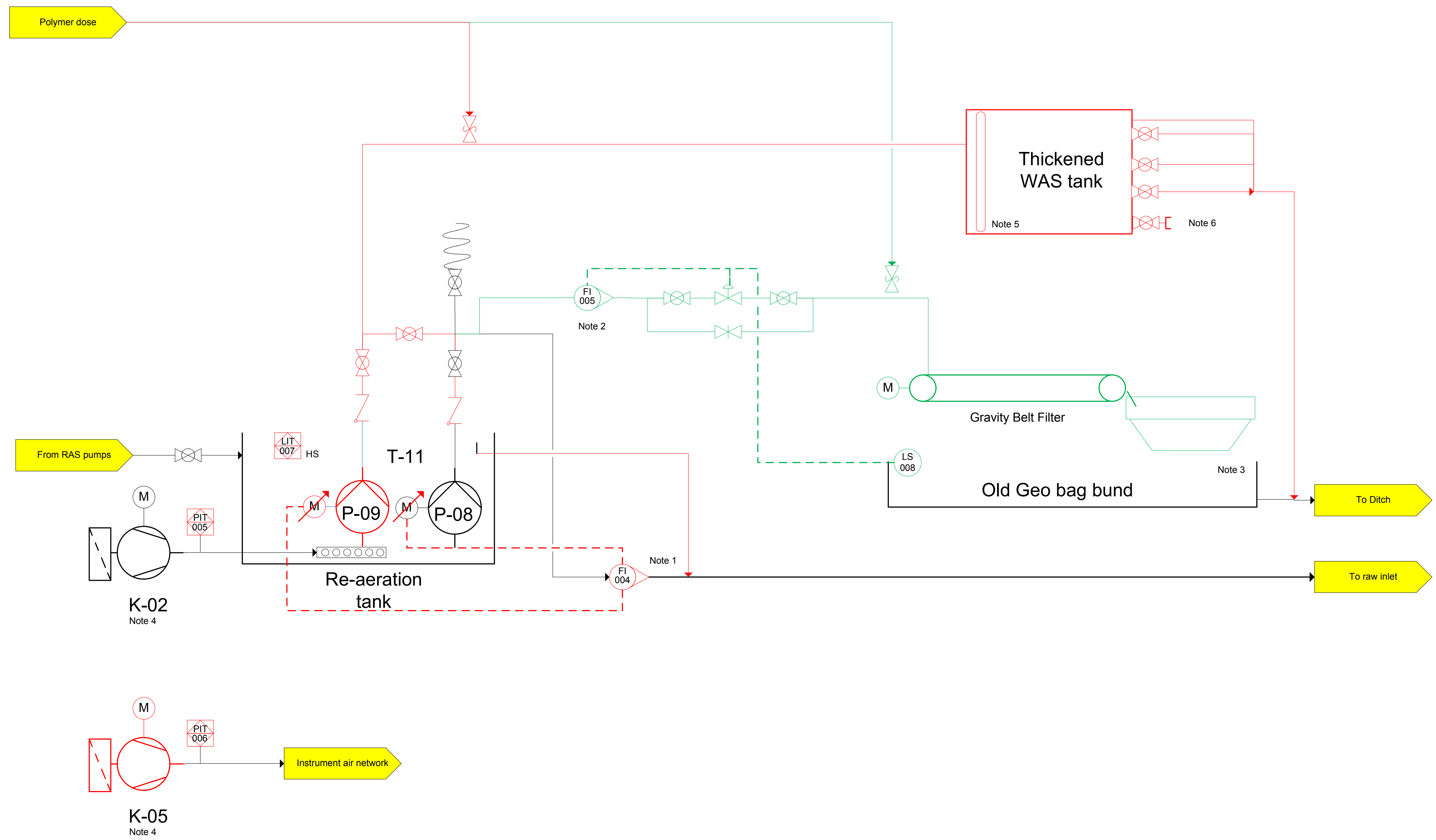
Revision: 3

NOTES:

General: Working revision. Not all valves identified. Not all pipe size and class identified.

Coloured items are proposed new:
Red: Stage 1
Green: Stage 2

1. Flow controlled by inlet flow
2. Wasting flow controlled by SCADA setting
3. Shed to be built over old geobag bund to keep equipment frost free
4. Keep capital spare blower and filter
5. Full scale sight glass
6. Suckertruck companion



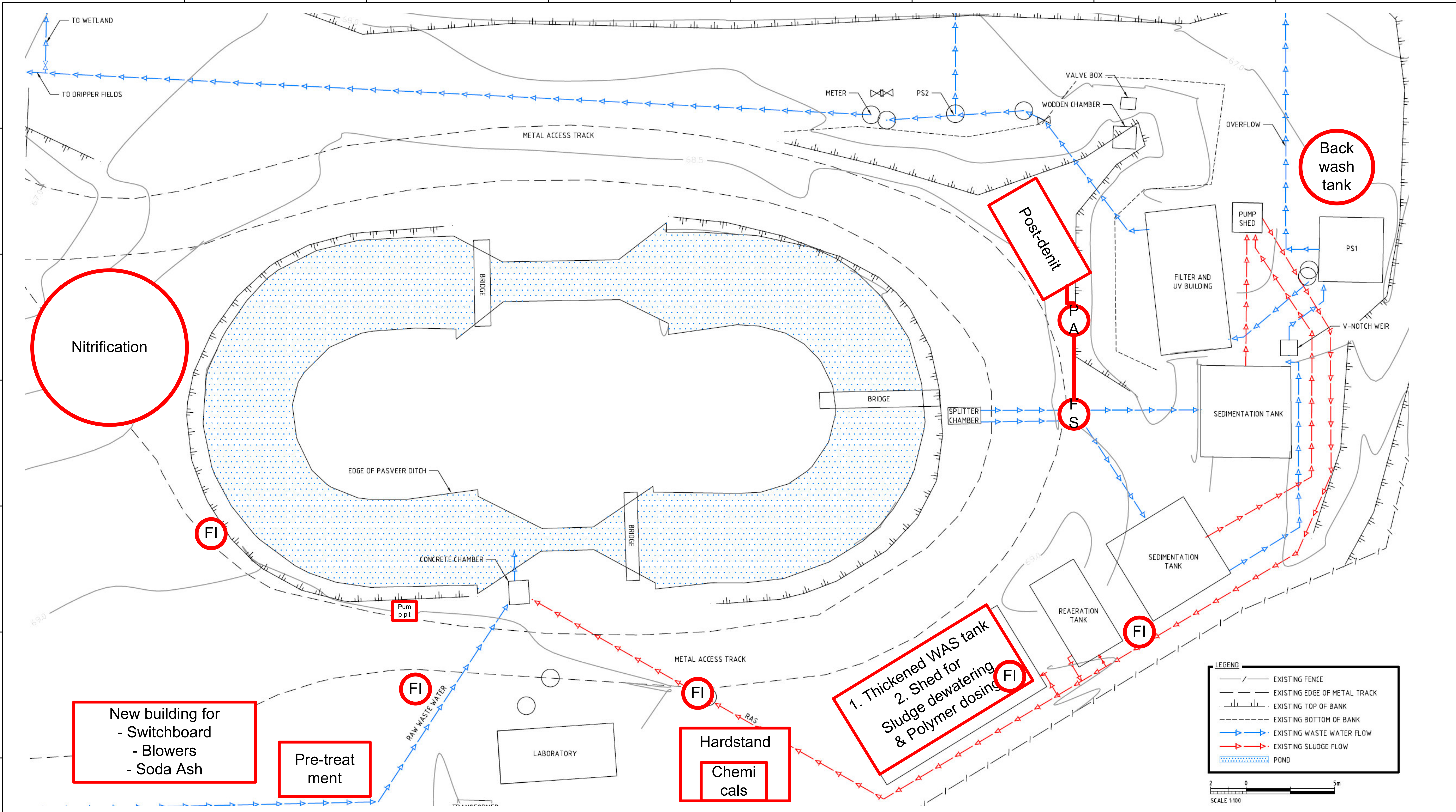
A1	DRAWING No.	TITLE	CODE	DATE	DESCRIPTION	DRN	DRCK	DES	DSCK	MGR	MANAGER		
											DESIGN	NdH	07/02/16
											DESIGN CHECK	PD	19/02/16
											DRAWN	NdH	13/06/16
											DRAWN CHECK		
	REFERENCE DRAWINGS		REVISIONS & ISSUES								SIGNATURES		DATE

VEOLIA WATER
A.C.N. 069 471 334

Whakapapa
Waste Water Treatment Plant P&ID
Sludge treatment
SHEET 3 of 3

Scale	NOT TO SCALE
CAD DWG =	Project no =
Drawing number	Revision
RES- 15007-01	3

APPENDIX B – WHAKAPAPA WWTP SITE PLAN INDICATING UPGRADES



NOTES:

All locations and sizes preliminary

FI = Flow Instrrument

PA = Post-Aeration tank

									MANAGER			
									DESIGN			
									DESIGN CHECK			
		1	08/03/16	FOR COSTING PURPOSES	NdH		NdH		DRAWN	NdH	20/05/16	
DRAWING No.	TITLE	CODE	DATE	DESCRIPTION	DRN	DRCK	DES	DSCK	MGR	DRAWN CHECK		
REFERENCE DRAWINGS		REVISIONS & ISSUES								SIGNATURES	DATE	

A1

VEOLIA WATER

A.C.N. 069 471 334

Whakapapa
Waste Water Treatment Plant
2016 upgrade
Site Plan
SHEET 1 of 1

Scale: 1:100

CAD DWG =

Project no =

Drawing number: VW- 15-008

Revision: 2

LIST OF REFERENCES

[i] Aquanet Consulting Ltd, 2016
[ii] GIS information supplied by DoC
[iii] Site inspection, Veolia, 2016
[iv] Whakapapa Wastewater Flow Report, MWH, 2014
[v] Whakapapa Wastewater Treatment Plant Process Modelling Nitrogen Reduction Options; MWH; 2015
[vi] Monitoring Report; Department of Conservation Turangi, Whakapapa WTP, Influent; DCM Process Control; 2014
[vii] Personal communication, Paul Carr, 2017
[viii] Wastewater Engineering, Treatment and Reuse, Metcalf & Eddy, Fourth Edition
[ix] Inflow/Infiltration Investigation at Whakapapa Village, MWH, 2014
[x] Inflow and Infiltration Control Programme, MWH, 2014
[xi] Operating & Maintenance manual, Wanaka WWTP, AWT, 2010
[xii] Issues and Options Report, MWH, 2014
[xiii] Whakapapa Wastewater Treatment Plant Summary of upgrade options, MWH, 2015
[xiv] Application for Resource Consent for Wastewater, Cheal, 2014

APPENDIX 4

PERMEABILITY REPORT - DBCON

ATTACHMENT 17

Derek Booth Consultancy t/a DBCON
Corner of Spa Road and Rotokawa Street
PO Box 1123
TAUPO 3351
info@dbcon.co.nz
Ph: 07 378 5067

Our Reference: 10591

DEPARTMENT OF CONSERVATION

WHAKAPAPA VILLAGE, MOUNT RUAPEHU

Emergency overflow pond floor sampling and permeability test

SUMMARY

The Department of Conservation are in the process of renewing a Resource Consent for the operation of their Wastewater Treatment System for the Whakapapa Village at the base of Mount Ruapehu.

As part of this process, the Regional Authority, Horizons, requested that a permeability test be undertaken on the pond floor lining material.

A sample was retrieved from the pond floor and sent to Opus International Consultancy's laboratory in Auckland for a constant head permeability test.

The test result shows that the soil has a permeability rate of 2.23 x (10 x -7) m/s.

LOCATION DETAILS

Owner/Agent:	Department of Conservation
Address:	Whakapapa Village, Mount Ruapehu
Contact:	Barry Strong DOC
Regional Authority:	Horizons

SITE ASSESSMENT AND SAMPLING METHOD

The site sampling was carried out 9th December 2010.

Prior to the sampling, a desktop investigation was commenced. The Department of Conservation provided a design drawing (circa 1966) that indicated the design working depth of the pond was 900mm. There was no description of soil types used in construction. The relevant part of the drawing is attached. No further information was discovered from available records.

Anecdotal information from Murray West, Contract Manager of Downer EDI Taumarunui, who was a surveyor for the Ministry of Works in 1967, and who worked on the construction, indicated that local materials were used for construction. His memory was that the soil was a mixture of volcanic ash and pumice materials.

A site visit and probing confirmed that the water depth was no more than 300mm deep and the soft sludge another 3 - 400mm deep.

In order to obtain a sample from the pond floor, it was decided to use an 1800mm diameter reinforced concrete manhole riser, 1500mm deep. The diameter allowed for mechanical excavation within the riser and a safe working environment for the retrieving of a sample. It also provided sufficient room to remove inflowing water from around the perimeter or up through the floor should that have eventuated.

The manhole depth provided compensation for any sinking of the chamber into the floor.

On the day of sampling, the manhole riser was lowered into the pond using an excavator. The riser was wriggled and tapped using the excavator to ensure it was well embedded. It was noted that the riser was proud of the surface by at least 600mm indicating it was resting on the pond floor.

The top 200mm of water/sludge was pumped out of the riser. The excavator then removed a further 400mm of wet sludge.

At that point the author climbed into the chamber and cleared the remaining sludge manually. Once an area of floor was exposed, a sample was taken and further excavation below the floor undertaken to inspect the underlying material.

OBSERVATIONS

Planning for the sampling exercise focussed on the probability that there would be water ingress from around the perimeter of the manhole and possibly up through the floor. In fact, there was no ingress of any moisture during the sampling process (approx 1.5 hours).

The attached bore log shows the various layers. The top 200mm was water and sloppy sludge able to be pumped. During the next 400mm of dark, fine sludge it was noticeable that the material was becoming quite firm.

Once enough of the wet sludge was removed, the author climbed into the manhole and noted that while the layer 300mm immediately above the pond floor was similar to the wet sludge in terms of particle size and appearance, its moisture content was low. A simple test of manually squeezing a handful of the sludge produced no excess moisture or even a sheen on the gloves.

The material appeared non-cohesive, but with moisture added was able to be rolled out into cohesive 'worms', indicating a reasonable level of plasticity.

Using feet to 'pump' this layer indicated that there was no capillary action bringing moisture up from below, helping confirm that there was no upward ingress of moisture and very little – if any – downwards.

The pond floor layer was excavated and the sample saved in a watertight container.

The floor layer was approximately 300mm thick and comprised of a mix of volcanic ash and pumice type materials. It was quite firm, and apart from the top 15 – 20mm, not stained with the dark colour of the overlying pond sludge.

Below the pond liner, the material was a grey volcanic ash/pumice material with higher moisture content than the floor but, no more than could be expected for this type of material. Squeezing by hand produced a sheen on the glove, but no excess moisture.

While the sample was being stored and photographs taken, the chamber and bore log hole were left open. At the end of a 45 minute period there was no water ingress in the bore log hole and no outflow of moisture from the overlying layer.

In the experience of the author, there was a contradiction in what was being observed and the properties of the pond lining. The pond lining looked like it would not have the desirable properties of permeability (1 x (10x -9)), yet there was no evidence of any leakage from the pond into the floor lining. Apart from the slight staining of the first 15 – 20mm of the pond lining, there was no evidence of past staining; thus indicating early leakage and subsequent sealing over time (43 years). There was also no obvious ingress of moisture into the underlying ash layer and none from the pond into the manhole. Observations indicate none, or at the very worst, insignificant movement of moisture from the pond into the ground below, even though the laboratory test indicates that the floor could allow significant moisture movement.

The bore log hole was then sealed using ready bagged concrete and the manhole riser removed from the pond.

The sample was delivered to Opus International Consultants Limited who completed a Constant Head Permeability test at standard compaction. The result was 2.23 x (10 x -7)m/s. This test was carried out at a head of 900mm to emulate the pond conditions.

CONCLUSIONS

The laboratory test result confirmed the site observation that the floor lining would have a higher permeability rate than the desired rate of 1 x (10 x -9).

However, the site observation indicated no passage of moisture from the pond into the underlying soils. The colour of the pond sludge can be described as a dark charcoal. The contamination of the first 15 -20mm of the pond layer was a light grey. The remaining pond lining was a natural pumice/grey ash colour (dark creamy colour).

It is concluded that the soil properties of the accumulated sludge is actually providing a barrier preventing leakage from the pond. Given the relative thin layer of contamination in the floor lining, it could be also concluded that this sealing occurred early in the life of the pond.

The field plasticity test tends to help the conclusion that the material is capable of providing such a barrier.

Only chemical testing of surrounding waters and inflow/outflow recordings and evaporation measurement would confirm this.

THE AUTHOR

As the laboratory result is at odds with the site observations, the author's experience needs to be noted.

Steve Benefield gained his early career experience as a civil engineering cadet with the Ministry of Works Wanganui.

Apart from civil engineering surveys, Steve spent 6 months on hydrological surveys and two terms of 3 months in the soils and materials testing laboratory. Of the three summer construction seasons spent on soil testing in the field, two of these were in the Ohakune region working with volcanic ash and grit.

Following this, Steve was a self-employed earthworks and civil engineering contractor in the Taupo region. During this time, as part of his quality control system, he trained his crew to utilise his experience by setting up field laboratories to undertake proctor and field density tests.

He has used volcanic ash as a pond lining material in forestry ponds, small wastewater ponds and most notably, the Huka Prawn farm's ash lined ponds that are still working as designed some 25 years later. In 2006, he project managed flood stopbank work on the Tongariro River where he used his knowledge to locate ash materials with the designed permeability properties.

Use of ash materials has allowed Steve to understand the permeability properties of ash and pumice soils to a point where site observations usually align with conclusive laboratory testing.

All observations are subjective, but based on 43 years experience have some relevance.

ATTACHMENT 17

Report Prepared By: .... Date: 19th January 2011

Steve Benefield
Engineering Technician

Report Peer Review By: .... Date: 19th January 2011

Derek J Booth
Chartered Professional Engineers
CPENG - 15472

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APPENDIX A

Drawing and bore log

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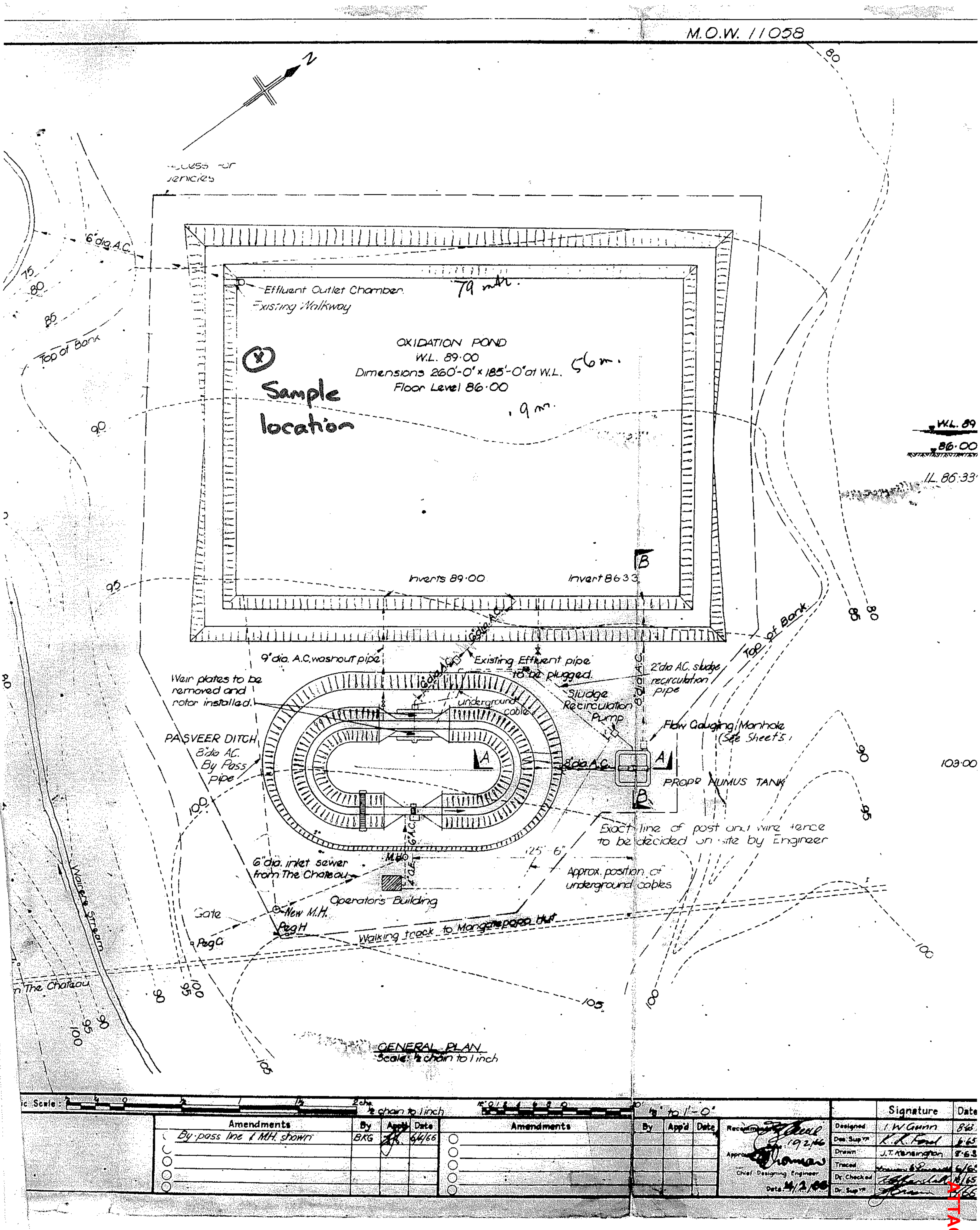
ATTACHMENT 17



ATTACHMENT 17

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dbcon beyond engineering
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Phone: 07 3785067
Fax: 07 3782800
www.dbcon.co.nz

Project			Job ref
Emergency Overflow pond, Whakapap Village, Mt Ruapehu			10591
Drawing ref	calculations by	revision	sheet no
	SMB		1
Element			Date
Test Location 1			Dec-10

Depth	Soil Description
0	pond surface
200	water and fine sludge (able to be pumped)
600	Wet (sloppy), dark charcoal sludge (fine particles)
900	Damp, dark charcoal sludge (fine particles)
920	Damp, light grey pumice ash mix
1200	Dark creamy pumice ash mix
1680	Grey volcanic ash mix End of hole

Notes:

1 Weather was fine.
2
3
4
5

APPENDIX B

Photos

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ATTACHMENT 17

Department of Conservation – Whakapapa Village

Emergency Overflow pond floor sampling and permeability test

Left: Sample hole in pond floor

Below: Sample hole plugged with concrete

APPENDIX 5

PROPOSED CONDITIONS

Whakapapa Village
Waste Water Treatment Plant

Proposed Conditions

20 March 2017

Table of Contents

Proposed Conditions

The Department of Conservation has proposed a suite of conditions to be attached to the resource consents to manage the effects of the Whakapapa Village Wastewater Treatment Plant, being the following:

1) A Discharge Permit for the discharge of treated wastewater onto land.

2) A Discharge Permit for the discharge of treated wastewater into water as an emergency measure during extreme weather events.

3) A Discharge Permit for the discharge of treated wastewater to land attributed to seepage from the treatment facilities.

4) A Discharge Permit for the discharge of contaminants to air (odour).

The table below provides explanation to a number of the acronyms and terms used in the conditions: **Definitions**	
20th FEP	20th Flow Exceedance Percentile means 9,063 cubic metres per second at the Whakapapa Footbridge flow monitoring site
AEE	Means the Assessment of Environmental Effects and application documentation submitted to Horizons Regional Council for the renewal of resource consents for Whakapapa Waste Water Treatment Plant, dated 20 March, 2017
Median flow	Median flow means [XX] cubic metres per second at the Whakapapa Footbridge flow monitoring site
Regulatory Manager	Means the Regulatory Manager of the Horizons Regional Council
Team Leader Compliance	Means the Team Leader Compliance of the Horizons Regional Council
WWTP	Means the Whakapapa Wastewater Treatment Plant, shown on the plan provided as **Schedule One** to these conditions
Act	Resource Management Act 1991
SCADA	Supervisory Control and Data Acquisition

CONDITIONS APPLICABLE TO DISCHARGE PERMITS XXXXXX AND XXXXXX

For the discharge of treated wastewater onto land and the discharge of treated wastewater to land attributed to seepage from the treatment facilities.

General

1. Except as modified by the conditions below, and subject to final design, the activity shall be undertaken in general accordance with the information provided in the AEE.

2. This Permit shall be for a term of 28 years from the date of commencement. Pursuant to Section 125 of the Act, this Permit shall not lapse within the period of its duration of 28 years.

Operations and Management Plan

3. The Operations and Management Plan submitted with the AEE shall be reviewed by the Permit Holder once every **five years**, or at any other time when a significant process or operational change occurs, and, if necessary, be updated. A copy of the revised Management Plan shall be forwarded to the Regulatory Manager within **One month** of any updated version being finalised.

Maximum Discharge Volumes

4. The waste water discharge authorised by these Permits shall be limited to:

    a. A maximum 12-month median daily discharge of 530 cubic metres; and

    b. A maximum 12-month 95th percentile daily discharge of 765 cubic metres

    of combined treated sewage effluent from the WWTP as measured at the effluent flow monitoring sites defined in Condition 19.

WWTP Stage 1 Works

5. Within **12 months** of the commencement of this Permit, the Permit Holder shall complete Stage 1A works as detailed in **Schedule Two** to these conditions.

6. Within **two years** of the commencement of this Permit, the Permit Holder shall complete Stage 1B works as detailed in **Schedule Two** to these conditions.

Stage 1 Post-Upgrade Review

7. Within **four years** of the commencement of this Permit, the Permit Holder shall engage an appropriately experienced and qualified water quality scientist and an appropriately experienced and qualified waste water engineer to jointly undertake a post-upgrade review of the effectiveness of Stage 1 works. The review shall be provided to the Regulatory Manager and shall address the following:

    a. A summary of the monitoring results obtained to date under Conditions 19 to 23 and reported annually in accordance with Condition 29;

b. An assessment of instream SIN concentrations at each monitoring site identified in Condition 0 including an analysis of the trajectory of change over the preceding five years;

c. An assessment of WWTP treatment process and performance overall;

d. An assessment of wetland performance overall, with particular focus on plant establishment and the efficacy of denitrification processes;

e. An assessment of progress towards meeting the Environmental Outcomes in Condition 13 overall at each monitoring site;

f. In consideration of (a) to (e) above, an overall assessment of the mid-point effectiveness of Stage 1 works and a recommendation on whether additional actions need to be advanced at this time to respond to any issues identified; and

g. A recommendation regarding the need to monitor stream flow in the Wairere Stream and/or its tributaries.

8. **Three years** following the completion of the post-upgrade review the Permit Holder shall provide an Environmental Outcomes Compliance Report to the Regulatory Manager which shall address the following:

a. A summary of the monitoring results obtained under Conditions 19, 0a. and 0b. and an assessment of wastewater treatment process and treatment performance;

b. A summary of the monitoring results obtained under Condition 0c. and an assessment of wetland performance;

c. A summary of the monitoring results obtained under Condition 0d., 0e., 0f and 21 to 23 [Stream water quality and ecological monitoring];

d. An assessment of whether the Environmental Outcomes in Condition 13 are met overall at each monitoring site; and

e. Recommendations regarding water quality and ecological monitoring, including whether the number of sites and/or the frequency of monitoring required under conditions 0 to 23 can be reduced.

Stage Two Upgrades – Adaptive

9. If the report required by Condition 8 identifies that the Environmental Outcomes in Condition 13 are not met overall, within six months of the submission of that report the Permit Holder shall confirm Stage 2 works are to be implemented by submitting a Stage 2 Best Practicable Option Assessment (“Stage 2 BPO Report”) to the Regulatory Manager for certification which shall address the following:

a. The causes of the Environmental Outcomes in Condition 13 not being met;

b. The range of options available to address those causes;

c. The best practicable option for works in Stage 2 to address those causes, having regard to, among other things:

i. the nature of the causes of the issues identified in the post-upgrade review required by Condition 7 and the sensitivity of the receiving environment;

ii. the financial implications, and the effects on the environment, of that option when compared with other options;

iii. the current state of technical knowledge and the likelihood that the option can be successfully applied.

If a written response is not provided by the Regulatory Manager within **20 working days** of the Permit Holder submitting the Stage 2 BPO Report for certification, then the certification shall be deemed to be confirmed.

10. The Permit Holder shall, within **12 months** of the certification of the Stage 2 BPO Report, if required by Condition 9, complete the Stage 2 additions and/or modifications in accordance with the as-certified Stage 2 BPO Assessment Report.

Archaeological Procedure

11. If kōiwi, taonga or other archaeological material is discovered in any area during the works, work shall immediately cease and the Permit Holder shall contact Ngāti Hikairo and Uenuku, Heritage New Zealand, and the Regulatory Manager within 24 hours. If human remains are found, the New Zealand Police shall also be contacted. The Permit Holder shall allow the above parties to inspect the site and, in consultation with them, identify what needs to occur before work can resume.

Review

12. The Horizons Regional Council may, pursuant to section 128 of the Act, initiate a review of any conditions of this Permit in the month of April annually, or in response to the outcomes of the report required by Condition 7. Any review shall be for the purpose of reviewing the effectiveness of the conditions in avoiding or mitigating any adverse effects on the environment, which may arise as a result of the exercise of this permit. The review of conditions shall be for the purpose of:

a. The modification of the monitoring programme, including reviewing the frequency of the monitoring or the determinants required;

b. Requiring compliance with any relevant rule of an operative Regional Plan;

c. The amendment, deletion or addition of new conditions as necessary to avoid, remedy or mitigate any adverse effect on the environment, but not limited to conditions to mitigate adverse effects attributed to any breach of any condition;

d. Addressing any adverse effects on the environment which may arise that are appropriately addressed at a later stage;

e. Requiring the permit holder to adopt the best practicable option to remove or reduce any adverse effects on the environment;

f. Assessing the performance of the wastewater treatment plant in terms of the quality of the effluent being discharged to the receiving environment;

g. Reviewing the effectiveness of the standards in the conditions of this permit in addressing the adverse effects on the unnamed tributary of the Wairere Stream and/or the Wairere Stream.

Environmental Outcomes – Northern and Southern Tributary

13. The Permit Holder shall progressively achieve the Environmental Outcomes for the unnamed Northern and Southern Tributary set out in (a) to (e) below, and shall undertake Stage 2 works if necessary to achieve the Environmental Outcomes. For the purposes of determining whether Stage 2 works are necessary, the monitoring results obtained under Conditions 0 to 24 shall be assessed against the following Environmental Outcomes, that after reasonable mixing the discharge does not cause:

a. the Chlorophyll *a* concentration at monitoring sites S2 and S4 to exceed 50 mg/m^2 on more than 8% of sampling occasions, on the basis of monthly measurements taken over a period of at least 36 months; or

b. The discharge does not cause the total ammonia (TNH4-N) concentration to exceed (based on pH 8 and temperature of 20°C):
   i. a rolling median concentration of 0.03 grams per cubic metre; or
   ii. a maximum concentration of 0.05 grams per cubic metre

c. The 95^{th} percentile of the *E. coli* concentration at monitoring sites S2 and S4 to exceed 260 *E. coli*/100mL, on the basis of monthly measurements taken over a period of 36 months; or

d. A reduction in QMCI of no more than 20% at monitoring site S2 compared with site S1 or at monitoring site S4 compared to site S3; or

e. a reduction in visual water clarity (measured as the horizontal underwater sighting range of a 200 mm black disc) of more than 20% at monitoring site S2 compared with site S1 and at monitoring site S4 compared to site S3.

Advice Note*: This condition sets out the Environmental Outcomes sought for the unnamed Northern and Southern Tributary that are to be progressively achieved. It does not set out compliance requirements that must be met immediately from the commencement of this permit. The circumstances where the Environmental Outcomes become Environmental Standards and are required to be met are set out in Condition 14 below. Monitoring requirements are set out in Conditions 0 to 24 of this Permit.*

Advice Note*: Compliance with Condition 13(b) shall be determined after pH and temperature adjustment of the data*.

14. The Environmental Outcomes in Condition 13 shall become Environmental Standards that are to be complied with in the Unnamed Tributary at monitoring site S2 and S4, at the earliest of the following times:

a. When the report required by Condition 8 confirms that the Environmental Outcomes have been met overall at each monitoring site; or

b. **12 months** following the completion of Stage 2 additions and modifications if these are required by Condition 9.

***Advice Note**: This condition sets out when the adaptive management phases end, and the Environmental Outcomes in Condition 13 become standards that must be met in the unnamed Tributary on an ongoing basis. For clarity, compliance with the environmental standards will be undertaken on the basis of 36 months of data collected from the date that environmental outcomes become standards.*

Environmental Standards – Wairere Stream

15. For the duration of this Permit, the discharge after reasonable mixing shall not cause:

a. the Chlorophyll *a* concentration to exceed 50 mg/m^2 at monitoring site S6 on more than 8% of sampling occasions, on the basis of monthly measurements taken over a period of at least 36 months; or

b. The discharge does not cause the total ammonia (TNH4-N) concentration to exceed (based on pH 8 and temperature of 20°C):
   i. a rolling median concentration of 0.03 grams per cubic metre; or
   ii. a maximum concentration of 0.05 grams per cubic metre

c. The 95th percentile of the *E. coli* concentration to exceed 260 *E. coli*/100mL, on the basis of monthly measurements taken over a period of 36 months; or

d. A reduction in QMCI of no more than 20% at monitoring site S6 compared with site S5; or

e. a reduction in visual water clarity (measured as the horizontal underwater sighting range of a 200 mm black disc) of more than 20% at monitoring site S6 compared with site S5.

***Advice Note**: This condition sets out the Environmental Standards that shall apply in the Wairere Stream from the commencement of this Permit. Monitoring requirements are set out in Conditions 0 to 24 of this Permit*.

***Advice Note**: Compliance with Condition 15(b) shall be determined after pH and temperature adjustment of the data*.

Water Quality and Ecology Compliance Assessment Requirements

16. Achievement against the Environmental Outcomes defined in Condition 13 and required to be met under Condition 14 and Condition 15, shall be assessed in the following manner:

a. If the Environmental Outcome in Condition 13d is exceeded downstream of the discharge, then the Permit Holder shall assess whether a more than 20%

change in QMCI score occurred. The assessment shall be conducted on the basis of an equivalence test based on samples taken upstream and downstream of the discharge;

b. If the outcomes defined in Condition 13a, b, c or e are exceeded the Permit Holder shall use a Wilcoxon Signed Rank test to determine if there are any significant increases or decreases between upstream and downstream. If it is determined that there are significant differences with the Wilcoxon Signed Rank occurring (p = 0.05 or lower), the Permit Holder shall undertake an investigation into the effects of the discharge from the WWTP compared with upstream water quality.

Advice note: *to perform the statistical test, analysis needs to be against a minimum of ten upstream and downstream paired results from the monthly sampling.*

c. The findings shall be reported in the Annual Report required by Condition 29.

Advice note*: This assessment shall be conducted for each pair of upstream and downstream monitoring sites on the Wairere Stream, Southern and Northern Tributary.*

Effluent quality standards

17. From the commencement of this permit until the standards in Condition 18 apply, the Permit Holder shall ensure that monthly grab samples taken of the treated wastewater as identified in **Schedule Three** to these conditions, meet the standards in Table 1, such that the number of exceedances in any consecutive 12 month period shall be no more than 8 and 2 respectively, based on the last 12 consecutive samples:

Table 1 – Treated Effluent Quality Standards for first 3 years

Parameter	Unit	No more than 8 exceedances out of 12 consecutive samples	No more than 2 exceedances out of 12 consecutive samples	Measuring Location
$cBOD_5$	mg/L	10	20	Tertiary Pond outlet
Total Suspended Solids	mg/L	15	35	Post UV wetwell
E.coli	/100 mL	100	1000	Post UV wetwell

18. **Four years** following the commencing of this Permit, the Permit Holder shall ensure that monthly grab samples taken of the treated wastewater as identified in **Schedule Three** to these conditions, meet the standards in Table 2, such that the number of

exceedances in any consecutive 12 month period shall be no more than 8 and 2 respectively, based on the last 12 consecutive samples:

Table 2 – Treated Effluent Quality Standards

Parameter	Unit	No more than 8 exceedances out of 12 consecutive samples	No more than 2 exceedances out of 12 consecutive samples	Measuring Location
$cBOD_5$	mg/L	10	20	Tertiary Pond outlet
Total Suspended Solids	mg/L	15	35	Post UV wetwell
E.coli	/100 mL	100	1000	Post UV wetwell
Total Ammoniacal Nitrogen	mg/L as N	8	20	Tertiary Pond outlet

Effluent flow monitoring

19. From the commencement of this permit the Permit Holder shall maintain flow meters to measure and record the daily volume of treated wastewater being discharged from the WWTP (wet well) and the lagoon, as identified in **Schedule Three** to these conditions. The flow meters shall be calibrated and maintained to have an accuracy consistent with manufacturer's specifications at all times. Following implementation of the SCADA system required in Stage 1A (Condition 5), the flow records shall be transferred daily to the Horizons Regional Council either via a telemetry system or similar system (FTP) in a format compatible with the Horizons Regional Council systems. Prior to Stage 1A works being completed, this data shall be transferred to Horizons Regional Council by request at a frequency not less than monthly.

Effluent and stream water quality sampling

20. From the commencement of this Permit, the Permit Holder shall sample monthly the treated effluent at the following locations, for the field measurements and laboratory analyses listed in **Table 2**:

a. At the outlet of the UV treatment plant (Wet Well, **Monitoring Site E1** as shown in **Schedule Four**);

b. At the outlet of the Tertiary Treatment Pond (**Monitoring Site E2** as shown in **Schedule Four**);

c. At the outlet of each of the constructed wetland(s);

d. In the Unnamed tributary (Southern Branch) upstream and downstream of the WWTP (Sites S1 and S2 in Schedule Four);

e. In the Unnamed tributary (Northern Branch) upstream and downstream of the WWTP (Sites S3 and S4 in Schedule Four); and

f. In the Wairere Stream upstream and downstream of the confluence with the Unnamed Tributary (Sites S5 and S6 in Schedule Four).

Table 3 – Treated Effluent and in-stream Monitoring

	Post-UV (Wet well, Site E1)	Post-lagoon (Lagoon outlet, Site E2)	Post-wetland	Wairere Stream, Southern and Northern Tributaries (Sites S1 to S6)
Dissolved Oxygen (Field Measurement)				√
pH (Field Measurement)	√	√		√
Temperature (Field Measurement)	√	√		√
Visual clarity				√
Soluble Carbonaceous BOD_5	√	√	√	√
POM	√	√	√	√
Total Ammoniacal – Nitrogen	√	√	√	√
Total Suspended Solids	√	√	√	√
Nitrate + nitrite – Nitrogen	√	√	√	√
DRP	√	√	√	√
Total Phosphorus	√	√	√	√
E.coli	√	√	√	√

Macroinvertebrate Sampling

21. The permit holder shall have an appropriately trained and experienced operator undertake macroinvertebrate sampling in the Wairere Stream and Unnamed tributary at the sites defined in **Schedule Four (Sites S1 to S6)**. The macroinvertebrate assessment shall be undertaken following a period of at least three weeks without a flood event and during a period of low flow. The timing of the monitoring shall be confirmed by the Regulatory Manager prior to the commencement of the monitoring.

The monitoring frequency shall be twice annually at sites S1 to S6 defined in **Schedule Four** until**:**

a. In the unnamed tributary, the monitoring frequency may reduce to once every two years for the sites where the Environmental Outcomes defined in Condition 13 have been met over the preceding 36-month period.

b. Monitoring in the Wairere Stream may cease provided the Environmental Standards defined in Condition 15 have been met over the preceding 36-month period.

***Advice Note**: A flood event is considered to be when the Whakapapa River is at the 20th FEP or higher and low flow is defined as a period when the river has been below the median flow for at least two weeks. As far as practicable, the monitoring sites should be comparable in terms of habitat, flow and light intensity*.

22. The consent holder shall ensure that the macroinvertebrate sampling referred to in Condition 21 above is to be undertaken annually between August and November inclusive. The macroinvertebrate sampling shall follow Protocols C3 (Hard-bottomed quantitative), P3 (full count with subsampling option) and QC3 (Quality control for full count with subsampling option) from the Ministry for the Environment's "protocols for sampling macroinvertebrates in wadeable streams" (Stark et al. 2001). This shall involve:

   a. Collection of 5 replicate 0.1 m^2 Surber samples at random within a 20 m section of riffle habitat at each sampling site.

   b. Full count of the macroinvertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macroinvertebrate Community Index (MCI).

   c. Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT individuals.

   d. Analysis of the QMCI results using equivalence testing at the 20% interval.

Periphyton monitoring

23. The Permit Holder shall engage an appropriately experienced operator to undertake an assessment of the percentage cover, biomass, chlorophyll *a* and community composition of periphyton, filamentous algae and cyanobacterial mats in runs.

The monitoring frequency shall be monthly at sites S1 to S6 defined in **Schedule Three** until:

   a. In the unnamed tributary, the monitoring frequency shall reduce to once every two years for the sites where the environmental outcome defined in Condition 13 have been met over the preceding 36 month period.

   b. Monitoring in the Wairere Stream may cease provided the Environmental Standards defined in Condition 14 have been met over the preceding 36 month period.

The monitoring shall include the following:

   c. a visual assessment of the percentage cover of both filamentous algae and algal mats (to the nearest 5%) at 5 points across each of four transects encompassing run habitat and extending across the width of the river at each sampling site. The visual monitoring methods shall follow the protocols outlined in Appendix 2 of "A periphyton monitoring plan for the Horizons Region" (Kilroy et al. 2008). Reported estimates shall include:

      i. percentage cover of visible stream or river bed by bacterial and / or fungal growths (sewage fungus) visible to the naked eye;

ii. percentage cover of visible stream bed by filamentous algae more than 2 cm long;

iii. percentage cover of visible stream bed by filamentous algae less than 2 cm long;

iv. percentage cover of visible stream bed by diatoms or cyanobacteria mats more than 0.3 cm thick;

v. percentage cover of visible stream bed by diatoms less than 0.3 cm thick; and

vi. percentage of visible stream bed that appears to be free of bacterial or fungal growths, filamentous algae, diatoms and cyanobacterial mats.

The collection of periphyton samples shall occur under the same flow conditions as specified in Condition 21 above. Analysis of periphyton samples shall follow the protocols outlined in Appendix 3 of 'A periphyton monitoring plan for the Manawatu-Wanganui Region' (Kilroy et al 2008) and shall involve extraction of chlorophyll *a* by ethanol.

24. The Permit Holder shall ensure that all samples taken for wastewater and river quality analysis required by this permit are collected by a suitably qualified or trained person and that the analyses are undertaken by an appropriately accredited laboratory and all methodologies adopted are appropriate for either wastewater or river quality analysis.

Provision for Growth

25. **Three years** following the granting of this Permit and every 3 years thereafter, the Permit Holder shall provide a Visitor Growth Assessment Report to the Regulatory Manager which shall address the following:

a. a report of visitor numbers per month to the area serviced by the WWTP over the preceding reporting period, and the identification of any trends in visitor numbers over time;

b. an assessment of the impact of any changes and/or trends in visitor numbers on:

i. WWTP treatment capacity and performance;

ii. the risks of exceeding the effluent quality parameters specified in Condition 18; and

iii. the risks of exceeding the environmental outcomes and/or performance standards specified in Conditions 13 and 15; and

c. considering (a) and (b) above, a reasoned recommendation on whether Condition 26 should be triggered.

26. Within **20 working days** of receiving the Visitor Growth Assessment Report required by Condition 25, the Regulatory Manager shall confirm to the Permit Holder whether or not Condition 27 is triggered. If a written response is not provided by the Regulatory Manager within **20 working days**, the recommendation provided in the Visitor Growth Assessment Report shall be deemed to be accepted.

27. Within **6 months** of this condition being triggered by Condition 26, the Permit Holder shall submit a Best Practicable Option Assessment to the Regulatory Manager for certification, which shall address the following:

a. the average daily SIN load discharged from the wetland over the preceding 3 years;
b. the range of options available to avoid an increase in the average daily SIN load discharged from the wetland caused as a result of increased visitor numbers; and
c. the best practicable option to avoid an increase in the average daily SIN load calculated in 27(a) having regard to, among other things:

i. the financial implications, and the effects on the environment, of that option when compared with other options;

ii. the current state of technical knowledge and the likelihood that the option can be successfully applied.

28. If a written response is not provided by the Regulatory Manager within **20 working days** of the Permit Holder submitting the Best Practicable Option Assessment required by Condition 27 for certification, the certification shall be deemed to be confirmed.

Reporting

29. Annual data records and a report summarising the results of monitoring undertaken under Conditions 19 to 23 for the year ending 30 June for each year shall be prepared, including:

a. the results of the monitoring under this Permit; and
b. an assessment of compliance against the Environmental Outcomes and Standards set out in Condition 13 and 15; and
c. Where macroinvertebrate monitoring is required under Condition 21 of this Permit:

i. The raw macroinvertebrate data; and

ii. An assessment of the effects of the discharge on macroinvertebrate communities in the Unnamed Tributary and the Wairere Stream based on the indices and statistical comparison methodology set out in Conditions 22c and 22d.

The report shall be forwarded to the Regulatory Manager in a suitable electronic format, by 30 September each year for the term of this Permit.

CONDITIONS APPLICABLE TO DISCHARGE PERMIT XXXXXX

For the discharge of contaminants to air (odour).

30. Except as modified by the conditions below, and subject to final design, the activity shall be undertaken in general accordance with the information provided in the AEE.

31. This Permit shall be for a term of 28 years from the date of commencement.

32. Pursuant to Section 125 of the Act, this Permit shall not lapse within the period of its duration of 28 years.

33. The discharges to air authorised by this Permit shall not cause the emission of, in the opinion of the Regulatory Manager, at occupied dwellings or buildings located beyond the property boundary of the WWTP.

34. The Permit Holder shall keep a complaints register to record any complaints relating to odour from the WWTP. The register shall include:

a. the details of the Complainant if given;
b. the location of where the odour was detected;
c. a description of wind speed and direction when the Complainant detected the alleged adverse environmental effect;
d. the date and time of the detection;
e. the most likely cause of the odour detected; and
f. any corrective action undertaken by the Permit Holder to avoid, remedy or mitigate the adverse environmental effect detected by the Complainant.

From the commencement of this Permit a copy of details in the register shall be forwarded to the Regulatory Manager by 30 September of each year for the term of this Permit, or as otherwise requested by the Regulatory Manager.

CONDITIONS APPLICABLE TO DISCHARGE PERMIT XXXXXX

For the discharge of treated wastewater into water as an emergency measure during extreme weather events.

35. Except as modified by the conditions below, and subject to final design, the activity shall be undertaken in general accordance with the information provided in the AEE.

36. This Permit shall be for a term of 28 years from the date of commencement.

37. Pursuant to Section 125 of the Act, this Permit shall not lapse within the period of its duration of 28 years.

38. Following a flood event which results in discharge into the surface water authorised under this Permit, within 24 hours of the discharge easing, the Permit Holder shall inspect the full length of the area traversed by the discharge prior to entering surface water, and shall identify any damage and cleanse any ponding area on the route. Any damage shall be made good as soon as reasonably practicable

39. Within five working days of the cessation of a discharge, the Permit Holder shall provide the Team Leader Compliance with a brief report detailing the exercise of the consent, including causes, river levels, discharge duration, estimated volumes of effluent discharged, the results of the inspection pursuant to Condition 38 of this Permit, and any remedial works intended, including the anticipated programme and completion date.

40. Within 3 months of the date on which this Permit commences the Permit Holder shall provide to the Team Leader Compliance, a public health communication plan which has been prepared in consultation with the Director, Public Health Services, Mid-Central Health. The plan shall detail the following:

i. signage and/or other appropriate means of advising the general public and any potentially affected parties, of the area affected by the discharge; and

ii. any other matters that will assist in avoiding or mitigating any health risk associated with the discharge.

Schedule One:

Whakapapa WWTP Location Plan

Whakapapa WWTP Location Plan

Schedule Two:

Staging of Works and Monitoring

PART 1 – DESCRIPTION OF ADDITIONS AND MODIFICATIONS

The following description of staged additions and modifications to the Whakapapa WWTP are sourced from, and described in more detail in, the report prepared by Veolia (March 2017*)* provided with the Assessment of Environmental Effects and application documentation submitted to Horizons Regional Council, dated 20 March 2017.

Stage 1 Works

Stage 1A (Condition 5)

- Wetland 1 construction;
- Measures around Return Activated Sludge and Waste Activated Sludge;
- Tertiary filter backwash facility;
- Filter upgrade;
- UVT instrument;
- Lab equipment for on-site monitoring of nitrogen and phosphorous.
- Installation of communications facilities at various sites;
- Installation of SCADA at WWTP site; and
- Upgrade of switchboard at WWTP site with sufficient capacity for new motors and instruments.

Stage 1B (Condition 6)

- Enhanced nitrification at WWTP to achieve effluent nitrification target.

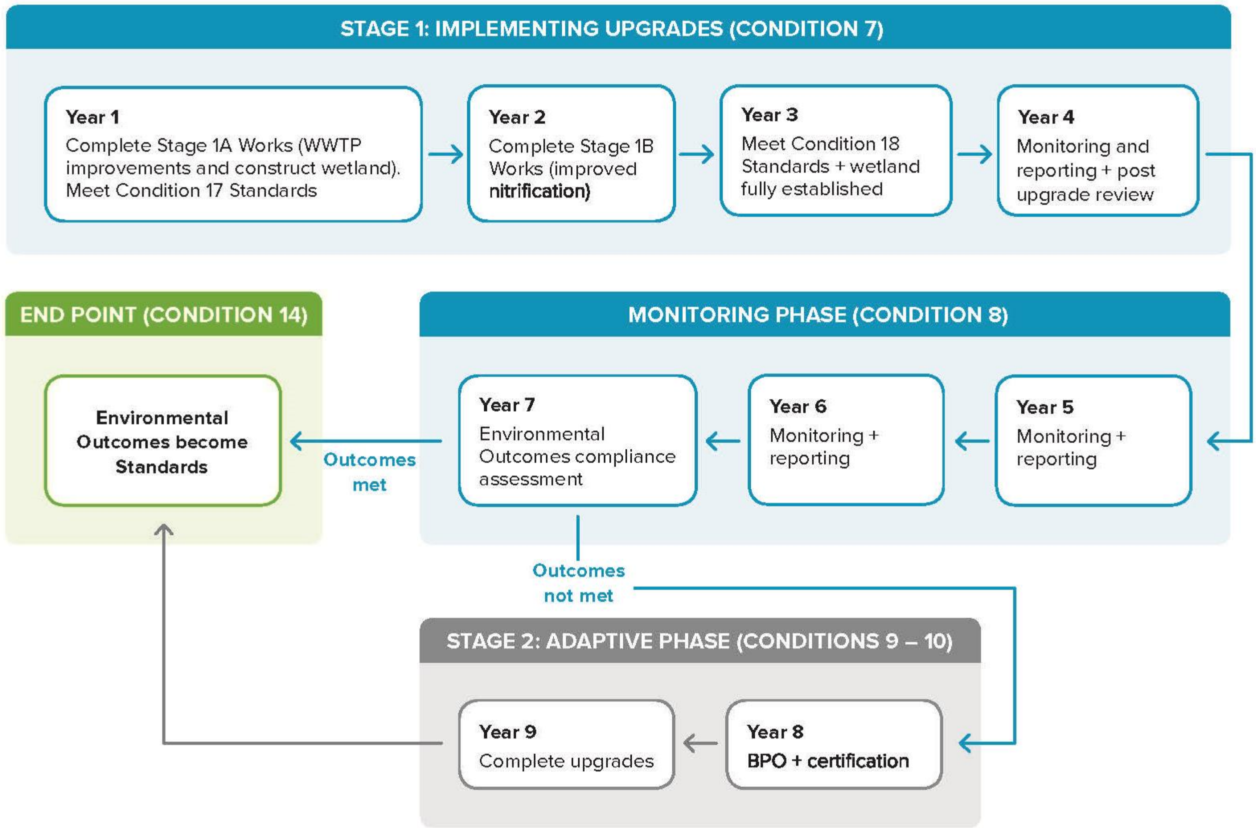
Stages 2 Works

Should Stage 1 not achieve the expected result, the nature of any subsequent additions and modifications in Stage 2 will be determined at the required time through a best practicable options (BPO) assessment, using actual plant performance and monitoring data.

If any future additions and modifications are required, it is anticipated that these will be either to increase nitrification processes at the WWTP, or to increase denitrification processes within the wetlands.

PART 2 – CONDITIONS FLOW CHART

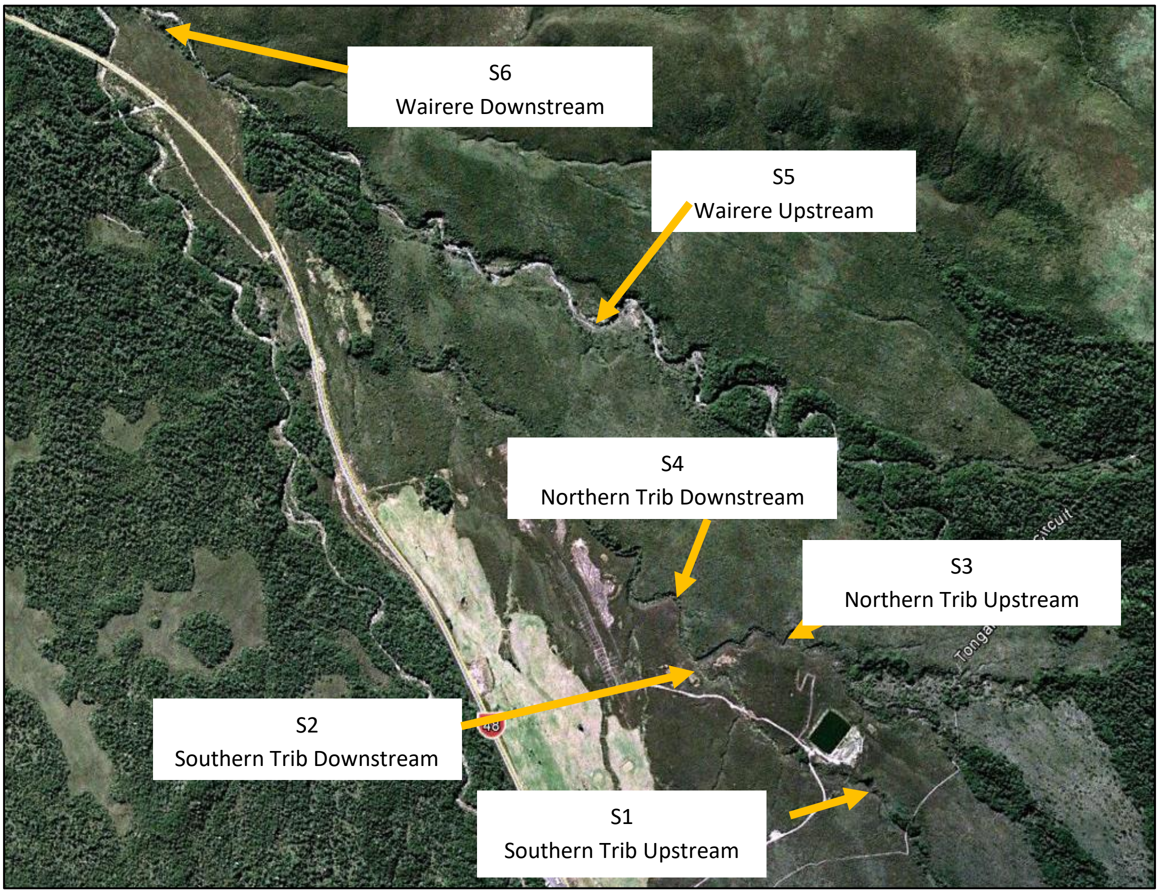
To assist interpretation, the flow chart on the following page describes how Conditions 5 through 10 function.



Schedule Three:

Location of Monitoring Sites

Location of Monitoring Sites



Monitoring Site		New Zealand Transverse Mercator Projection GPS		New Zealand Geodetic Datum 2000 GPS	
		E (Start)	N (Start)	Latitude	Longitude
S1	**Southern Trib U/S**	1819816	5658344	39 11 46.956 S	175 32 43.490 E
S2	**Southern Trib D/S**	1819448	5658623	39 11 38.249 S	175 32 27.838 E
S3	**Northern Trib U/S**	1819738	5658640	39 11 37.434 S	175 32 39.895 E
S4	**Northern Trib D/S**	1819108	5659332	39 11 21.93 S	175 32 12.09 E
S5	**Wairere U/S**	1819229	5659391	39 11 13.558 S	175 32 17.821 E
S6	**Wairere D/S**	1818420	5659968	39 10 55.592 S	175 31 43.461 E

APPENDIX 6

WETLAND REPORT AND RECOMMENDATIONS - NIWA

Whakapapa Wastewater Treatment Constructed Wetland

Conceptual design and revised performance modelling

Prepared for Department of Conservation

February 2017

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	Approved for release by:	David Roper

Contents

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Executive summary

In 2016, the Department of Conservation (DOC) contracted NIWA to undertake a conceptual design of constructed wetlands treating the Whakapapa Wastewater Treatment Plant (WWTP) effluent. Key components of the design were that it achieve a good "fit" with the landscape and demonstrate respect for the cultural values of local iwi, while still incorporating attributes to achieve desirable levels of nitrogen reduction, prior to discharge into a tributary of the Wairere Stream. A conceptual constructed wetland design was produced initially for Area G - Wetland 1, comprising three or more stepped cells (~0.6-1 ha each) operated in series.

The conceptual design was provided to wetland designers, Morphum Environmental Ltd, who have since produced a working design for the site which uses 4 cells. Detailed site investigations have resulted in actual wetland areas of 1.1 ha, with an additional infiltration area for final assimilation of treated effluent. In addition, current and predicted future flow estimates to be treated in the upgraded wastewater treatment plant (the inflow to the wetland) have been improved. This report provides updated performance modelling of the wetland based on these operational values.

Using available data and information from a literature review of cold-climate constructed wetlands, likely performance of the wetland was modelled. Key inputs include Whakapapa climate data (e.g., mean winter temperatures of 3.7°C, rainfall of 2727 mm/year), inflows (currently 237 m^3/d in summer and 228 m^3/d in winter), and likely water quality of the WWTP effluent.

It is expected the proposed wetland will have an average hydraulic retention time (HRT) of 15.7 days (summer: 16.2 d; winter: 15.3 d) based on the current flow conditions, and would achieve significant levels of de-nitrification.

We predicted annual TN removal of 65-75% (average effluent TN <12 mg/L) under current flow conditions, and 50-60% (average effluent TN <16 mg/L) under predicted future flow conditions. The wetland is expected to achieve high TSS and BOD_5 removal (effluent values <10 mg/L) under most circumstances throughout the year. Phosphorus removal may also be affected by the low temperature in winter, but low values in the effluent would still be expected (<2.0 mg/L).

Additional areas are available (Areas A, B, & C) to construct additional wetlands and/or assimilation areas if these prove necessary based on future increases in visitor numbers to Whakapapa, or potential lower performance than anticipated of the wetland or the wastewater treatment plant.

1 Introduction

The Department of Conservation (DOC) operates a wastewater treatment plant and disposal system at Whakapapa Village, Tongariro National Park. The existing consent for the wastewater discharge expired on 1 December 2014, thus DOC currently seeks to replace the existing consent while upgrading the Whakapapa wastewater treatment plant (WWTP) to improve its performance particularly on nitrogen removal and management of peak flows during the winter season.

DOC has reviewed various options for further treatment and disposal of the WWTP effluent. The review concluded that the use of the existing dripper irrigation fields will be discontinued, and that the most practicable and feasible option for final treatment and disposal of the treated effluent is a Constructed Wetland system, which uses natural processes associated with vegetation, soil, and micro-organisms to treat incoming pre-treated wastewater flows and also provides for aesthetic enhancement of the terrestrial ecology adjacent to the existing WWTP.

In 2015, DOC contracted NIWA to undertake a conceptual design of constructed wetlands treating the Whakapapa wastewater treatment effluent, focusing on reduction of the nitrogen flux to a tributary of the Wairere Stream. The specific services requested were to:

- review background information provided on a wastewater treatment system upgrade and associated resource consent documents
- undertake a site visit including any required consultation with relevant parties, and
- develop a conceptual design of the constructed wetland including recommended dimensions, planting specifications, and expected wastewater treatment performance.

NIWA produced a report (Park, Sukias et al. 2016) with a conceptual wetland design to be developed adjacent to the existing WWTP in Area G (as shown in Figure 1), receiving all treated wastewater from the WWTP. That report also included performance modelling for the conceptual wetland design.

The concept was provided to wetland designers, Morphum Environmental Ltd, who have produced a detailed constructed wetland design for the site. This has resulted in a revised number of wetland cells and wetland areas. A final infiltration area has been included for assimilation of the effluent from the constructed wetland. In addition, improved flow estimates have been produced for the site.

Thus this report updates the earlier report by utilising these new values to generate revised performance estimates of the wetland[1], but still includes general theories of constructed wetland operation and the specific suitability of a wastewater treatment constructed wetland at Whakapapa with respect to climate, flow and water quality inputs. We show the NIWA conceptual constructed wetland design, and the Morphum Environmental Ltd detailed site design with anticipated performance. General planting recommendations and monitoring locations are repeated from the earlier report. It should be noted that infiltration area included in the Morphum Environmental Ltd design will provide additional treatment, but this has not been included in our performance modelling.

[1] Thus there is considerable use of information supplied in the earlier report.

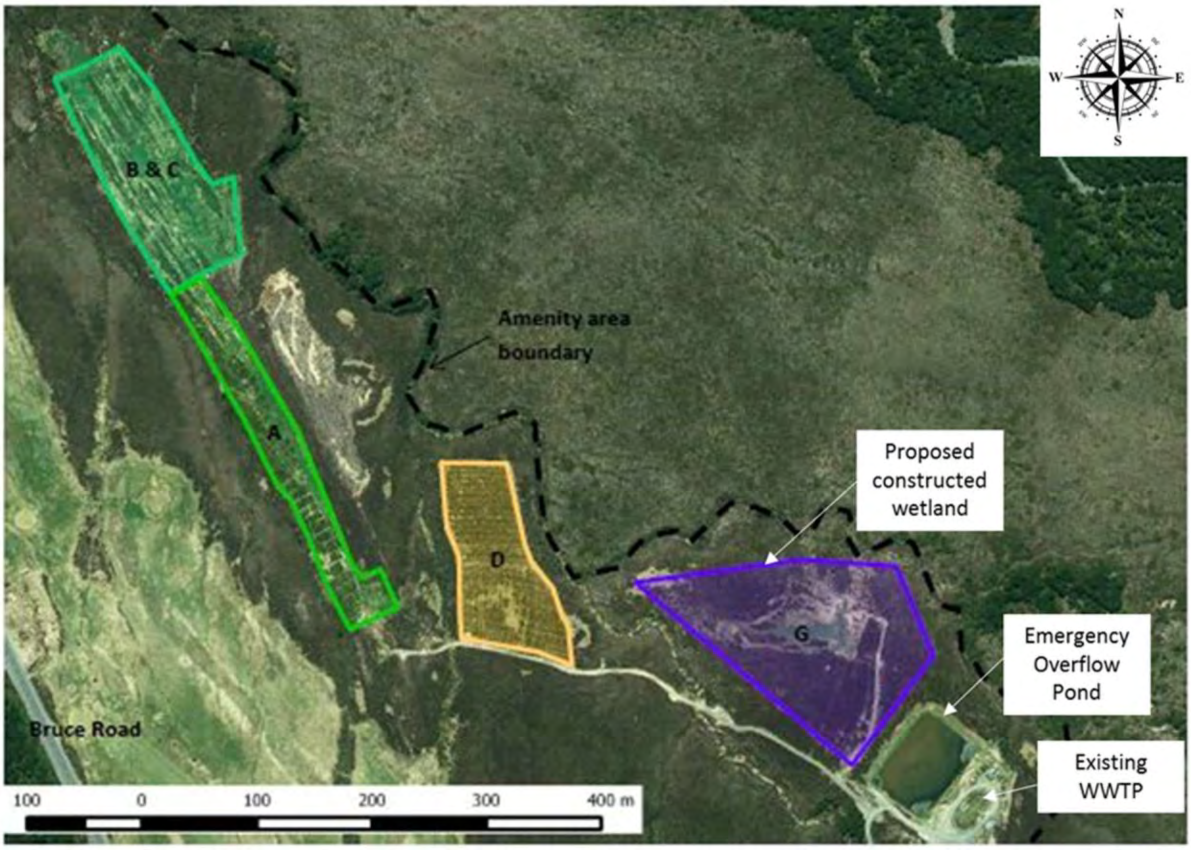


Figure 1: Wastewater treatment plant at Whakapapa Village, emergency overflow pond and proposed wetland at Area G (Wetland 1). Figure supplied by Department of Conservation.

2 Feasibility of constructed wetlands for treating Whakapapa WWTP effluent

This section reviews the current literature on constructed wetlands for wastewater treatment, and explores some critical design and operational parameters for the development of constructed wetlands for the treatment of Whakapapa WWTP effluent.

2.1 Constructed wetlands for wastewater treatment

Wastewater treatment using constructed wetlands largely relies on natural mechanisms such as physical (filtration, settling and precipitation), biological (nitrification/denitrification for nitrogen removal, plant uptake, and bacterial degradation) and biochemical (volatilization, complexation and adsorption) treatment processes (Knight and Kadlec 2000, Jenssen, Maehlum et al. 2005, Chavan, Dennett et al. 2008, Jayaratne, Seyb et al. 2010). Moreover, the effectiveness of constructed wetland technology for wastewater treatment depends on a number of factors such as hydraulic, organic and nutrient loadings, hydraulic retention time (or contact time), vegetation density/type, and ambient environmental conditions (Gearheart 1992, Reed, Middlebrooks et al. 1993). Additional factors include efficient flow dispersion across the available area and the capacity of the vegetation and sediments to retain and/or cycle certain constituents at ambient temperatures (Gearheart 1992).

Constructed wetland wastewater treatment is more influenced by local climatic conditions including temperature, solar radiation, precipitation and evaporation than conventional wastewater treatment methods such as the activated sludge process. As a system relying on many biological processes, constructed wetland wastewater treatment operates more effectively in warm regions (Maehlum, Jenssen et al. 1995, Wittgren and Mæhlum 1997, Jenssen, Maehlum et al. 2005, Chavan, Dennett et al. 2008), however many constructed wetland are now operating successfully in cold regions. For example, over 1000 full-scale constructed wetlands have been installed in North America as a cost-effective, efficient treatment alternative due to their inherent ability to attenuate contaminant flows, conserve natural resources, reduce the flood hazard and erosion, and create wetland habitat (Cole 1998, Knight and Kadlec 2000, Kennedy and Mayer 2002). In particular, 67 constructed wetlands have been developed in cold climatic regions in Canada to treat various waste streams such as domestic wastewater, industrial discharges, livestock wastewater, and stormwater (Kennedy and Mayer 2002).

Wittgren and Maehlum (1997) stated that “cold climate” regions are where the coldest month has a mean temperature below -3°C and the warmest a mean above 10°C, which is largely equivalent to the regions where snow cover normally occurs at least one month per year (e.g., Canada, Alaska and northern contiguous USA, Scandinavia, eastern Europe, Russia and north-eastern China). Neighbouring the cold temperate regions are the "polar" region (warmest month mean below 10°C), where wetland treatment is not feasible (at least not year-round) and warm climate regions (the coldest month mean between -3 and 18°C), where winter problems are only occasional. This suggests that while low temperatures during the winter months may reduce their efficiency, a constructed wetland is still likely to be an effective option to treat wastewater treatment plant effluent.

2.2 General constructed wetland design parameters

General design parameters for constructed wetlands vary depending on inflow water quality, local geological and climatic conditions and treatment objectives Table 1.

Table 1: Design summary of constructed wetland. (Knight and Kadlec 2000, Kennedy and Mayer 2002).

Design parameters	Range
Total area (ha)	0.1–486
Hydraulic load, cm/d	0.001–19.5
Aspect ratio (length/width)	0.7–84
Cell number	1–17

Constructed wetlands are broadly divided into two categories depending on the flow type such as Surface Flow Wetlands (SFWs) and Sub-Surface Flow Wetlands (SSFWs). While both wetland designs have been successfully employed for wastewater treatment worldwide, there are advantages and disadvantages associated with each wetland type (Kadlec 1996, Kennedy and Mayer 2002). The SF wetlands offer a greater 'natural' aesthetic value and lower construction and maintenance costs compared with the SSF wetlands. In contrast, construction and maintenance costs for the SSF wetlands are generally higher than the SF wetlands, because they require a porous media (e.g., gravel) that may need to be replaced after several years of operation due to its blockage. However, the superior wastewater treatment capacity of the SSF wetlands may outweigh the advantages of SF wetlands particularly in cold climatic regions mainly due to greater thermal protection and a greater surface area for microbial activity (Reed, Middlebrooks et al. 1993, Maehlum, Jenssen et al. 1995, Kennedy and Mayer 2002). However, DOC seeks a constructed wetland concept, which will fit nicely within the surrounding landscape and meet the cultural expectations of local iwi. Taking into account the level of upstream pre-treatment, SF constructed wetlands are recommended as the most suitable for treatment of the Whakapapa WWTP effluent. Moreover, SF constructed wetlands will have lower construction and maintenance costs than Subsurface Flow constructed wetlands and achieve better integration with the surrounding landscape and ecosystem.

Hydraulic loading rates and retention time, water depths, cell configuration, inlet/outlet systems, wetland plant species, and local soil composition of the wetland system within the landscape will also need to be considered for the wetland design to meet water quality limits (Gearheart 1992).

2.3 Climate conditions at Whakapapa

As discussed in Section 2.1, local climate conditions such as temperature and precipitation may affect the performance of the constructed wetland in terms of wetland plant establishment and micro-biological processes (particularly nitrogen removal).

Daily maximum and minimum temperature and rainfall from 2011 to 2015 in Whakapapa are summarized in Table 2. The weather station is located at the Whakapapa village (latitude: -39.1977°; longitude: 175.54491°, Figure 2) and the climate data was downloaded from NIWA National Climate Database (http://cliflo-niwa.niwa.co.nz/). Monthly mean temperature at the Whakapapa village varied from 3.1°C to 12.6°C (annual mean temperature: 7.7°C) over one year and the mean summer (December to February) and winter (June to August) temperature was 12.0°C and 3.7°C respectively (Figure 3)[2]. A substantial amount of rain falls directly onto the area identified for constructed wetland development throughout a year (average annual rainfall of 2727 mm over the last five years), which would increase the hydraulic loading rate in the constructed wetlands by 47% (this will be further discussed in Section 3.1).

[2] In comparison with the climate definitions of Wittgren and Maehlum (1997), the Whakapapa site would actually sit within the "warm climate" definition, but would be close to the boundary with the "cold climate" definition. We note that occasional winter ice cover of the emergency overflow pond has been recorded, but repeat that even within true "cold climate" regions, wastewater treatment constructed wetlands perform adequately.

Figure 2: Location of the NIWA weather monitoring station in Whakapapa. (Latitude: -39.1977°; longitude: 175.54491°), Google Earth image. The wastewater treatment plant can be seen in the upper half of the image.

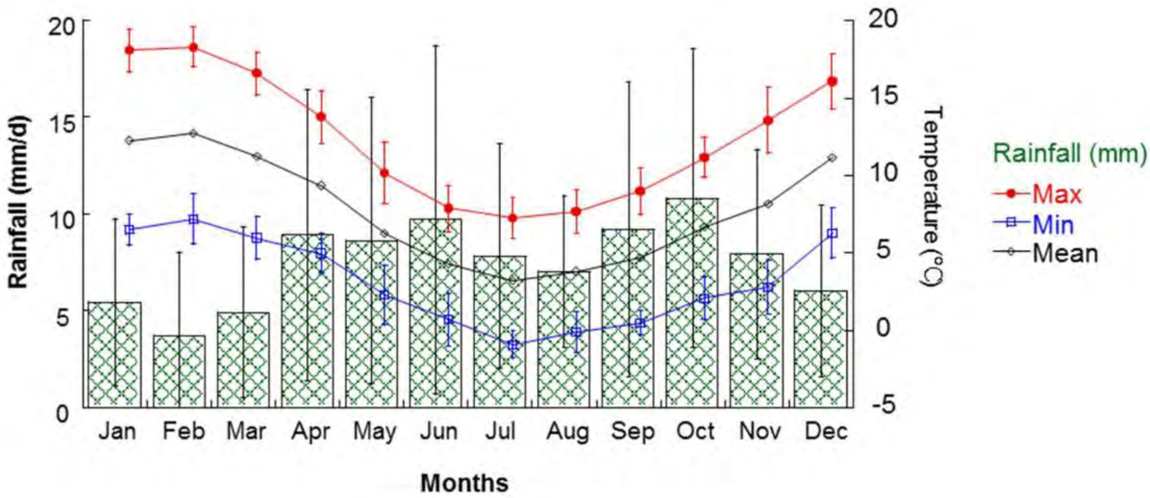


Figure 3: Whakapapa daily temperatures, and monthly total rainfall on a daily basis over the last five years. Temperatures are mean, maximum and minimum and rainfalls are monthly totals from 2011 to 2015. Note rainfall will frequently occur in the form of snow during the winter period.

2.4 Analysis of historical effluent water quality data

DOC and Veolia have recorded the daily flow of the treated effluent (m^3/d) discharged from the Whakapapa wastewater treatment plant using a V-notch weir and flowmeter (installed post-clarifiers and prior to the wastewater being discharged to the infiltration area). Additional validation of this data has been undertaken by Veolia using water treatment plant values. WWTP water quality (TSS, BOD_5, nitrogen and phosphorus species and E.coli) has also been monitored on a monthly basis since 2012. The daily wastewater outflow and effluent water quality data were provided by DOC and analysed to determine the loadings of these pollutants to the constructed wetland.

2.4.1 Wastewater flows and historical concentrations of key contaminants

Daily flow of the treated effluent from the Whakapapa WWTP and historical concentrations of key wastewater contaminants are summarized in Table 3 with statistical analysis in terms of mean, standard deviation, and maximum/minimum.

The existing Whakapapa WWTP system consists of a Pasveer Ditch, two clarifiers, tertiary filters and UV disinfection units. The TSS and BOD_5 concentrations in the treated effluent was highly variable, ranging from 3 to 180 mg/L and 1 to 90 mg/L respectively (Table 3.1). Moreover, the WWTP has performed very poorly (and inconsistently) for nitrogen removal, with a mean Dissolved Inorganic Nitrogen (DIN) concentration of 26.2±20.7 mg N/L in the final effluent (Table 3.1). In particular, very limited nitrification (oxidising NH_4-N to NO_3-N) occurred in winter (NH_4-N: 34.7±31.6 mg/L; NO_3-N: 11.9±20.1 mg/L in the final effluent, Table 3.3).

However after upgrading, the WWTP is designed to achieve increased levels of nitrification. Thus, this historical data can be used to predict likely total nitrogen concentrations the wastewater treatment constructed wetland is likely to receive, but with incoming nitrogen being further nitrified.

Current estimates of average daily flows to the WWTP in summer and winter are 237 m^3/d and 228 m^3/d respectively (Table 3), with an annual average daily flow of 230 m^3/d.

Table 2: Whakapapa average daily temperatures and rainfall over the last five years. Temperatures are mean, maximum and minimum, and rainfalls are monthly totals from 2011 to 2015.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean temp. (°C)	12.2±1.0	12.6±1.1	11.2±1.1	9.3±1.4	6.2±1.8	4.2±1.4	3.1±0.8	3.7±1.2	4.6±0.9	6.6±1.0	8.1±1.7	11.1±1.5
Ave. max temp. (°C)	18.0±1.4	18.2±1.2	16.5±1.4	13.7±1.7	10.1±2.0	7.8±1.5	7.2±1.3	7.6±1.4	8.9±1.5	11.1±1.3	13.5±2.1	16.0±1.8
Ave. min temp. (°C)	6.4±1.0	7.1±1.6	5.9±1.4	4.9±1.3	2.2±1.9	0.6±1.7	-1.0±0.9	-0.2±1.3	0.4±0.8	2.0±1.4	2.7±1.7	6.2±1.6
Monthly total rainfall (mm)	166.2	104.2	150.4	265.8	265.4	291.4	241.1	216.0	277.1	333.3	237.0	179.2

Table 3: Historical Whakapapa WWTP effluent daily flow and concentrations of key contaminants. Data measured monthly from 2012 until 2015, (Table 3.1: Annual data; Table 3.2: Summer data from December to February; Table 3.3: Winter data from June to August).

Table 3.1: Annual	Outflow (m^3/d)	Concentrations of key contaminants in the effluent						
		TSS (g/m^3)	BOD_5 (g/m^3)	DIN (g/m^3)	NH_4-N (g/m^3)	NO_3-N (g/m^3)	DRP (g/m^3)	E. coli (cfu/100mL)
Median	278	14.0	3.0	20.9	6.9	6.8	3.4	1,456.3
Mean ± s.d.	-	24.7±32.2	5.8±13.2	26.2±20.7	16.4±22.7	9.9±11.9	3.6±1.7	295,325±1,773,951
Max.	-	180.0	90.0	82.0	81.4	67.5	7.5	12,022,644
Min.	-	3.0	1.0	1.2	0.0	0.0	0.4	1.0
90%ile	-	59.5	6.5	63.6	52.9	21.5	6.1	46,500
10%ile	-	5.0	1.0	7.0	0.2	0.0	1.6	28.0
# of data points	-	46	46	46	46	46	46	46

Table 3.2: Summer	Outflow (m^3/d)	ConcentrationsofkeycontaminantsintheEffluent						
		TSS (g/m^3)	BOD_5 (g/m^3)	DIN (g/m^3)	NH_4-N (g/m^3)	NO_3-N (g/m^3)	DRP (g/m^3)	E. coli (cfu/100mL)
Median	225	13.0	3.0	13.9	5.1	5.9	3.2	288.4
Mean ± s.d.	-	27.1±31.3	3.5±2.2	15.3±9.2	8.5±9.4	6.8±7.1	3.5±1.4	4,165±7,484
Max.	-	90.0	7.0	30.0	30.0	22.8	6.3	23,000
Min.	-	3.0	1.0	3.9	0.1	0.0	1.6	1.0
90%ile	-	73.0	6.0	27.9	19.1	15.2	5.0	13,000
10%ile	-	4.0	1.0	6.0	0.2	0.3	2.0	4.0
# of data points	-	11	11	11	11	11	11	11

Table 3.3: Winter	Outflow (m^3/d)	ConcentrationsofkeycontaminantsintheEffluent						
		TSS (g/m^3)	BOD_5 (g/m^3)	DIN (g/m^3)	NH_4-N (g/m^3)	NO_3-N (g/m^3)	DRP (g/m^3)	E. coli (cfu/100mL)
Median	417	14.0	4.0	43.0	35.3	2.3	3.4	602.6
Mean ± s.d.	-	16.8±13.1	3.7±2.3	46.6±25.1	34.7±31.6	11.9±20.1	4.3±2.0	29,318±72,874
Max.	-	47.0	6.0	82.0	81.4	67.5	7.5	240,000
Min.	-	3.0	1.0	12.2	0.1	0.0	1.6	2.0
90%ile	-	29.0	6.0	81.4	80.5	22.4	6.8	70,000
10%ile	-	5.0	1.0	20.6	2.2	0.0	1.9	120.0
# of data points	-	11	11	11	11	11	11	11

3 Conceptual design

The initial conceptual design of a wastewater treatment constructed wetland is reproduced in Figure 4. Factors which have influenced the design incorporate:

- Effective wastewater treatment.
- Maori cultural expectations of wastes treated via Papatūānuku.
- Achieving an appropriate "landscape fit" for a national park.

Figure 4: Initial conceptual wetland design for area G.

Morphum Environmental Ltd have developed a detailed site design based on their practical experience of wetland design and construction. This is reproduced in Figure 5.

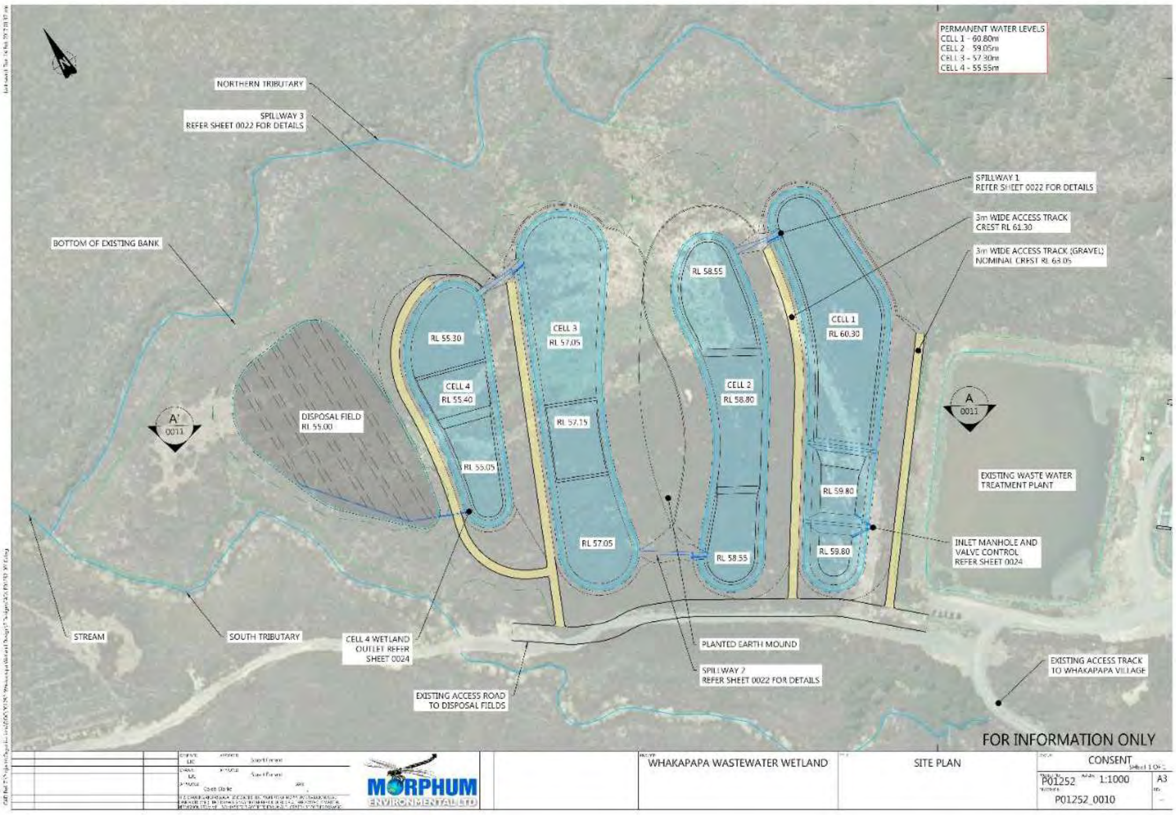


Figure 5: Morphum Environmental Ltd constructed wetland design for Whakapapa.

4 Modelled treatment performance

Key factors influencing constructed wetland performance treating domestic sewage include influent wastewater strength and flow, ambient temperatures, as well as wetland size and depth. We have used constructed wetland performance kinetic model developed by Kadlec and Tanner (3 TIS k-C* approach based on Kadlec and Knight 1996) to evaluate the expected treatment performance of the wetland design developed by Morphum Environmental Ltd). Flows and influent wastewater quality (supplied by Veolia) have been used to calculate hydraulic residence times (see Table 4) and expected treatment performance (Tables 5 & 6).

The model is used to predict the performance of a constructed wetland design optimised for water quality improvement. Such an optimal design might be rectangular in shape, with input and output devices to optimise flow distribution. While the current design achieves many water quality design objectives, e.g., plants arranged in transverse bands across the flow path, as well as inclusion of deeper zones to encourage good flow distribution and plug flow (Figure 5), it also includes features to enhance landscape fit as well as aesthetic appearance. These include positioning of the outlets from each wetland cell (to one side of the wetland) and rounded corners, which create some unavoidable reduction from idealised flow. These may result in a decrease from optimum performance efficiency. Therefore, the modelled effluent water quality should be considered a maximum achievable removal with some allowance made for these design features as well as some uncertainties of constructed wetland performance at lower temperatures.

Table 4: Areas, water depths, average flows, and hydraulic retention times (HRT) of each wetland cell in Area G based on current and predicted future flow cond.

		Area (ha)	Wetland depths (m)	Current flow conditions Ave. Flow (m^3/d)	HRT (d)	Future flow conditions Ave. Flow (m^3/d)	HRT (d)
Winter	Cell 1	0.34	0.51	237	7.0	334	5.0
	Cell 2	0.26	0.34	237	3.6	334	2.6
	Cell 3	0.32	0.21	237	2.7	334	1.9
	Cell 4	0.19	0.27	237	2.1	334	1.5
	Total	1.11	-	-	15.3	-	11.0
Summer	Cell 1	0.34	0.51	228	7.4	373	4.6
	Cell 2	0.26	0.34	228	3.8	373	2.3
	Cell 3	0.32	0.21	228	2.8	373	1.7
	Cell 4	0.19	0.27	228	2.2	373	1.3
	Total	1.11	-	-	16.2	-	10.0
Annual	Cell 1	0.34	0.51	230	7.1	353	4.7
	Cell 2	0.26	0.34	230	3.7	353	2.5
	Cell 3	0.32	0.21	230	2.8	353	1.8
	Cell 4	0.19	0.27	230	2.1	353	1.4
	Total	1.11	-	-	15.7	-	10.4

Flow data from the WWTP treated effluent, and anticipated influent water quality (Total Suspended Solids (TSS), BOD_5, DRP, NH_4-N and NO_3-N) was supplied by Veolia. Temperature and rainfall (from the 5-year climate record) was used to assess seasonal performance expectations. Performance was based on average cell depths provided by Morphum Environmental Ltd.'s wetland design. We have used the effluent from each cell as the influent to subsequent cells (rather than model the constructed wetland as a single entity).

Projected effluent water quality for TSS, BOD_5, DRP, and E.coli are summarized in Table 5.

Table 5: The wetland influent and modelled effluent water quality over one year. Data are annual, winter and summer averages.

	TSS (mg/L)	BOD_5 (mg/L)	DRP (mg/L)	E.coli (cfu/100 ml)
Inf. (annual avg.)	24.3	5.7	3.7	1.1×10^3
Modelled eff. (1) (Annual avg.)	6.1	3.5	0.9	1×10^2
Inf. (Winter avg.)	16.7	3.9	4.4	1.1×10^3
Modelled eff. (Winter avg.)	6.1	3.4	1.1	1.1×10^2
Inf. (Summer avg.)	25.9	3.3	3.5	2.3×10^3
Modelled eff. (Summer avg.)	6.1	3.5	0.8	9.7×10^1

The proposed wetland is expected to achieve high removal of TSS, DRP and BOD_5 (TSS: <10 mg/L; DRP <2.0 mg/L; BOD_5: <5 mg/L) throughout the year. Furthermore, approximately 1-log E.coli removal could be achieved in the wetland (with a final effluent E. coli concentration of ~1.0×10^2 cfu/100 ml in both winter and summer).

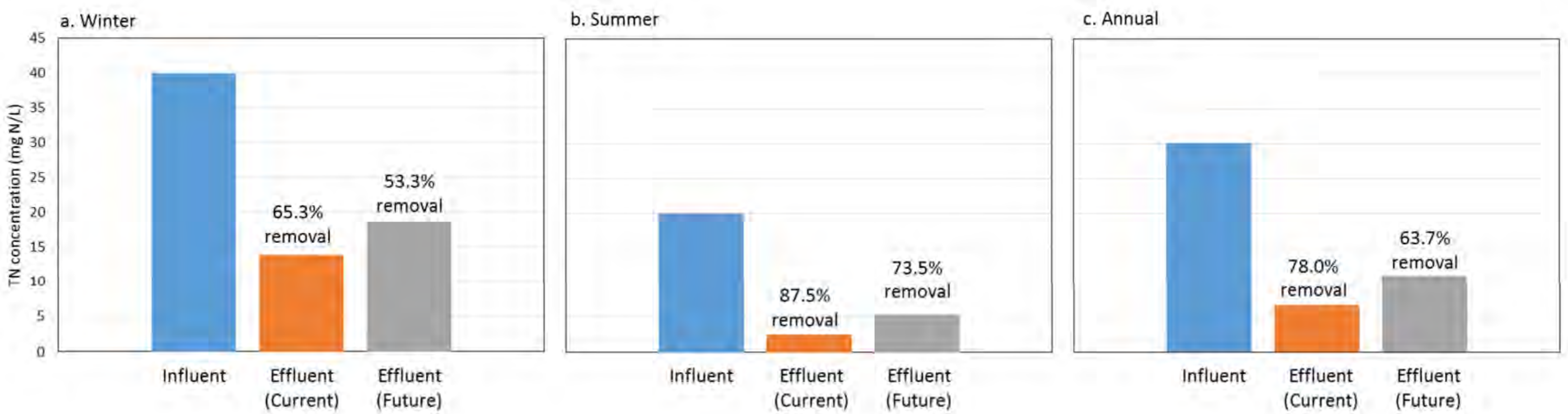
Nitrogen removal performance of an idealised constructed wetland was modelled on predicted summer and winter performance of the improved WWTP design. Results based on current and predicted future flow rates are summarized in Table 6 and illustrated in Figure 6.

Under current flow conditions and anticipated inflow water quality concentrations from the improved WWTP, the model predicts an optimised constructed wetland design would achieve TN removal 65% in winter and 88% in summer, with an annual average removal of 78%. Under predicted future flow conditions, these would reduce to 53% TN removal in winter, 74% in summer, and an annual average of 64%. As mentioned previously, some allowance must be made for non-idealised conditions within the constructed wetland. Therefore, we would have greater confidence that the constructed wetland would achieve 50-60% in winter and around 80-85% in summer (65-75% annual removal, average effluent TN <12 mg/L) under present flow conditions, with 40-50% removal in winter and 65-70% in summer (50-60% annual removal; average effluent TN <16 mg/L) under predicted future flow scenarios.

Table 6: Modelled nitrogen removal performance of an idealized wetland design at Area G based on the current and future flow conditions.

	Current flow conditions									Future flow conditions				
		Influent N concentrations					Effluent N concentrations					Effluent N concentrations		
	Area (ha)	NH_4-N (mg/L)	NO_3-N (mg/L)	TN (mg/L)	Ave. Flow (m^3/d)	HRT (d)	NH_4-N (mg/L)	NO_3-N (mg/L)	TN (mg/L)	Ave. Flow (m^3/d)	HRT (d)	NH_4-N (mg/L)	NO_3-N (mg/L)	TN (mg/L)
Winter	1.11	13.0	27.0	40.0	237	15.3	3	11	14	334	11.0	5	15	20
% removal	-	-	-	-	-	-	77%	60%	65%	-	-	65%	47%	53%
Summer	1.11	1.3	18.7	20.0	228	16.2	<0.5	3	3.5	373	10.0	<0.5	5	5.5
% removal	-	-	-	-	-	-	84%	88%	87%	-	-	68%	74%	74%
Annual	1.11	5.0	25.0	30.0	230	15.7	1	6	7	353	10.4	2	10	12
% removal	-	-	-	-	-	-	81%	77%	78%	-	-	67%	63%	64%

Figure 6: Influent and effluent TN concentrations of an idealised wetland at Area G based on the current and future flow conditions. Percentage TN removal is shown in the text boxes.



5 Wetland plants

Wetland plants provide a number of key functions including natural aesthetics. When initially planted they absorb nutrients from incoming wastewater, however after a number of seasons' plant nutrient uptake and release are roughly balanced. However falling leaf litter from the plants forms a matrix of high carbon mulch which is used as an energy source by bacteria for denitrification. In addition, the plants assist with maximising the flow path through, and minimising short-circuiting in, the wetland cells. Moreover, the plants themselves provide an attachment surface for bacterial biofilm to promote nutrient removal.

Guidance on suitable plant species to the site conditions and potentially capable of nutrient removal for the constructed wetland is given by Singers (2016). These may include:

- Toetoe (Austroderia fulvida, A. toetoe).
- Harakeke (Phormium tenax).
- Purei (Carex secta), C. sinclarii, C. coriacea, C. virgata.
- Holy grass (Hierochloe redolens).
- Giant spiked sedge (Eleocharis sphacelata).
- Raupo (Typha orientalis).

Using these general guidelines, we recommend use of species such as Eleocharis sphacelata in deeper areas, with purei in shallower areas. Harakeke, toetoe and holy grass may be placed in wet margins and on bunds and embankments. Use of raupo should be sparing, as it tends to dominate high nutrient environments, and may displace other species, possibly resulting in a monoculture of wetland plants.

It is critical for planting success that initial planting of the site occur early in the growth season, which is normally around November. This allows the new plants to establish a strong root system into the new substrate, as well as good above ground growth and adequate energy reserves (e.g., underground starchy rhizomes) for the ensuing winter period. Due to the harsh winter conditions that the plants might experience at the end of their first season, we recommend that the plants to be used should be as large as possible (at least equivalent to 1 L pot grade). However, because of the short period available to propagate plants from seed, we realise plants may not be large. Thus where only small propagules are available, in general we would recommend a planting density of up to 4 plants m^2, although lower densities will be acceptable for larger propagules, and for larger species such as flax. Based on the likely areas available within Area G, recommended plant numbers are shown in Table 7. These numbers are intended to be indicative, and different locally suitable species can be substituted, such as Toetoe, Macherina arthrophylla and M. rubiginosa in place of the smaller Carex species, depending on availability.

Table 7: Recommended wetland plant numbers for different species.

Species	Area of planting (m^2)	Number of plants required
Open water areas	2400	0
Eleocharis sphacelata	4800	19200
Carex secta	3600	14400
Carex virgata	4800	19200
Carex sinclarii	1200	4800
Carex coriacea	1200	4800
Phormium tenax	Shallow edge areas	2000
Hierochloe redolens	Occasional	
Typha orientalis	1200	4800

5.1.1 Marginal planting

As noted above, the outer bunds and cell dividing bunds may planted with shallow rooting herbaceous species such as toetoe and harakeke. Purei (Carex spp.) would also be suitable for surrounding areas. Adjacent amenity areas may, in addition, be planted with taller shrubs and trees as identified by Singers (2016) (e.g., Manuka, Alpine Celery Pine, Bog Pine, Mountain Toetoe) as well as red and silver tussock, Bog Pine, Koromiko, Inaka etc. By using these taller species, the general outline of the wetland is further "softened" and broken up, making it appear more natural (and thus less like an engineered wastewater treatment system). In addition, use of a wider variety of plants allows for the inevitable loss of some plants because conditions during establishment have the potential to be harsh.

Further details on the wetland plants and ecological assessment are included in the report prepared by Singers (2016), and we recommend the use of such experts to assist with translating the conceptual designs into a reality with good "landscape fit". In addition, this will allow desirable plants already growing in the wetland area to be transplanted into the wetland surrounds after construction of the bunds and islands.

It is important that tall growing species establish well in the areas of standing water in order to exclude weed intrusion. Natural colonisation of local species in addition to those intentionally planted is expected and will enhance biodiversity values. We recommend that after planting there should be a two year period of monitoring and aftercare. This should include an allowance for some plant replacement given the harshness of the local climate. A second period of assessment of plant establishment after a suitable period (e.g., 4-5 years) would also be valuable to assess the success of this project and to inform later wetland projects at this site.

6 Summary

A wastewater treatment constructed wetland has been designed for the Whakapapa Wastewater Treatment Plant. The design includes four constructed wetland cells (Cells 1-4), which will be operated in series followed by an infiltration area for effluent assimilation. Impermeable bunds will be placed around the boundary of the wetland and between the wetland cells.

Receiving the annual average flow of 230 m^3/day will give a hydraulic retention time (HRT) of 15.7 days in the constructed wetland, with a hydraulic loading rate of 2.1 cm/d.

Native wetland plants such as Toetoe (Austroderia fulvida, A. toetoe), Harakeke (Phormium tenax), Purei (Carex secta), C. sinclarii, C. coriacea, C. virgata, Holy grass (Hierochloe redolens), Giant spiked sedge (Eleocharis sphacelata), and Raupo (Typha orientalis) were identified as the most suitable plant species at the wetland site and are appropriate for the surrounding landscape in the Whakapapa village in the Tongariro National Park.

A kinetic model predicting the performance of this multi-cell wastewater treatment constructed wetland receiving wastewater from the improved WWTP was developed. Taking into consideration the limited number of constructed wetlands currently in New Zealand which are exposed to the cold temperatures of a Whakapapa winter combined with peak loading at this time and inclusion of features to enhance landscape fit at the national park, we predicted annual TN removal of 65-75% (average effluent TN <12 mg/L) under current flow conditions, and 50-60% (average effluent TN <16 mg/L) under predicted future flow conditions. The wetland is expected to achieve high TSS and BOD_5 removal (effluent values <10 mg/L) throughout the year. Phosphorus removal may also be affected by the low temperature in winter, but low values in the effluent would still be expected (<2.0 mg/L).

While the constructed wetland design has been designed to current best practice, some aspects of performance as well as future use scenarios are difficult to predict with certainty. Thus we endorse the adaptive management approach suggested by the Department of Conservation, whereby staged wetland development be undertaken, with additional areas of constructed wetlands and/or infiltrations zones beyond those specifically addressed in this report be developed if this proves necessary. This also allows incorporation of new knowledge from results of earlier stages, while reducing the potential for oversizing of the system, and potential costly mishaps in terms of construction, operation and maintenance within the initial short timeframe in which improvements in system performance are required.

7 Acknowledgements

The Department of Conservation has assembled a multidisciplinary team of experts to address issues at this site. We wish to acknowledge the value of discussions had with them, and their various inputs to this report.

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APPENDIX 7

WETLAND DESIGN REPORT AND PLANS - MORPHUM

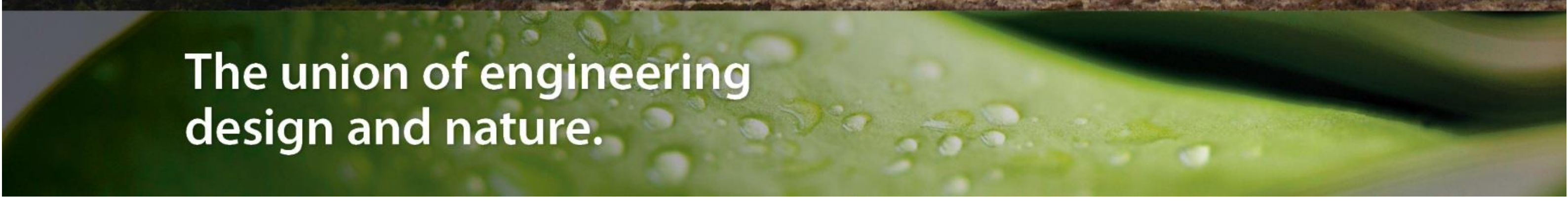
Engineers & Consultants

Design Summary Report

Whakapapa Wastewater Treatment Wetland

Draft

Prepared for Department of Conservation by Morphum Environmental Ltd
February 2017



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Executive Summary

Morphum Environmental Limited (Morphum) were engaged by the Department of Conservation (DOC) to develop the design of a constructed wetland to treat effluent from the existing wastewater treatment plant (WWTP) which is located north east of Whakapapa Village within the boundaries of Tongariro National Park. The design of the proposed constructed wetland builds on an initial concept developed by NIWA and previously submitted in support of the resource consent application. Following this, a formal S92 request was made by Horizons Regional Council, including requirements for further design development and documentation.

The design has been developed to optimise the water quality treatment performance within the constraints of the site whilst balancing the cut fill balance as much as practical and integrating the constructed wetland into the landscape. The design has also considered a range of operational conditions including infrequent storm events and climatic extremes.

Based on these considerations a constructed wetland system comprising a series of four terraced cells connected by spillways is proposed. These will have variable water depths and support dense plantings of emergent macrophyte plant species. Treated effluent from the constructed wetland shall discharge to land via a dedicated infiltration area which will include trenches penetrating below the identified low permeability volcanic ash layer. This report should be read in conjunction with other supporting technical reports and the Technical Drawing set issued by Morphum for Resource Consent purposes. Key design dimensions and parameters are presented below.

Parameter	Measure
Total wetland area at Permanent Water level (PWL) (m^2)	11,095
Total volume at PWL (m^3)	3,811
Direct infiltration area - trench base (m^2)	600
Total site area (m^2)	29,720
Total cut volume (m^3)	12,400
Total fill volume (m^3)	11,400
Excess soil volume (m^3)	1,000

Wetland cell	Area at PWL (m^2)	Volume at PWL (m^3)	Depth range (mm)	PWL RL(m)
1	3,436	1,745	500 to 1000	60.80
2	2,617	893	250 - 500	59.05
3	3,174	672	150 - 250	57.30
4	1,868	501	150 - 500	55.55

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1.0 Introduction and background

Morphum Environmental Limited (Morphum) were engaged by the Department of Conservation (DOC) to develop the design of a constructed wetland to treat effluent from the existing wastewater treatment plant (WWTP) which is located north east of Whakapapa Village within the boundaries of Tongariro National Park. The constructed wetland is part of a managed system which is intended to provide a high level of treatment of wastewater from facilities within the Whakapapa and Iwikau Villages and those within the Whakapapa ski area including public facilities, staff facilities and private lodges.

The design of the proposed constructed wetland builds on an initial concept developed by NIWA and previously submitted in support of the resource consent application. Following this, a formal S92 request was made by Horizons Regional Council. This included seeking clarifications around the design details of the constructed wetland and further detail on its function. Morphum's brief was to design a wetland which optimises the use of the previously identified area (referred to as area G) to support sustained water quality improvements prior to discharge to land. This has necessitated some changes to the initial concept in response to site topography and constraints but has maintained a focus on achieving the key biological function which is critical to support ongoing water treatment.

NIWA have used the dimensions and operating conditions within the proposed constructed wetland as the basis for inputs to their customised kinetic performance model. This model has been used to represent the estimated water quality treatment with respect to the incoming effluent quality, the volume and depth of the constructed wetland cells and the corresponding residence time. The expected treatment performance of the proposed constructed wetland is not discussed or quantified in this report but rather the attributes from this design have been provided to NIWA as the basis of their revised modelling and performance reporting. This summary report and the constructed wetland design plans should therefore be read in conjunction with the NIWA report (Whakapapa Wastewater Treatment Constructed Wetland: Conceptual design and revised performance modelling, NIWA, 2017). Detailed information on site soils and hydrogeology is contained in the Lattey report (Hydrogeological Investigation – Area G, Lattey, 2017). Accordingly this report does not provide any detailed descriptions of site soils etc.

This design summary report provides descriptions of key elements of the constructed wetland design, the function of the system and the rationale or basis for certain design parameters.

2.0 Site Description

The proposed Whakapapa constructed wetland is located approximately 750 m north of Whakapapa Village immediately west of the existing wastewater treatment plant (WWTP). The elevation is approximately 1120 m a.s.l and is wholly within the Tongariro National Park. The total site area is approximately 2.9 ha comprising a flat topped ridge between two tributaries of the Wairere Stream. These are referred to as the 'north' and 'south' tributaries, both of which are incised channels with well-defined banks and limited active flood plains. The overall site has a relatively uniform slope with a gentle 4 % fall from east to west. The total fall across the proposed total wetland area is approximately 9m which has resulted in the need to design the system as series of terraces to integrate into the landscape and avoid excessive earthworks. Figure 1 shows a portion of the area proposed for the constructed wetland.

Figure 1 View of proposed constructed wetland area looking east towards existing WWTP with Whakapapa Village in distance

This site of the proposed constructed wetland is currently used as part of the land disposal area (referred to as area G) for the discharge of treated effluent from the existing WWTP. The land is considered to be highly modified having previously been cleared for livestock (pigs) and more recently having distribution pipework installed for the disposal field. Due to ongoing issues with the operation of the disposal field there are a number of artificial rivulets and saturated ground where the effluent is presently flowing across the surface towards the stream. Whilst this water has received treatment within the wastewater treatment plant it understood to contain elevated nutrient levels (in particular nitrogen) and is not currently being discharged in a controlled manner. Due to the legacy landuse across the site, the soils have been found to be contaminated with elevated levels of e-coli in particular (Detailed Site Investigation, Lattey, 2016). The prevalence of contaminated soils and the issue with disposal options compatible with the local geology has been reflected in the design of the constructed wetland to reduce the overall volumes of earthworks and maintain soils within the site area where feasible. Figure 2 shows the existing condition of the site with unintended overland flow of effluent from the WWTP discharging across the surface.

Figure 2 Existing overland flow of effluent in area of proposed constructed wetland

The site of the proposed constructed wetland currently comprises a mix of exotic and native grasses and shrubs. This assemblage is understood to be highly modified due to the historical landuse practices and is not representative of the natural state. Morphum have not been engaged to undertake any ecological assessment of the site as part of this design process based on the understanding that the site has previously been identified as being suitable for the proposed constructed wetland.

Site investigations by Lattey (refer Hydrogeological Investigation – Area G, Lattey, 2017) have been undertaken to determine the soil strata across the site. This has determined that the site is underlain by a number of distinct layers of volcanic origin. These include topsoil, medium grained pumice sands, volcanic clays (derived from ash) and a base layer of a mixed gravel matrix. These layers were found to be relatively uniform across the site (based on six hand augers) and appear to follow the surface landform. Observations of the soils was also made in a number of exposed cuttings which confirmed the sequence identified in the soil logging as well as highlighting the variability in depths within the strata which may be encountered during construction. Based on this it will be important to include close construction supervision and selective stockpiling of materials to ensure that the design intent is achieved.

The site is presently not accessible to the public with vehicle access restricted to DOC staff and WWTP contractors via a locked gate which services the WWTP and disposal fields.

3.0 Treatment wetland design

3.1 Design objectives

An initial site inspection, and discussions with DOC representatives and the project team, was undertaken on 18th November 2017. In addition, the documents submitted in support of the original resource consent application and corresponding S92 response were reviewed. Based on this, a number of objectives were identified which have informed the design process. These are summarised as:

- Develop the wetland design to optimise the use of the available space whilst supporting the required water quality treatment processes within a constructed wetland.
- Ensure that the constructed wetland retains water at all times and does not exhibit uncontrolled exfiltration of partially treated flows to the subsoils and shallow groundwater.
- Integrate the constructed wetland into the landscape without excessive use of large embankments, structures or heavily 'engineered' features.
- Design the wetland to reflect the site specific climatic conditions including low temperatures, potential for frost heave and seasonal snow.
- Manage the overall earthworks volumes to balance the cut to fill ratio and reduce the amount of excess cut requiring disposal (due to concerns with contamination).
- Use site sourced materials wherever possible to support the construction of the wetland and avoid the import of soils from beyond the site.
- Use only locally sourced vegetation suited to the operating conditions within the constructed wetland (which differ significantly from those within a natural wetland or alpine tarn situation)
- Design the wetland to treat the estimated effluent flowrates whilst also allowing for direct rainfall during storm events.
- Design the system to support the further development of the stage 2 wetland if required by considering future connections and adaptations to the overall system.
- Ensure that the design considers safety to contractors, operations personnel and the public for the operational life of the wetland.

These objectives have been reflected throughout the design which has been developed in consultation with the project team as it has progressed.

3.2 General description

The proposed constructed wetland system will receive piped inflows from the existing WWTP and provide further water quality improvements. In particular the design has been developed to optimise the removal of nutrients (in particular nitrogen) through a mix of physical, biological and chemical processes.

Treatment processes within constructed wetlands depend on complex interactions within a permanently saturated substrate which is planted with a mix of emergent macrophytes selected specifically for the modified flow regime of the constructed system. The emergent macrophyte vegetation provides oxygen to the soils (to support anoxic conditions), provides a growing medium (stems) for algal biofilms and directly takes up nutrients into foliage. In addition the design of the constructed wetland is intended to effectively remove residual total suspended solids (TSS) and manage the biological oxygen demand (BOD) in the pre treated effluent from the WWTP. Whilst the design is based on the normal operating conditions of the WWTP it includes provision for infrequent events such as potential malfunctions within the WWTP or significant rainfall events.

The constructed wetland has been designed to hold and retain a near constant water level with effluent flowing through the system in a manner which optimises the exposure with the important treatment pathways. This is achieved by a flow through configuration whereby flows enter at the upstream end and discharge at the downstream end with no attenuation of flows or detention to respond to event based loading.

Due to the grade across the site the constructed wetland has been designed as a series of four distinct cells (referred to as cells 1 to 4) which are effectively terraced from the inlet (east) end to the outlet (west) end where fully treated flows will discharge to land. Water enters each cell at one end, travels along its full length and drops into the subsequent cell via a rock lined chute (which provides intermittent oxygenation through the system). The permanent water levels within each cell are maintained through the use of cast in-situ concrete weirs which are constructed into the perimeter bunds at the head of these chutes with a precise crest level defined. There is a vertical fall of 1.75 m between each of the wetland cells (vertical distance between upstream weir crest and downstream water level) in order to integrate the cells into the landscape without excessive earthworks or large bund structures.

The internal bathymetry within each cell has been designed to create a variability of depths to support a diverse range of aquatic plant species and increase the resilience of the system by ensuring that if particular species struggle due to the conditions on site, there will be others that may continue to thrive. This variation in depth is also designed to provide a suitable permanent water volume to support an acceptable residence time whilst also enabling a mix of shallow and deep marsh plant species. The design of the internal bathymetry also ensures that the cross section perpendicular to the flow direction is constant (i.e. no defined deeper channels through the wetland) to ensure that flows are distributed across the full width to maximise the contact with plant based treatment processes and reduce redundancy resulting from areas of stagnant water. The wetland will be fully planted with dense vegetation (3 plants/m^2) apart from the entry forebay (south end of cell 1) and small open water areas immediately upstream of the spillway weirs.

Operational maintenance is to be provided via 3m wide vehicle access benches which will provide access to each of the spillway/rock chute areas and associated hydraulic structures. These tracks will be planted with grasses following construction with an expectation that full vehicle access will be seldom required and can be scheduled during dry weather only. Provision for isolation and cleanout of the forebay, when required, is provided via the double bay design with an isolating valve enabling the drawdown of the southernmost forebay cell for removal of sediments, whilst the second forebay cell remains operational.

At the downstream end of cell 4 the treated flows shall be discharged to ground via a series of trenches to be excavated through the volcanic ash layer (low permeability) and into the more permeable gravel conglomerate below.

3.3 Hydraulic connections

Due to the controlled nature of inflows discharging into the constructed wetland from the WWTP, the hydraulic function is relatively simplified based on the principles of a flow through wetland. This means that flows enter at the upstream end and discharge at the outlet without the need to account for significant instantaneous fluctuations in flowrates or the need to attenuate flows and provide detention storage and hydraulic control such as is typical with urban stormwater treatment wetlands. Whilst there will be variability in the discharge flowrates, based on information provided by Veolia we anticipate that these will not exceed 10 L/s under normal operational conditions and will generally be around 2 – 4 L/s. These flowrates are considered to be very low for the purposes of design and will not result in excessive velocities within the wetland which can impact performance due to scour of algal biofilms from plant stems.

During periods of heavy rain, the wetland will be subject to inflows from only the immediate site area including the wetland cells and immediate perimeter batters. Due to the position on a spur between the incised tributaries rainfall beyond this will be conveyed away from the proposed constructed wetland. Based on high level calculations using the rational method and the full 2.15ha site (which is able to drain into the wetland cells) it is estimated that the peak flowrate from rainwater in a 100 year 10 minute event (worst case) will be approximately 400 L/s. Whilst this would only be experienced at the downstream end of the constructed wetland system (cell 4), the design has been tested to ensure that it would be able to pass these flows through all of the weir structures without uncontrolled overtopping.

3.3.1 Inlet forebay

Flows will enter the south end of cell 1 into dedicated twin 1m deep forebays via the existing pipework from the WWTP and a flow split manhole. The forebay cells are separated by an earthen bund, with a crest at the permanent water level, to spread the concentrated inflows across the full width. The flow split manhole (refer drawing P01252_0024) enables the flows to ordinarily discharge into the southernmost end of the forebay cell but includes the ability to isolate this cell (through manually shutting the gate valve) to enable it to be drawn down (using syphon or pump) and desilted. During this time, flows would be discharged into the second of the forebay cells. Due to the level of pre-treatment provided within the WWTP it is not expected that influxes of sediments/solids will be an issue except in the instance of system malfunction within the WWTP (such as bypass of filtration screens). The inclusion of the double forebay is therefore considered to be a conservative element but provides resilience for unforeseen conditions with minor infrastructure requirements.

3.3.2 Permanent water level control

Each of the four wetland cells will retain a standing water level (referred to as permanent water level or PWL) via a formed concrete weir which will define this level as well as formalising discharges between respective cells (refer drawing P01252_0022/0023). From the weir flows will discharge via the rock spillway to the cell below. The crest of the weirs shall be constructed level at the nominated RL as shown in Table 1.

Table 1 Permanent water levels in wetland cells

Wetland cell	Permanent water level (PWL)
1	RL 60.80 m
2	RL 59.05 m
3	RL 57.30 m
4	RL 55.55 m

The weirs have been sized at 1 m width to enable the controlled discharge of flows up to the full 100 year ARI flowrate (10 minute duration) and will pass 400 L/s with under 400 mm head providing a further 100 mm freeboard. Under normal peak wastewater flowrates of 10 L/s it is calculated that the weir will maintain a 30 mm head only. The spillway weirs have been designed to support the retention of water under all conditions (i.e. liner able to be securely installed around structure). There are three spillway weirs/chutes in total at alternating ends of the wetland cells with maintenance access provided via a 3m wide access bench.

3.3.3 Water level control manhole

Adjacent to each of the spillways will be a separate hydraulic control manhole which includes a manual valve set at 250mm below the PWL (refer drawing P01252_0024). Under normal operating conditions the valve will remain closed with a charged pipe connecting to the upper cell and an outlet from the manhole connecting to discharge onto the lower spillway. This enables the water level within the wetland cells to be manually drawn down for the establishment of the initial plantings, maintenance of perimeter batters or to improve periodic succession and propagation of plants which prefer exposed soils for germination rather than standing water. Due to the stepped nature of the wetland cells these valves can be selectively operated to either lower all cells together or individually depending on the operational requirements. Operation of these controls will be incorporated into the long term asset management guidance. Access to these manholes is via the same 3m wide bench provided for the spillways.

3.3.4 Discharge to infiltration area

Outflows from the lower cell (cell 4) shall discharge via an open grated manhole (crest defines PWL) which connects to the land based infiltration area (refer drawing P01252_0024). This is discussed further in Section 3.6.

3.4 Site soils and construction methodology

Site soils are considered typical of the regions volcanic nature and comprise a mix of materials deposited in distinct layers. Investigations by Lattey have included soil logging across the site, investigations into the hydrogeological relationships and sample collection from the identified ash layer for laboratory testing for saturated hydraulic conductivity. In addition to the hand auguring, a number of exposed cuttings (on banks of incised stream and road) were inspected to visually assess the condition of the distinctly layered soils. The methodology and findings of these investigations are included in the report Hydrogeological Investigation – Area G, Lattey, 2017 which should be referred to for further details.

In summary, the site was found to be overlain in a topsoil layer beneath existing vegetation, with a layer of pumice sand over a defined layer of volcanic ash (silty clay). Beneath this there was a layer of a variable gravel matrix of undefined thickness. This underlying gravel conglomerate appeared to be variable in condition with observations of differing gravel/boulder sizes, fractures and areas of tightly consolidated conglomerate.

Early discussions with Iwi representatives, DOC and Ruapehu District Council indicated that the objective to avoid the use of a synthetic liner wherever possible was desirable to maintain a connection between the water and the natural soils of the site. The importance of maintaining a permanent water level in constructed wetlands (to ensure that the objective of adequately treating water quality is achieved) was raised with these stakeholders and investigations were therefore focussed on verifying whether site soils would be suitable to use as an effective liner for the constructed wetland.

The ash layer was found to be present at depths below ground level of between 1.1 m and 1.4 m. For the purpose of modelling the existing site soils an approximation of a uniform 1.3 m below ground level was adopted which is considered to be a conservative estimate with most areas expected to include clay rich ash soils at shallower depths. Two samples were collected from this ash layer and tested to confirm hydraulic conductivity at optimum compaction. The permeability results for the ash layers came in between 8.74×10^{-08} and 4.52×10^{-08} m/s. This is considered more permeable than the target of 1×10^{-9} m/s (typical for compacted clay liners) and is considered to be on the margin of a 'poor drainage material' and 'practically impervious'. It is noted that this permeability equates to between 0.16 and 0.31 mm/hr exfiltration if it was consistent across the entire wetland base. When this is extrapolated across the entire 1.2 ha constructed wetland area, an overall exfiltration rate of between 0.5 and 1.0 L/s would be expected. Based on the annual mean flowrate of 3.7 L/s (321 m^3/day) these rates of exfiltration would not result in sustained drawdown of water in the wetland but it is noted that they are based on an assumption of achieving a homogeneous compacted liner across the entire wetted area. Achieving this homogeneous liner through a combination of cut and fill was considered to be high risk with a high likelihood of variability across the base potentially resulting in higher rates of exfiltration loss. These losses pose risks in terms of the discharge of partially treated effluent to the shallow groundwater and potential to impact on the biological processes and corresponding treatment performance within the constructed wetland itself. The decision was therefore made (based on discussions with the project team, DOC and Iwi representatives) to fully line the constructed wetland cells with a geosynthetic clay liner (GCL). A GCL is effectively a layer of high quality, highly expansive bentonite clay sandwiched between layers of high grade geotextile. Following placement, an overlying layer of topsoil is immediately placed and compacted to form a consolidating layer. When the GCL is wetted the swelling bentonite clay expands laterally (due to topsoil overburden) and forms a robust homogenous impermeable layer. Verified testing provides a permeability of 1×10^{-11} m/s for GCL which is widely used for similar constructed wetlands.

3-Dimensional earthworks modelling (Civil 12D) has been used to model the required excavation extent and determine the cut fill balance. Based on this, each cell will be constructed as a combination of cut and fill with selective separation of materials to be specified. In particular an initial stripping of the existing vegetation shall be followed by removal of the top 200 mm (or deeper where suitable) topsoil which shall be temporarily stockpiled until the GCL is being installed. Excavation of the main cells shall be undertaken with the pumice sand soils stockpiled separately from the ash material. In parts certified compacted fill shall be required to form the low bunds separating respective cells. Between cells 2 and 3, the design includes an earth mound to be formed with compacted soils. This mound (which will be fully planted) is intended to provide diversity and a more naturalistic aesthetic to the site and partially screen parts of the constructed wetland. In addition the mound provides a means of using a significant portion of the excess cut soils and avoid the issue of offsite disposal. Drawings P01252 0011 – 0021 should be referred to for an overview of the earthworks through the site.

All batters have been maintained at no steeper than 1V:4H to account for the risk of instability from frost heave and wind generated waves. The perimeter of all cells will be formed with a 1V:8H safety bench sloping down from the PWL. This bench is intended to avoid the risk of unintentional ingress but also to support a 2 m wide shallow bench which will support vigorous flanking vegetation as a transition from the terrestrial edge species into the aquatic emergent zone. This bench is also well suited to the infrequent drawdown via the control valve (see Section 3.3.3) to support successional propagation of plants which favour the wetted mud rather than standing water. The frequency of this drawdown is likely to be in the order of 3 – 5 years and will be addressed in a management plan following construction. Drawing P01252 0020 should be referred to for the detail through the wetland batters.

Following construction of the bulk shape of the respective cells, the GCL will be installed and the topsoil overburden placed. The methodology for the liner installation shall be well documented in the construction specifications with clear instruction on the material verification, installation methodology, quality assurance and post installation protection.

Figure 3 shows the construction of Norton Park wetland (Palmerston North) which includes a full GCL across the entire floor. Figure 4 shows the same constructed wetland 5 months after planting.

Figure 3 Norton Park wetland under construction with GCL installed beneath topsoil

Figure 4 Norton Park wetland 5 months following planting

3.5 Plant selection

Plant species have been selected in conjunction with the project ecologist (Nick Singers) based on the local provenance and suitability for the high altitude conditions. Seed has been collected from suitable locations within the national park or in close proximity. These plants must be suited to growing in the constructed wetland habitat whilst also performing key functions in terms of oxygenating the substrate and not impeding through flows. The proposed wetland bathymetry has been designed to provide a range of shallow and deep marsh habitats with approximately 36 % of the area of the constructed wetland comprising deep marsh species (300 - 500 mm depth at PWL) and 57% comprising shallow marsh area (< 300mm). A further 7% will be maintained as open water (forebay) without planting. Plants shall be planted at a density of 3 plants/m^2 and shall be grown from seed collected from areas in proximity to the site. Table 2 summarises the planting zones within the wetland itself (i.e. below the PWL).

Table 2 Constructed wetland planting areas

Planting zone	Depth range (mm)	Total area (m^2)
Deep marsh	300 – 500 below PWL	3,950
Shallow marsh	150 – 300 below PWL	4,420
Very shallow marsh	0 – 150 mm below PWL	1,900
Littoral edge	0 – 200 above PWL	1,200
Terrestrial	Remainder	16,765

Plants within the constructed wetland shall be supported during initial establishment (6 – 12 months) through maintaining a reduced water level (through open control valve) in the constructed wetland cells. Whilst this may reduce the treatment performance during this period it is important to ensure a vigorous plant cover to support long term performance.

All disturbed area across the site will be planted as part of the construction. This includes the access benches, perimeter batters and areas of fill beyond the immediate wetland footprint.

3.6 Constructed wetland discharge

Discharges from the constructed wetland will be via a single point at the southern end of the downstream cell (cell 4). The outlet will comprise an open grated manhole (scruffy dome) with a shallow outlet pipe connecting in turn with a flow split control box and five 90 mm PVC lines to the dedicated infiltration field. The infiltration field comprises five 2m wide trenches excavated 2.3m below the existing ground surface with a total length of 300 m (refer drawings P01252_0025/0026).

Based on the geological modelling the trenches will penetrate the ash layers (with low permeability) and intersect with the underlying higher permeability gravel conglomerate. Whilst this material has not been tested for permeability (due to challenges with replicating field conditions in the lab) it comprises a mix of gravels in a conglomerate of sands and clays and is expected to have a permeability of between 1×10^{-05} m/s and 1×10^{-06} m/s. This represents the transition from 'good' to 'poor' drainage and equates to between 3.6 mm/hr and 36 mm/hr. Based on the dimensions of the proposed infiltration area (total area of 600 m^2) an infiltration rate of approximately 20 mm/hr (5.5×10^{-06} m/s) is required to infiltrate the mean daily flowrate of 321 m^3 /day. In the instance that these permeability rates are not achieved (or flowrates significantly exceed the mean rate) flows will backwater within the sand filled trenches until they reach the downslope elevation of the clay/sand interface at which point they will be able to travel across the surface of the clay layer as interflow towards springs and seeps in cuttings downstream. It is important to note that this shallow interflow and connection with downstream waterways is the natural hydrogeological pathway for the site (given the imperviousness of the clay rich ash layer) and will only comprise the fully treated portion of flows following treatment within the wetland cells. It is considered that the risk of progressive binding of soils (and resultant reduction in permeability) is reduced due to the anticipated reduced nutrient concentration in the flows and preferential discharge to the deeper sand filled trenches. In the instance that additional infiltration is required, this could be delivered as part of the second stage expansion.

Flood flows resulting from direct rainfall within the constructed wetland's immediate catchment are able to be detained above the PWL in cell 4. Based on the 500 mm depth between the crest of the outlet manhole and the lower bund a total volume of 950 m^3 will be achieved. This will provide buffering storage for up to the 1 hour, 100 year ARI rainfall event. Engagement of this detention storage will be enabled by the throttled outlet from the manhole in cell 4 which will be sized as part of the detailed design stage.

4.0 Constructed wetland summary

The design of the proposed Whakapapa constructed wetland has been undertaken to satisfy the objectives identified at the outset of Morphum's engagement. This is delivered by a system comprising four separate cells which will operate as a single flow through system before discharging via infiltration to ground via constructed trenches to intersect the consolidated gravels below the volcanic ash which is considered to act as an aquitard limiting infiltration in the current disposal fields. This design is considered to have optimised the available site whilst integrating into the landscape and balancing the cut to fill balance as much as practical. Table 3 and Table 4 summarise the main design parameters and dimensions which have formed the basis of performance modelling by NIWA.

Table 3 Constructed wetland design parameters

Parameter	Measure
Total wetland area at PWL (m^2)	11,095
Total volume at PWL (m^3)	3,811
Direct infiltration area - trench base (m^2)	600
Total site area (m^2)	29,720
Total cut volume (m^3)	12,400
Total fill volume (m^3)	11,400
Excess soil volume (m^3)	1,000

Table 4 Individual cell parameters

Wetland cell	Area at PWL (m^2)	Volume at PWL (m^3)	Depth range (mm)	PWL (m)
1	3,436	1,745	500 to 1000	60.80
2	2,617	893	250 - 500	59.05
3	3,174	672	150 - 250	57.30
4	1,868	501	150 - 500	55.55

5.0 Construction methodology and ESCP

The construction of the proposed constructed wetland system will be undertaken on the gently sloping site with an intent to achieve the optimal constructed wetland performance with minimal amounts of earthworks. To achieve this, the design is based on a series of 4 terraces which enable the cut to fill volumes to be balanced and avoiding the need to transport material off-site.

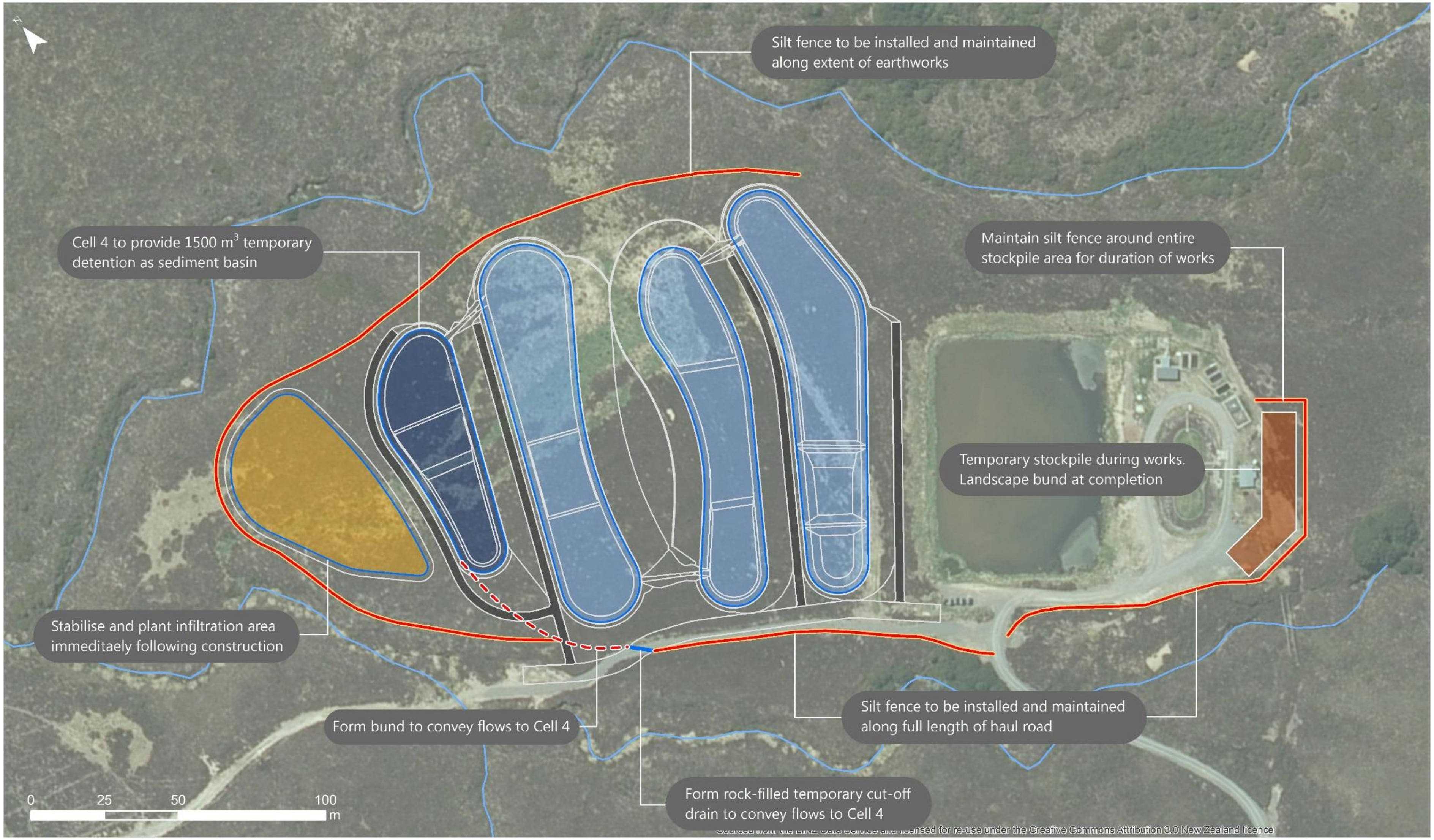
Due to the topography of the site, all works will be protected from flood flows within the adjacent streams with no overland flow paths through the site. Essentially the site will only be subject to rainfall which falls within the immediate footprint negating the need for clean water diversions or bunding. Likewise it is noted that the works involve the construction of depressed cells which themselves will receive any rainfall related inflows during works. This significantly reduces the risk of sediment laden flows discharging away from the site and into the stream environment as the scale of each respective cell is such that they can detain runoff and perform the role of sediment basins during works. These are then managed by the contractors with syphon drawdown from one to the other possible following rain to facilitate dry working areas whilst also supporting sediment drop out. Wetland cells will remain unlined for the majority of the time that the site is 'open' and therefore inflows will be able to be at least partially drawn down through infiltration which will effectively filter sediments through the soil matrix.

Based on this the following overall construction sequencing is proposed to support a robust and reliable ESC outcome.

- Silt fences shall be installed around the entire perimeter as shown on the ESCP (Appendix A). Silt fences shall be installed in accordance with the Greater Wellington Regional Councils ESC Guidelines and ensure that there is no potential for flows to bypass beneath the silt fence or concentrate flows in a constrained location. The silt fence must define the extremity of all working areas with no works to be undertaken beyond the silt fence. This shall include adjacent to the haul road between the wetland area and stockpiles and around the base of the stockpile also. All silt fences shall be maintained throughout the duration of works (weekly inspections and following rainfall). All accumulated sediments shall be removed and any repairs made.
- Works shall not commence until such time as the ESC physical works (perimeter silt fence) are constructed and have been approved by the Engineers Representative. Vegetation clearance and topsoil stripping to only be undertaken in areas of works immediately prior to bulk earthworks taking place. Areas which are not due for earthworks shall remain undisturbed and vegetated.
- All stripped vegetation and topsoils shall be trucked to the nominated stockpile area (east of WWTP) and placed separately. All material shall be track rolled in stockpiles.
- Bulk earthworks shall proceed from the bottom of the slope upwards (west to east). The infiltration trenches shall be excavated and formed (with pipe work installed) prior to construction of the wetland cells. Once completed the infiltration area shall be protected from potential impacts from site generated runoff during construction of the remainder.
- Wetland cell 4 shall be bulk excavated to form a 1,500 m^3 void defined by its downslope bund crest. This is calculated to provide approximately 500 m^3/ha of excavation which is significantly more than the recommended 200 m^3/ha provided in the Greater Wellington Regional Councils ESC Guidelines as a suitable temporary sediment retention pond. A small raised bund shall be constructed near the south west corner of this cell and a shallow dish drain across the existing access track south of the site to ensure that all site generated flows from the approximately 3 Ha catchment will discharge into this cell whilst it functions as a temporary sediment basin. Due to the size of the basin and the largely sandy soils it is considered that effective settlement will be achieved without the use of flocculants or controlled drawdown.

- As works progress in an easterly direction, respective wetland cells will effectively form intermediate detention ponds in the occurrence of rainfall. Management of these ponds will be more of a construction issue rather than ESC with upper cells drained through pump or syphon to lower cells as required. Cell 4 shall be maintained as the primary sediment basin during these works. All material will be selectively stockpiled as required for reuse.
- Any areas of fill which fall towards the north tributary shall be stabilised and planted as soon as completed (note silt fence extends beneath these work areas).
- Topsoil shall be placed and lightly compacted in all cells as part of the installation of the GCL (following bulk earthworks and construction of hydraulic structures). At this point all cells shall be trimmed to finished grades and bathymetry.
- Wetland cells and perimeter batters shall be planted as soon as possible following topsoiling.
- All silt fences, cut off bund and dish drain shall remain and be maintained (weekly checks and following rainfall) for no less than 3 months following planting and until such time as it is verified that the site is stable without risk of surface scour occurring.

Appendix 1 Erosion and Sediment Control Plan



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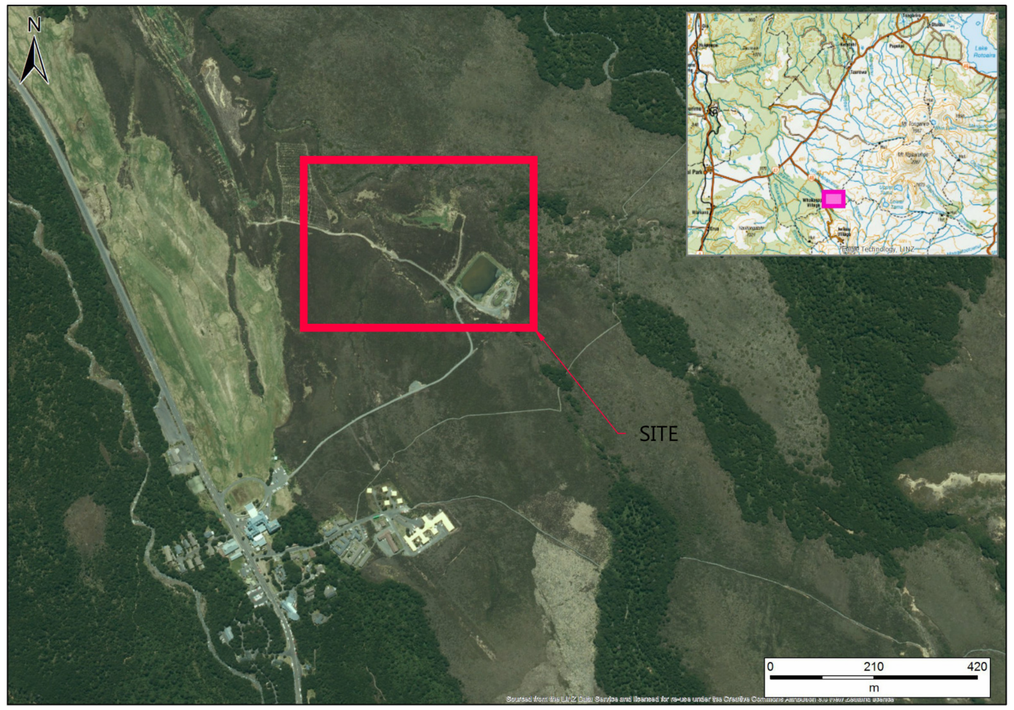
LOCATION PLAN



WHAKAPAPA WASTEWATER WETLAND

	SHEET NUMBER	DRAWING TITLE	ISSUED BY	LJC
				24-02-2017
P01252	0001	INDEX AND LOCATION PLAN		-
	0005	SITE PLAN		-
	0010	CONSTRUCTED WETLAND PLAN		-
	0011	POST DEVELOPMENT CONTOUR PLAN		-
	0012	LONGITUDINAL SECTION A-A' OF CONSTRUCTED WETLANDS		-
	0013	LONGITUDINAL SECTION - CELL 1		-
	0014	LONGITUDINAL SECTION - CELL 2		-
	0015	LONGITUDINAL SECTION - CELL 3		-
	0016	LONGITUDINAL SECTION - CELL 4		-
	0020	TYPICAL SECTIONS CONSTRUCTED WETLAND		-
	0021	TYPICAL BUND SECTIONS		-
	0022	SPILLWAY PLAN AND SECTIONS		-
	0023	WEIR DETAILS		-
	0024	INLET AND OUTLET CONTROL STRUCTURES		-
	0025	INFILTRATION TRENCH PLAN AND SECTION		-
	0026	INFILTRATION AREA DETAILS		-
	0030	EARTHWORKS CUT FILL PLAN		-

ISSUED TO		
CLIENT	DEPARTMENT OF CONSERVATION	A3 PDF
CONTRACTOR		
OTHER		
OTHER		

DETAILS

DRAWING ISSUES	COMMENTS
24-02-2017	ISSUED FOR RESOURCE CONSENT

FOR INFORMATION ONLY

DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: INDEX AND LOCATION PLAN

STATUS: CONSENT
SHEET 1 OF 1

PROJECT No: P01252 | SCALES: NTS | A3

DRAWING No: P01252-0001 | REV: -

CAD Ref: Z:\Projects\Organisations\DOC\P01252_Whakapapa Wetland Design\7 Design\CAD\ P01252_0001.dwg

Last saved: Fri, 24 Feb 2017 02:12 pm

DESIGNED: LJC	APPROVED: Stuart Farrant	
DRAWN: LJC	APPROVED: Stuart Farrant	
APPROVED: Caleb Clarke		DATE: 24-02-2017

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PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: SITE PLAN

STATUS: CONSENT

SHEET 1 OF 1

PROJECT No: P01252 | SCALES: 1:1000 | A3

DRAWING No: P01252_0005 | REV: -

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke	DATE: 24-02-2017		

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Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: CONSTRUCTED WETLAND PLAN

STATUS: CONSENT
SHEET 1 OF 1

PROJECT No:	SCALES:	
P01252	1:1000	A3
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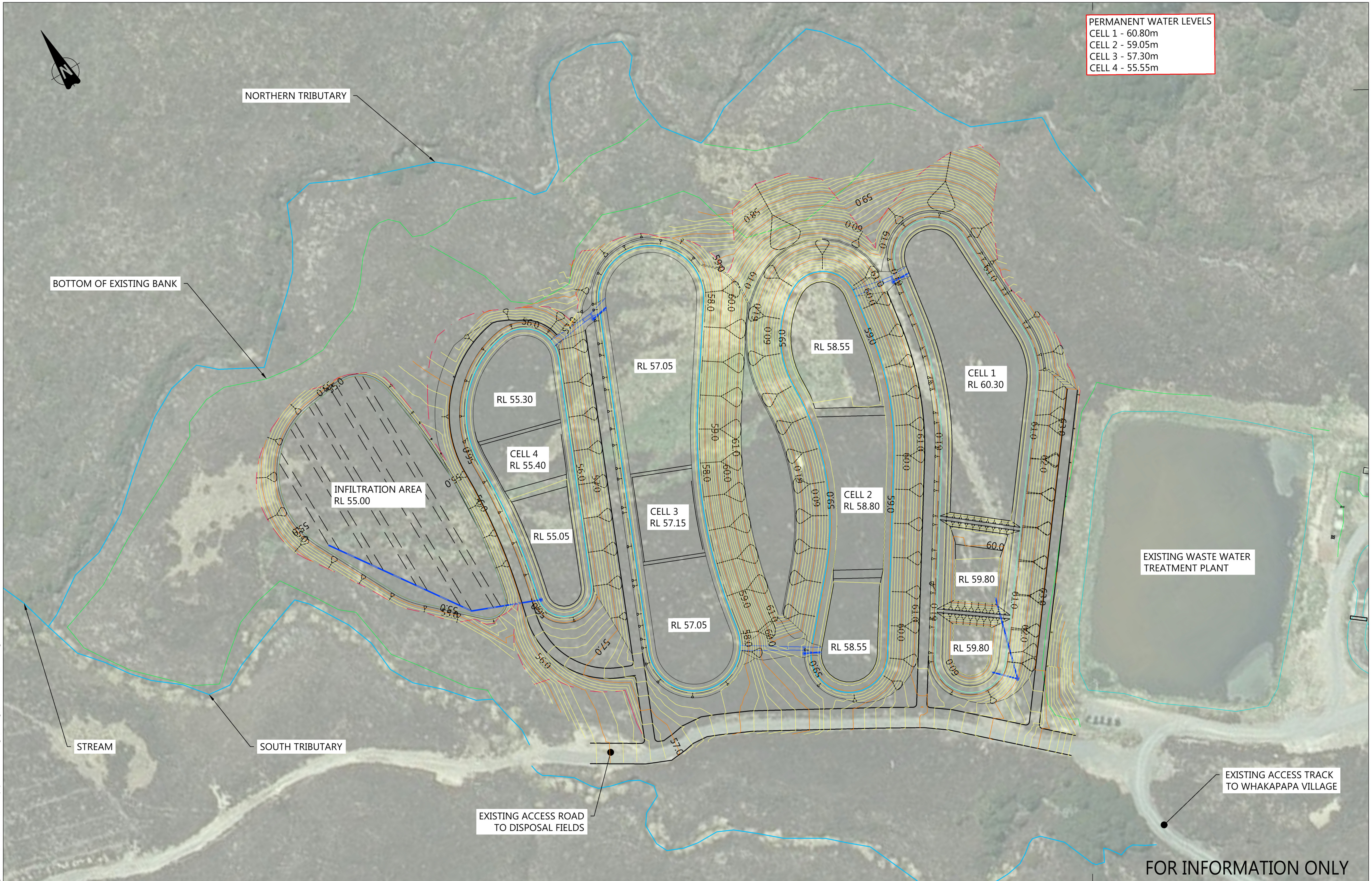

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke	DATE: 24-02-2017		

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PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: POST DEVELOPMENT CONTOUR PLAN

STATUS: CONSENT

SHEET 1 OF 1

PROJECT No: P01252 | SCALES: 1:1000 | A3

DRAWING No: P01252_0011 | REV: -

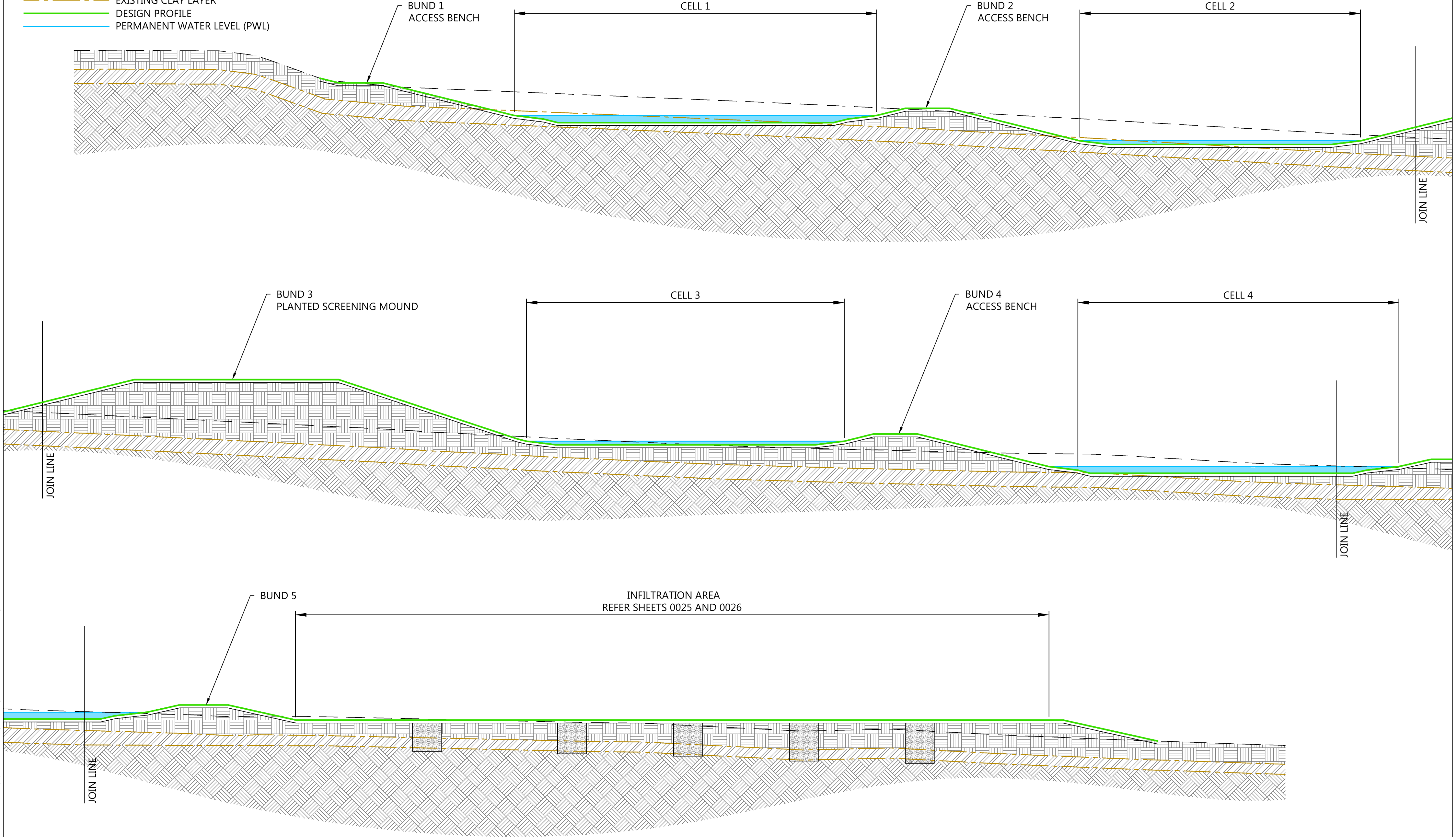
Last saved: Fri, 24 Feb 2017 10:29 am

LEGEND:

- EXISTING GROUND PROFILE
- EXISTING CLAY LAYER
- DESIGN PROFILE
- PERMANENT WATER LEVEL (PWL)

NOTES:

1. PLANTING NOT SHOWN ON SECTIONS FOR CLARITY



FOR INFORMATION ONLY

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DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: LONGITUDINAL SECTION A-A' OF CONSTRUCTED WETLANDS

STATUS: CONSENT	SHEET 1 OF 5	
PROJECT No: P01252	SCALES: 1:250	A3
DRAWING No: P01252_0012		REV: -

Last saved: Fri, 24 Feb 2017 10:29 am

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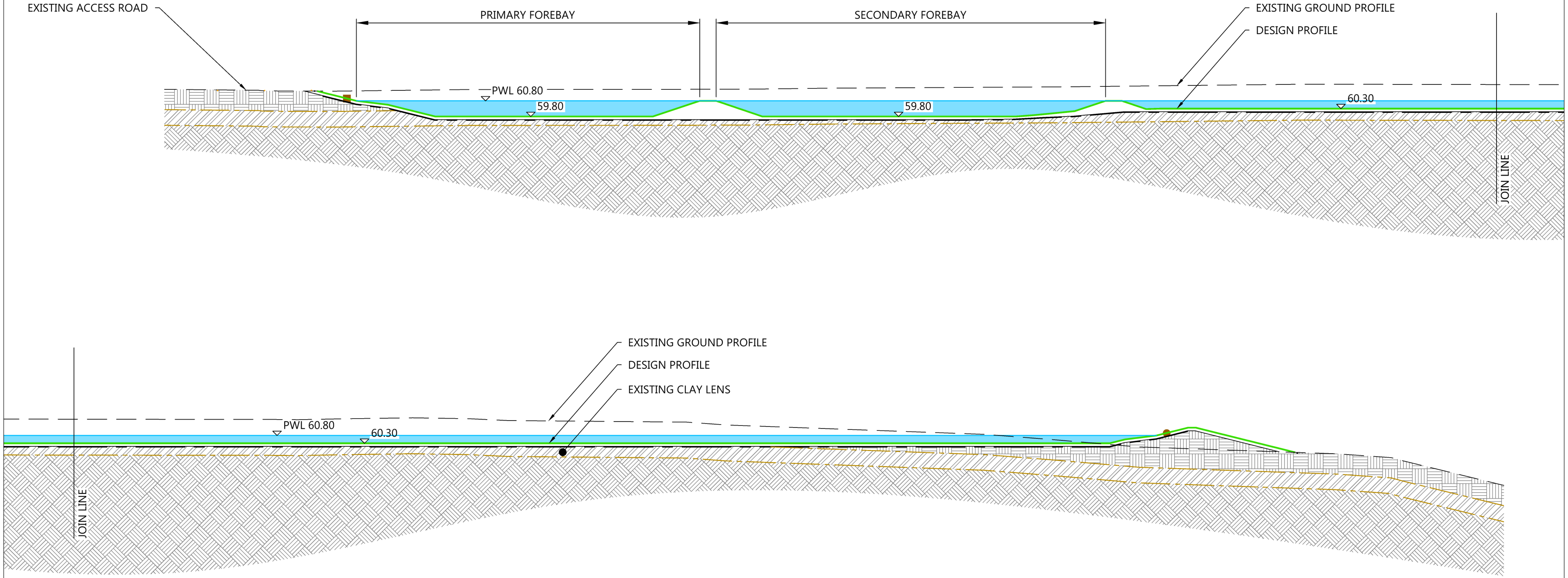

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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Department of Conservation
Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: LONGITUDINAL SECTION CELL 1

STATUS: CONSENT

SHEET 2 OF 5

PROJECT No: P01252 | SCALES: 1:250 | A3

DRAWING No: P01252_0013 | REV: -

CAD Ref: Z:\Projects\Organisations\DOC\P01252_Whakapapa Wetland Design\7 Design\CAD\ P01252_0012-0016.dwg

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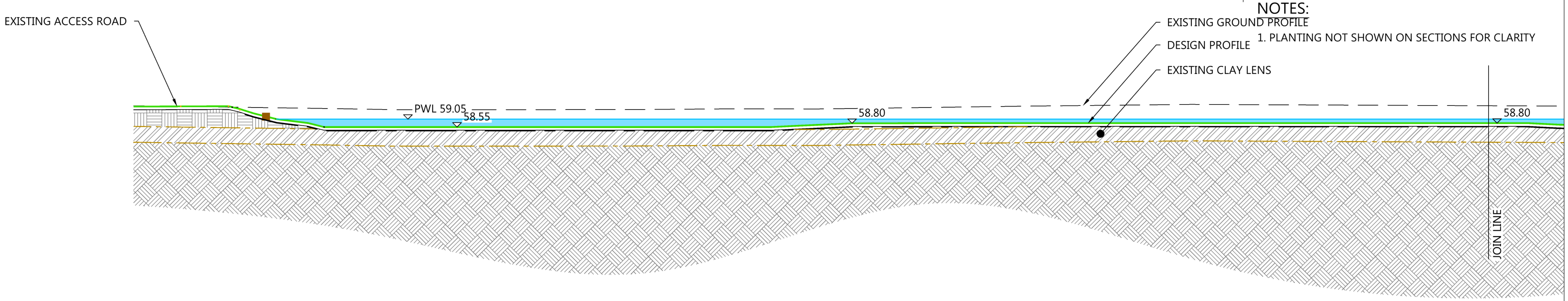

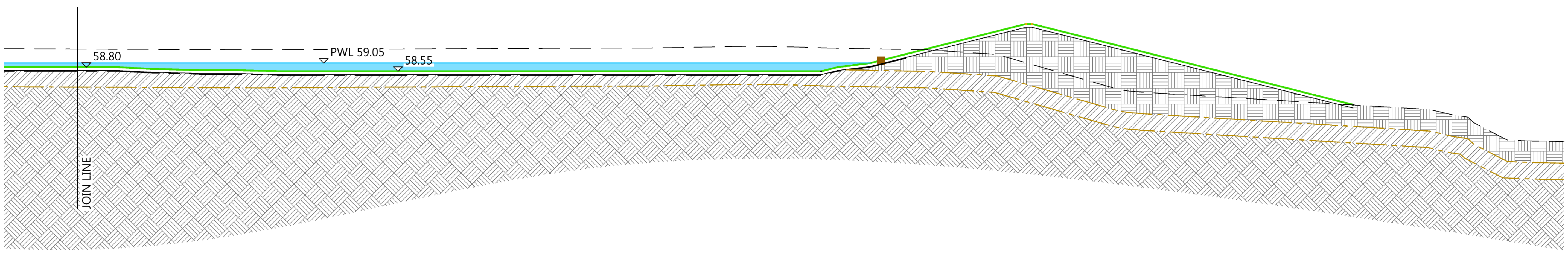

FOR INFORMATION ONLY

DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: LONGITUDINAL SECTION CELL 2

STATUS: CONSENT

SHEET 3 OF 5

PROJECT No: P01252 | SCALES: 1:250 | A3

DRAWING No: P01252_0014 | REV: -

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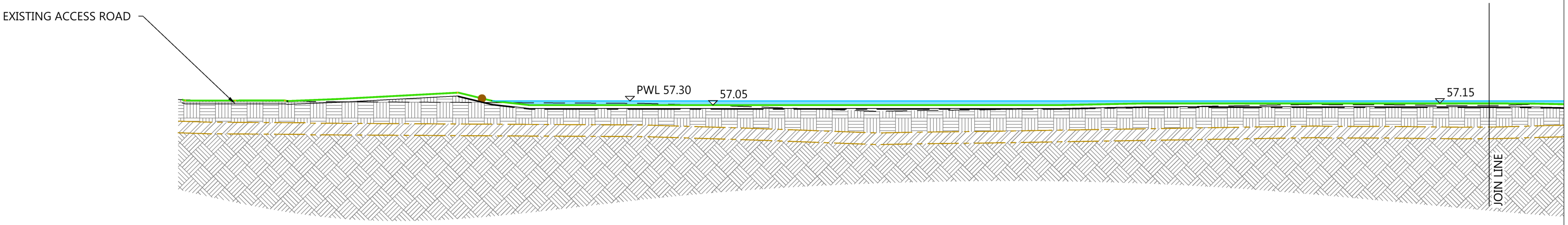

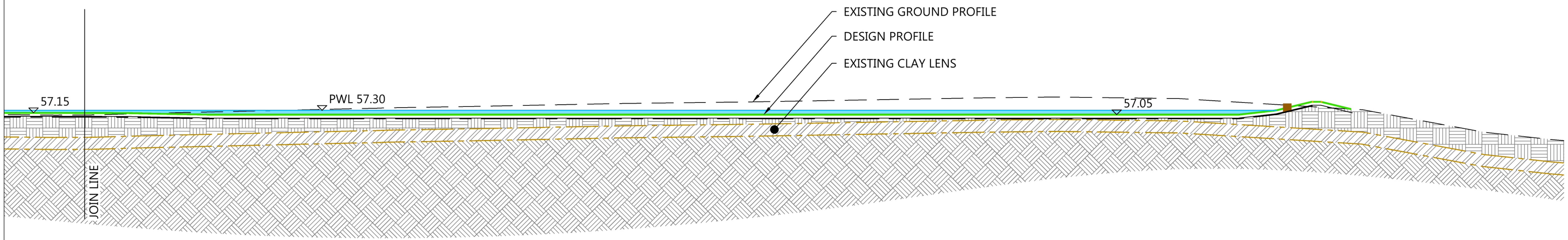

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: LONGITUDINAL SECTION CELL 3

STATUS: CONSENT		SHEET 4 OF 5
PROJECT No: P01252	SCALES: 1:250	A3
DRAWING No: P01252_0015		REV: -

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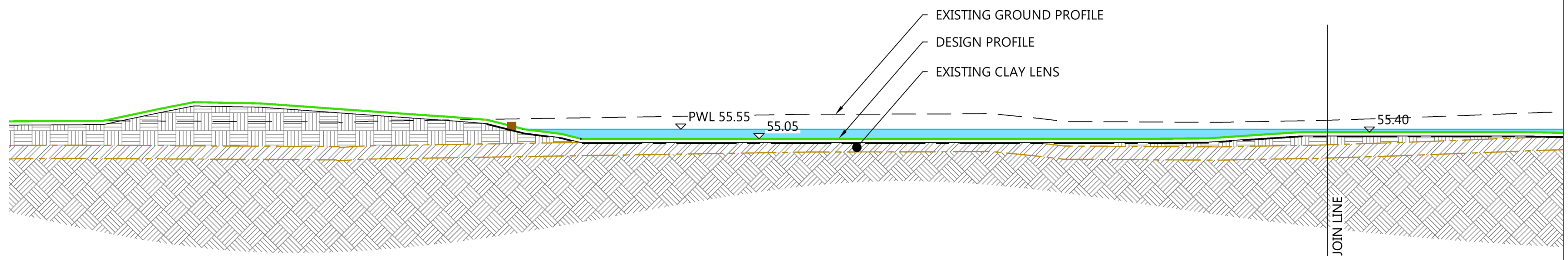

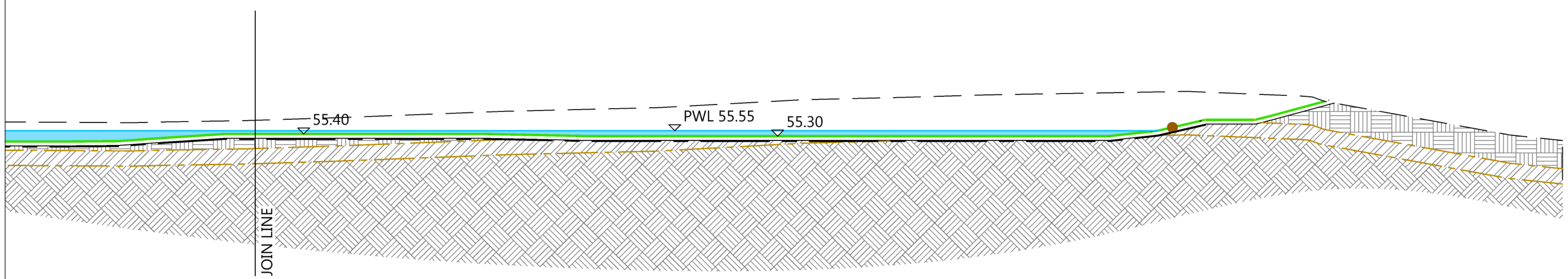

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: LONGITUDINAL SECTION CELL 4

STATUS: CONSENT		SHEET 5 OF 5
PROJECT No: P01252	SCALES: 1:250	A3
DRAWING No: P01252_0016		REV: -

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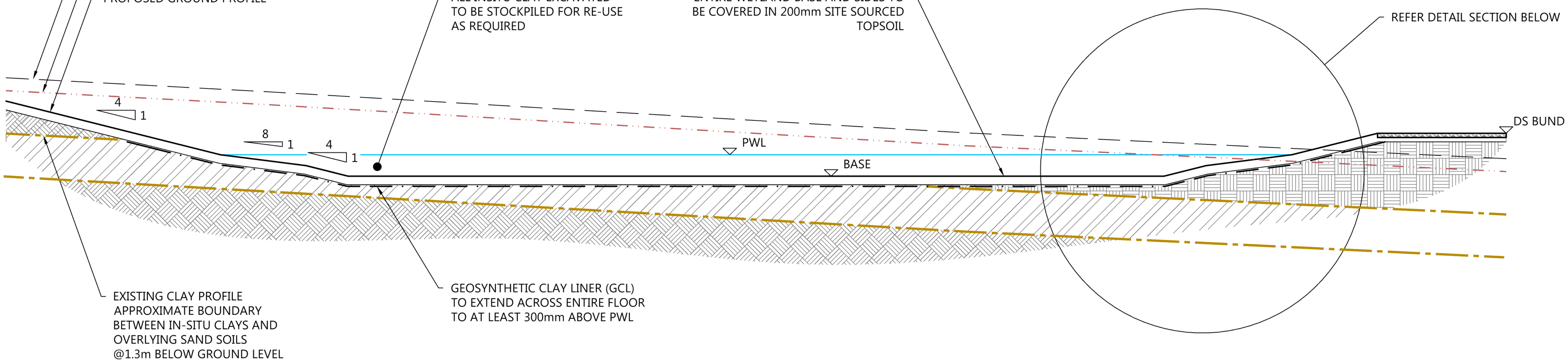

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TYPICAL WETLAND CELL

-

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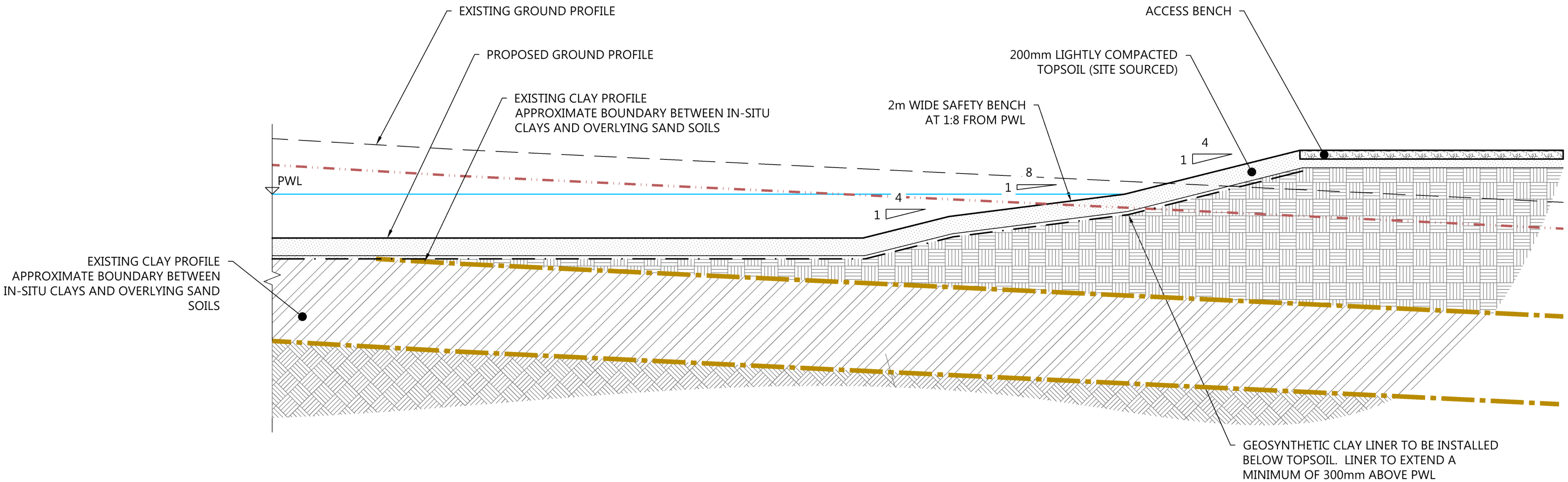

SECTION
TYPICAL GCL LINER TO BATTER

-

REF. - SCALE : 1:50

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: TYPICAL SECTIONS CONSTRUCTED WETLAND

STATUS: CONSENT
SHEET 1 OF 1
PROJECT No: P01252
SCALES: AS SHOWN A3
DRAWING No: P01252_0020
REV: -

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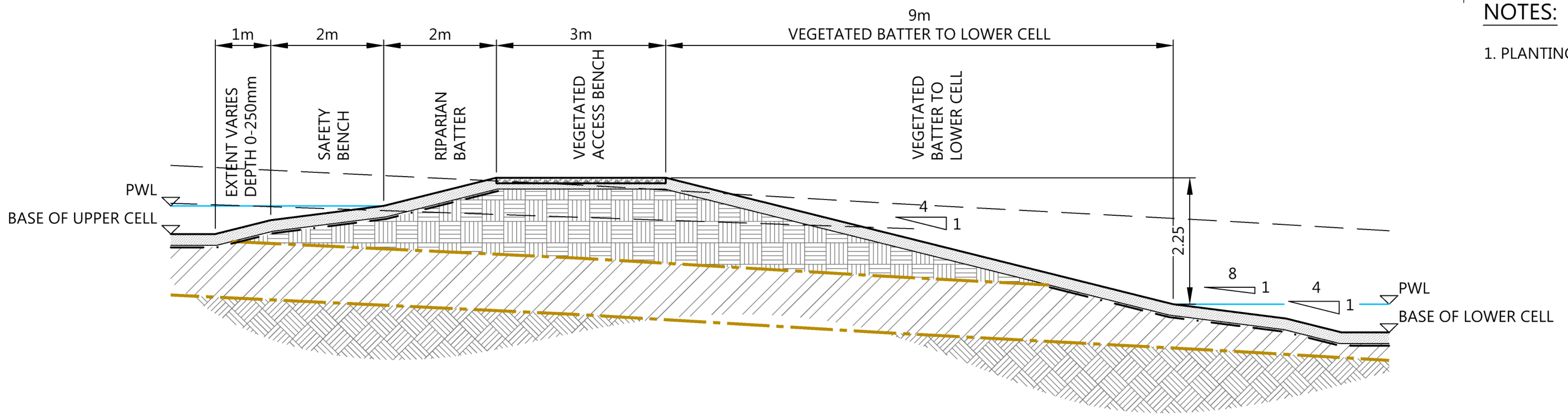
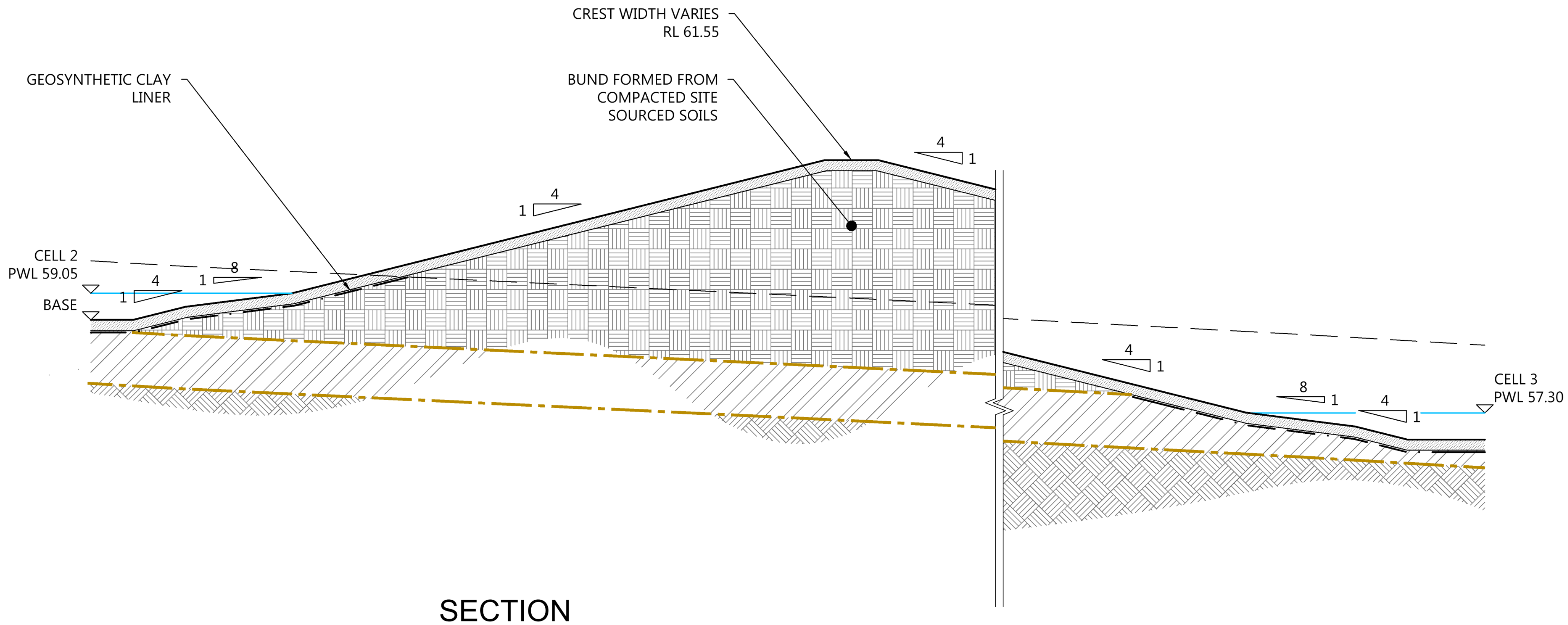


SECTION
TYPICAL PLANTED EARTH BUNDS

-

REF. -

SCALE : 1:100



SECTION
TYPICAL PLANTED EARTH MOUND

-

REF. -

SCALE : 1:100

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER WETLAND

TITLE: TYPICAL BUND SECTIONS

STATUS: CONSENT

SHEET 1 OF 1

PROJECT No: P01252

SCALES: AS SHOWN A3

DRAWING No: P01252_0021

REV: -

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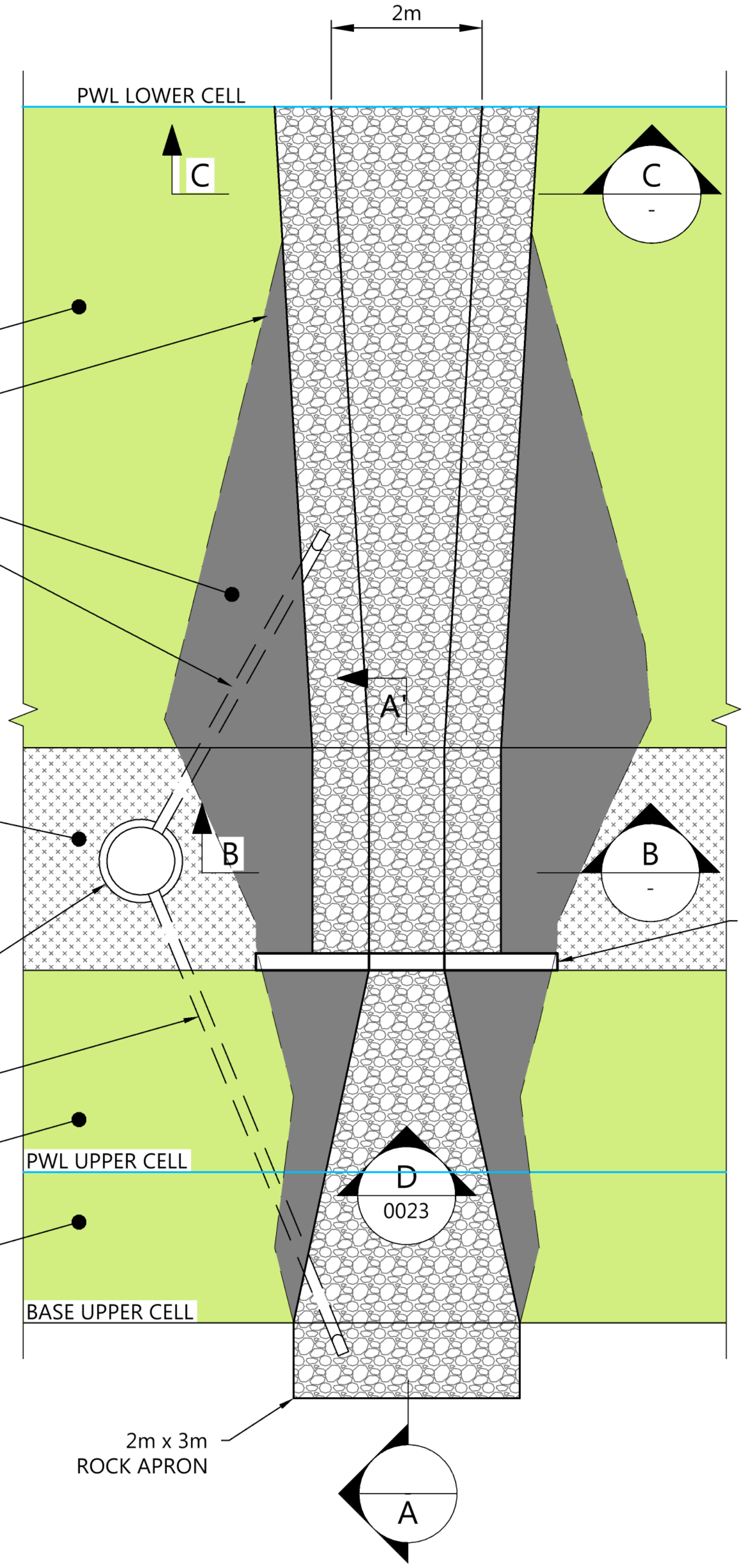
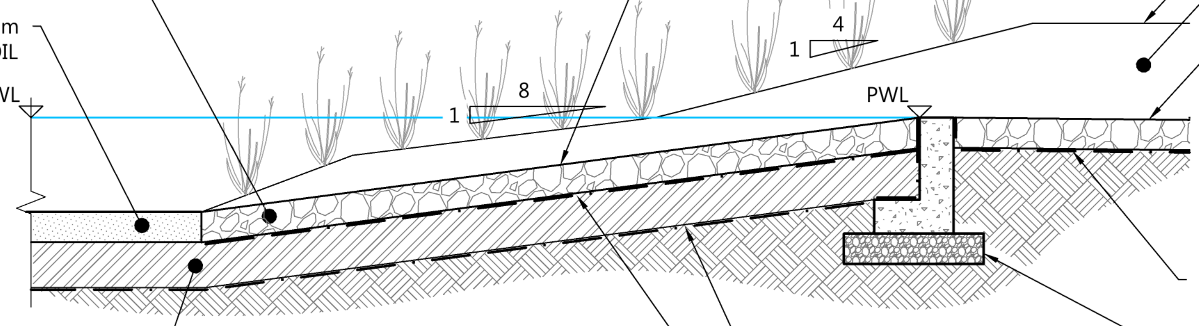
SPILLWAY TABLE	
NAME	RL
SPILLWAY 1	60.80
SPILLWAY 2	59.05
SPILLWAY 3	57.30
SPILLWAY 4	55.55



E

OUTLET SPILLWAYS - PLAN VIEW

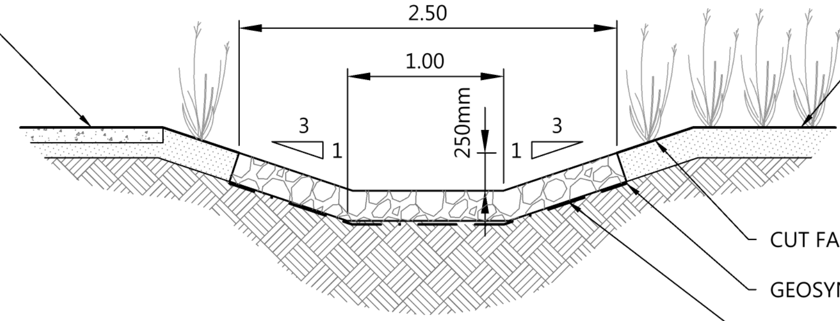
REF. 00XX SCALE : 1:100



A

SECTION INLET TO SPILLWAYS

REF. 00XX SCALE : 1:50



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SECTION SPILLWAY CHUTE

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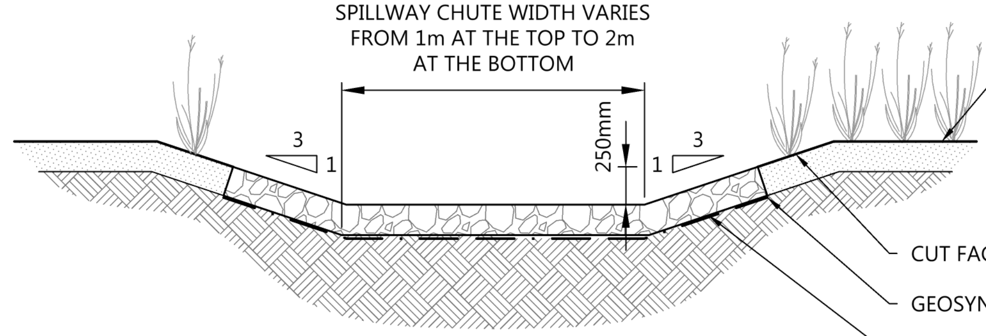

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SECTION SPILLWAY CHUTE

REF. - SCALE : 1:50

FOR INFORMATION ONLY

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DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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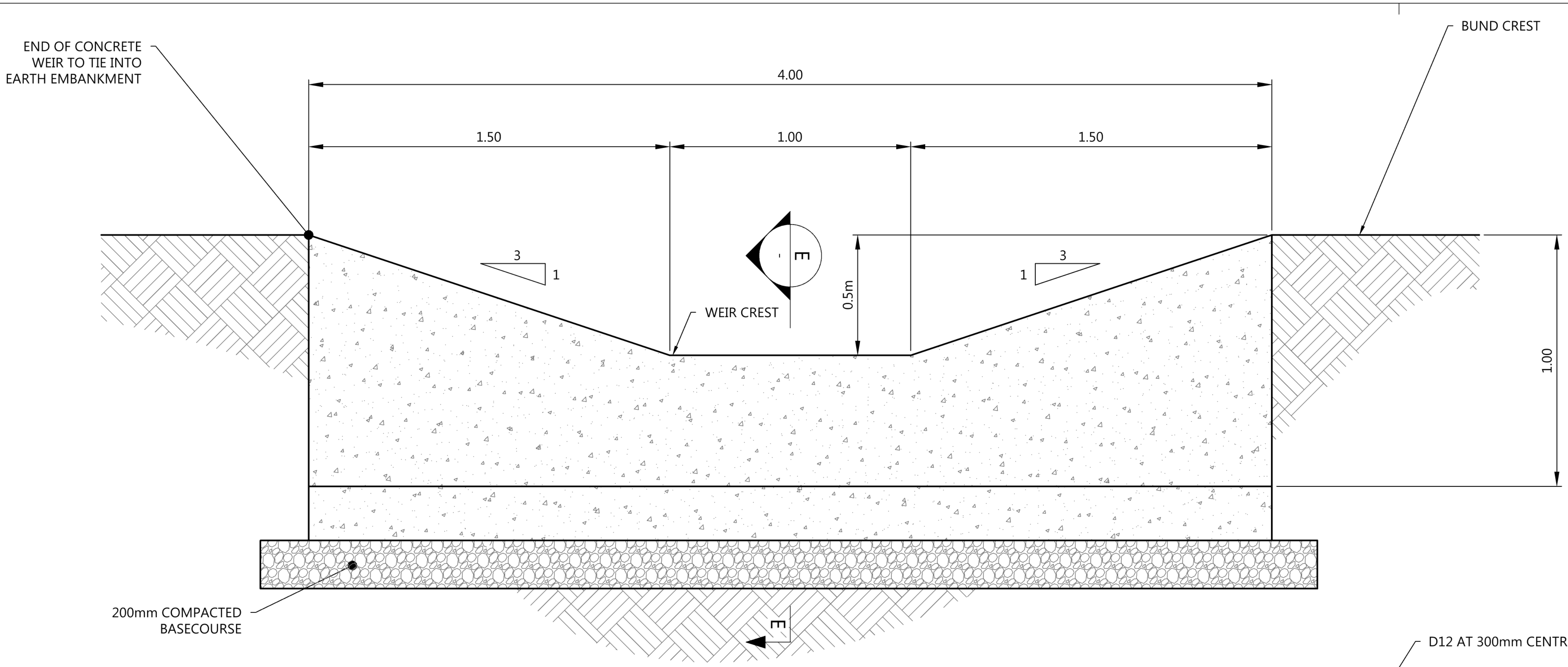
PROJECT: WHAKAPAPA WASTEWATER WETLAND

TITLE: SPILLWAY PLAN AND SECTIONS

STATUS: CONSENT
SHEET 1 OF 1
PROJECT No: P01252
SCALES: AS SHOWN A3
DRAWING No: P01252_0022
REV: -



D ELEVATION - SPILLWAY WEIR

REF. 0022 SCALE : 1:20

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CELL NUMBER	WEIR CREST RL
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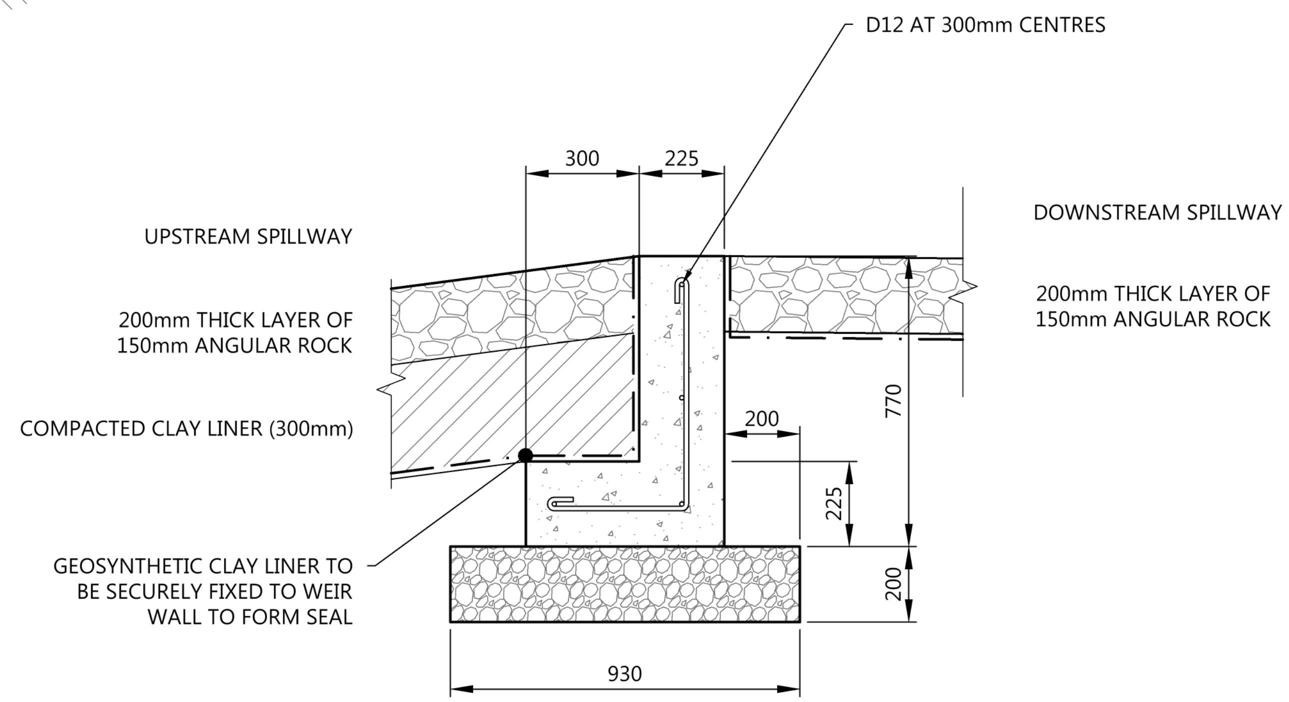
CELL 2	59.05
CELL 3	57.30
CELL 4	55.55



E SECTION - SPILLWAY WEIR

REF. - SCALE : 1:20

FOR INFORMATION ONLY

DESIGNED: LJC
APPROVED: Stuart Farrant
DRAWN: LJC
APPROVED: Stuart Farrant
APPROVED: Caleb Clarke
DATE: 24-02-2017

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PROJECT: WHAKAPAPA WASTEWATER WETLAND

TITLE: WEIR DETAILS

STATUS: CONSENT
SHEET 1 OF 1

PROJECT No: P01252 SCALES: AS SHOWN A3

DRAWING No: P01252_0023 REV: -

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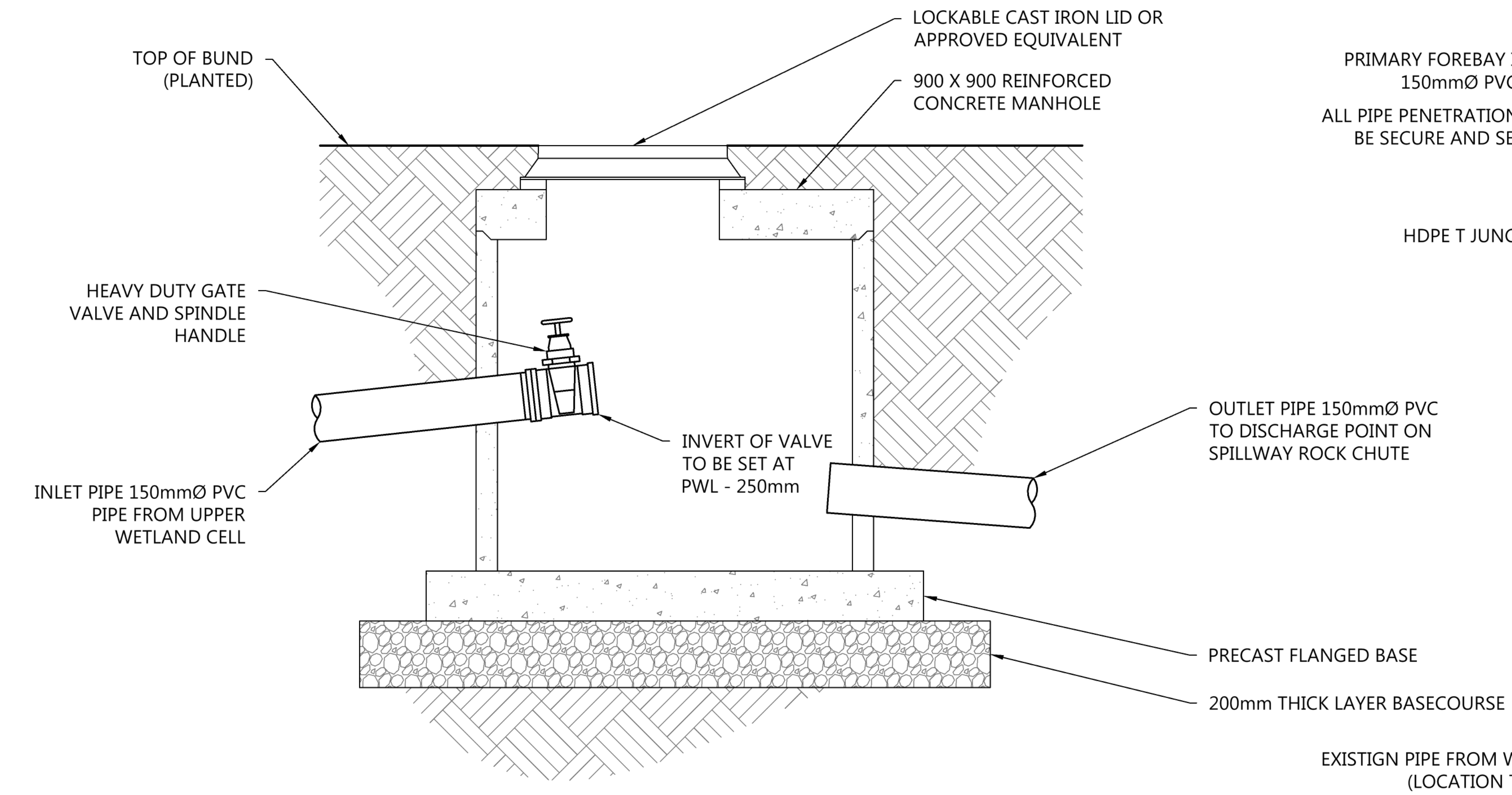

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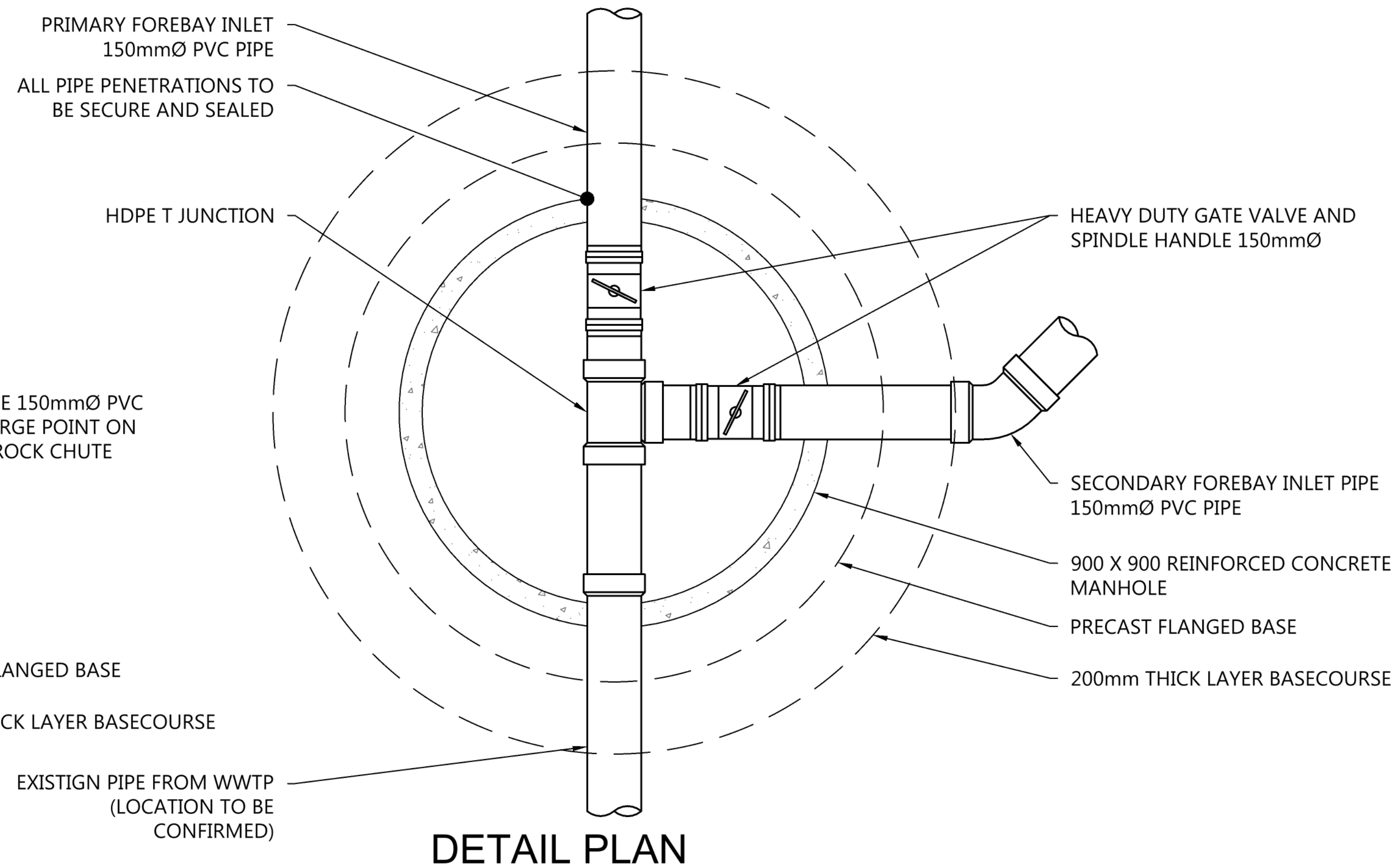
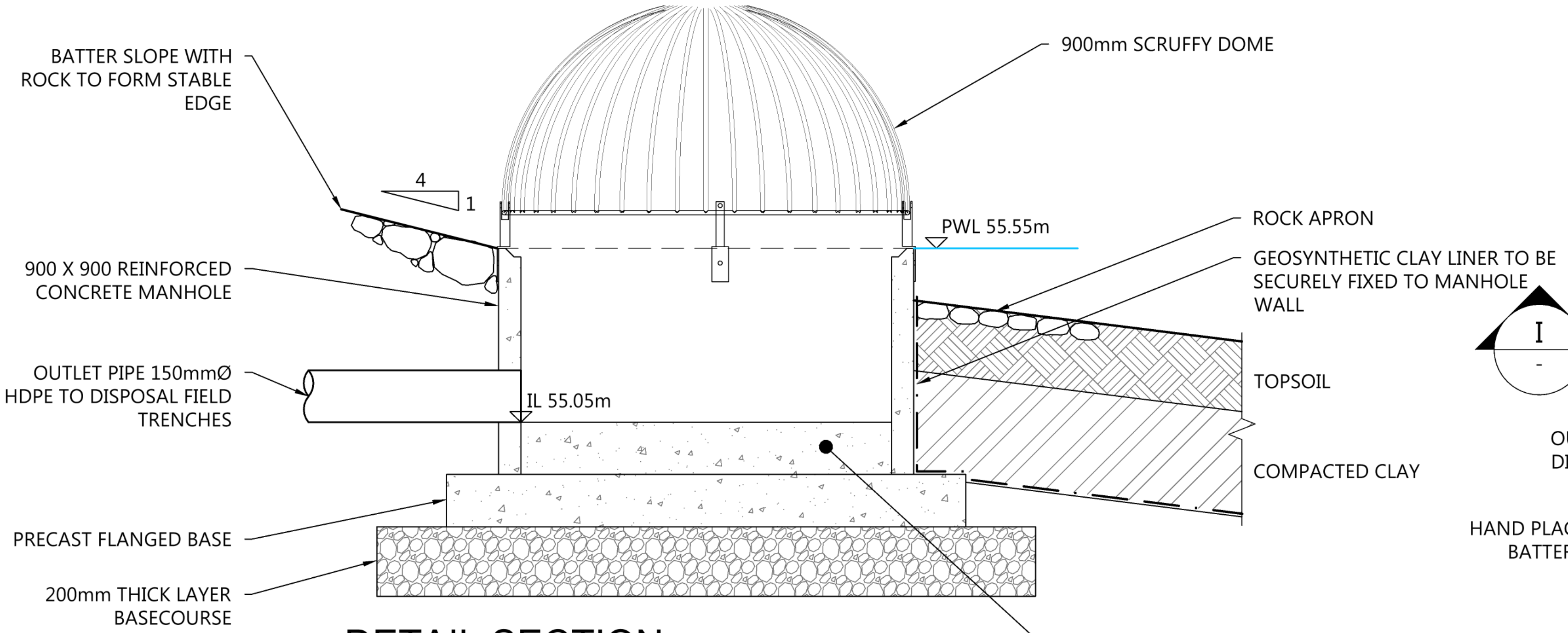
DETAIL SECTION
WETLAND CONTROL MANHOLE
REF. 0022 SCALE : 1:20



G
DETAIL PLAN
INLET MANHOLE AND VALVE CONTROL
REF. 0010 SCALE : 1:20



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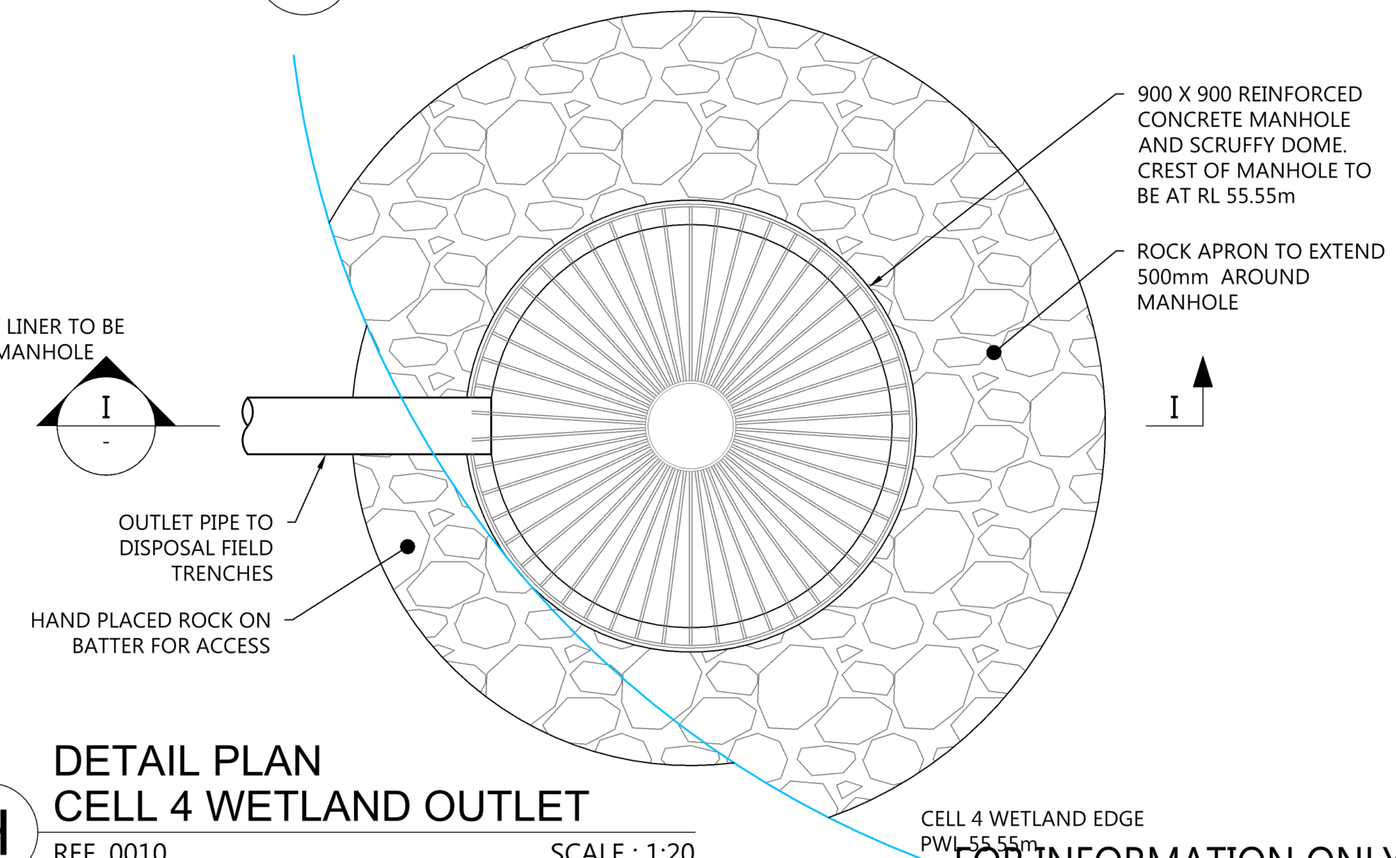
DETAIL SECTION
CELL 4 WETLAND OUTLET
REF. - SCALE : 1:20



H
DETAIL PLAN
CELL 4 WETLAND OUTLET
REF. 0010 SCALE : 1:20

FOR INFORMATION ONLY

DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

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Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER WETLAND

TITLE: INLET AND OUTLET CONTROL STRUCTURES

STATUS: CONSENT
SHEET 1 OF 1
PROJECT No: P01252 SCALES: AS SHOWN A3
DRAWING No: P01252_0024 REV: -

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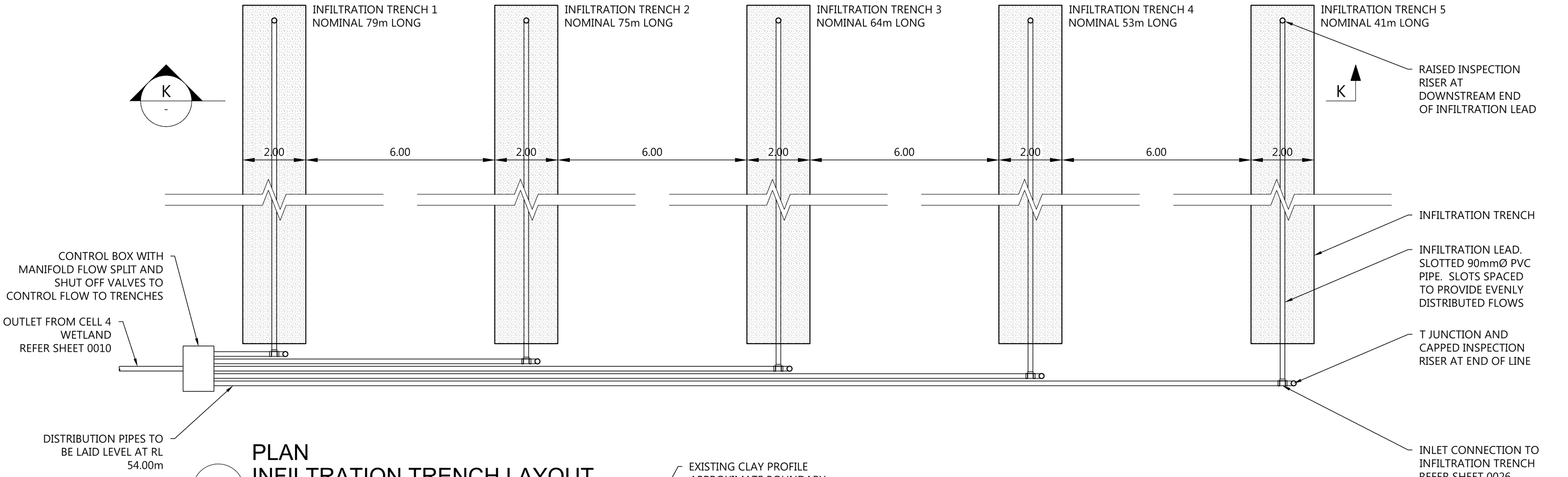
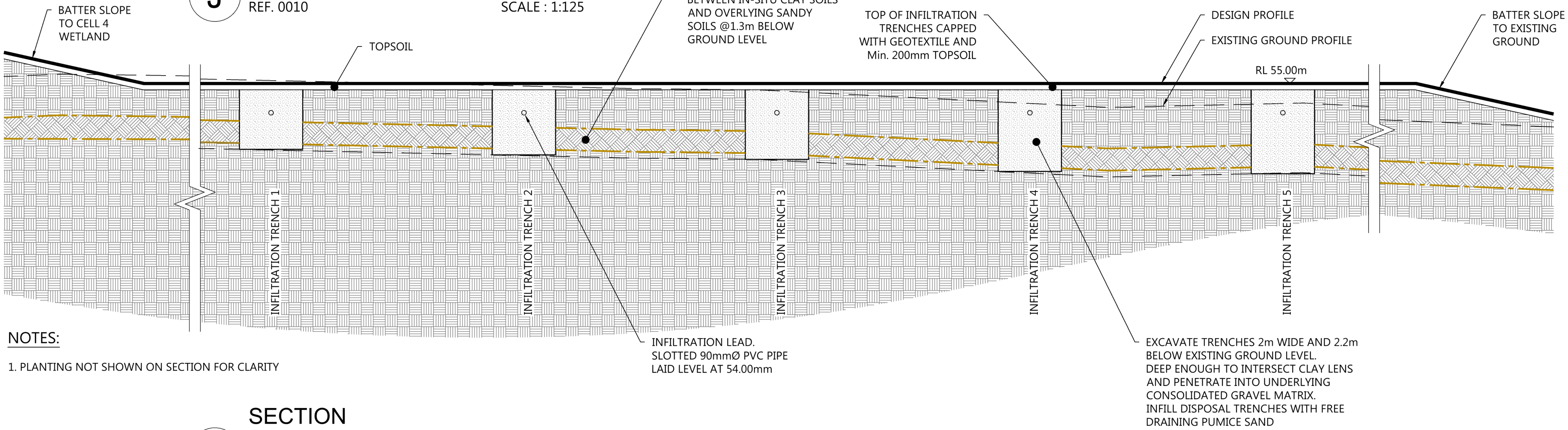


J

PLAN
INFILTRATION TRENCH LAYOUT

REF. 0010 SCALE : 1:125



NOTES:

1. PLANTING NOT SHOWN ON SECTION FOR CLARITY

K

SECTION
INFILTRATION TRENCH LAYOUT

REF. - SCALE : 1:125

FOR INFORMATION ONLY

DESIGNED: LJC	APPROVED: Stuart Farrant	PROJECT: WHAKAPAPA WASTEWATER WETLAND	TITLE: INFILTRATION TRENCH PLAN AND SECTION
DRAWN: LJC	APPROVED: Stuart Farrant	STATUS: CONSENT	SHEET 1 OF 1
APPROVED: Caleb Clarke	DATE: 24-02-2017	PROJECT No: P01252	SCALES: 1:125 A3
		DRAWING No: P01252_0025	REV: -

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Department of Conservation
Te Papa Atawhai

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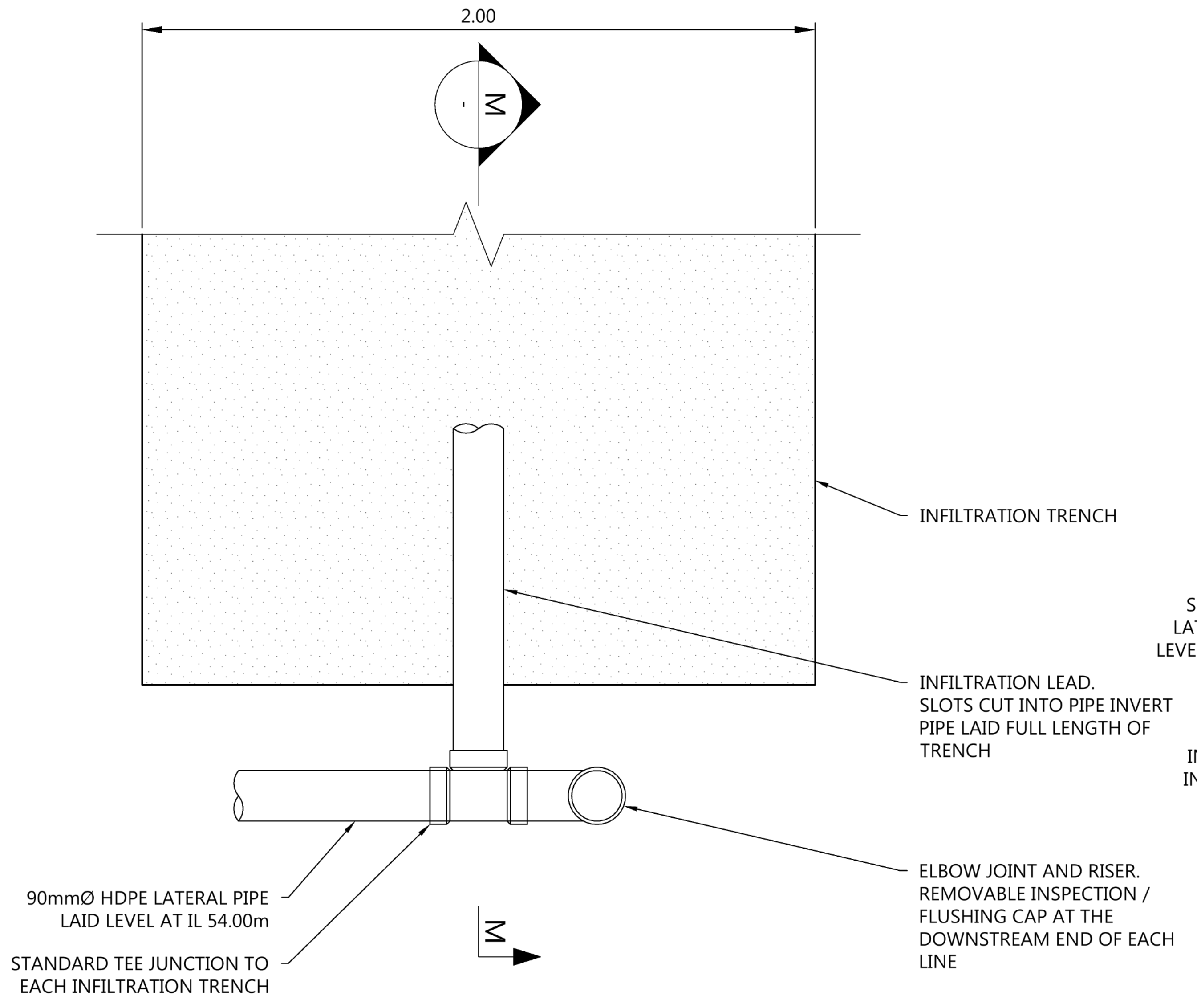
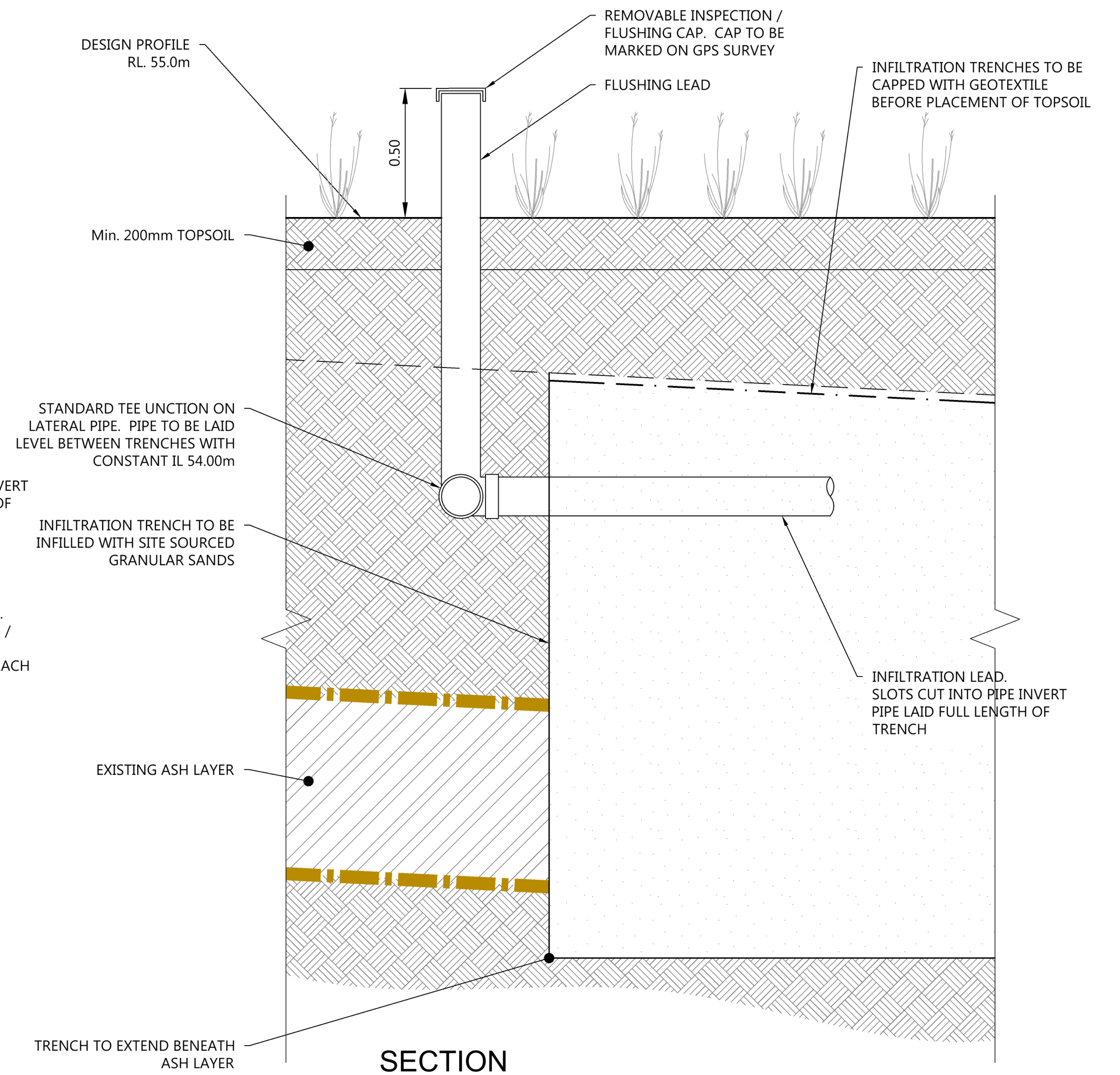


L

DETAIL PLAN
INLET CONNECTION TO INFILTRATION AREA

REF. 0025 SCALE : 1:20



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SECTION
INLET CONNECTION TO INFILTRATION AREA

REF. - SCALE : 1:20

FOR INFORMATION ONLY

DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

MORPHUM ENVIRONMENTAL LTD

Department of Conservation
Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER WETLAND	TITLE: INFILTRATION FIELD DETAILS	STATUS: CONSENT	SHEET 1 OF 1
		PROJECT No: P01252	SCALES: 1:20 / A3
		DRAWING No: P01252_0026	REV: -

Last saved: Fri, 24 Feb 2017 10:32 am

CAD Ref: Z:\Projects\Organisations\DOC\P01252_Whakapapa Wetland Design\7 Design\CAD\ P01252_0030.dwg

DESIGNED: LJC	APPROVED: Stuart Farrant		
DRAWN: LJC	APPROVED: Stuart Farrant		
APPROVED: Caleb Clarke		DATE: 24-02-2017	

MORPHUM ENVIRONMENTAL LTD

Department of Conservation
Te Papa Atawhai

PROJECT: WHAKAPAPA WASTEWATER CONSTRUCTED WETLAND

TITLE: EARTHWORKS CUT FILL PLAN

STATUS: CONSENT
SHEET 1 OF 1

PROJECT No:	SCALES:	
P01252	1:1000	A3
DRAWING No: P01252_0030		REV: -

APPENDIX 8

INGRESSION AND INFILTRATION LIST

Whakapapa Village
Stormwater Infiltration Visual Inspections (MWH July 2015)

Date	Item	Location	Stakeholder	Stormwater infiltration issue	Work Required	Contractor Comments	DOC Comments	Completed	Date completed
7/07/2014	1	Scripture Union Crusaders Lodge	Scripture Union Crusaders Lodge	Exposed sewer behind the Scripture Union Crusaders lodge, looks like coming from F&B (Refer Figure 2 of MWH Report dated 4/7/14)	Repair or replace sewer from hut to manhole N; Inspection of MH N during wet weather will be required to confirm stormwater infiltration	Some sections of pipe are visible, but no leaks observed. There may not be any water ingress in this section of pipe work. CCTV would confirm this. There is approx 76 metres of pipe - indicative costs $240 p/m plus $1750 each for manholes ($22k). Any upgrades should run down the road along with all other services for easy access.	Recommend CCTV and pipe replacement as part of the horizontal upgrade. (MM)	YES	May 2015
7/07/2014	2	Scripture Union Crusaders Lodge	Scripture Union Crusaders Lodge	Two gully traps at back of building both at ground level (Refer Figures 3 & 4)	Raise gully traps to 100mm above ground level	Easy repair		YES	May 2015
7/07/2014	3	DOC Yard	DOC	Manholes (3) in wash-down area full of water. The outlet for all 3 manholes were blocked. Sump blocked (Refer figures 5 & 6)	Sump and manholes to be cleaned		Work completed (MM)	YES	17/08/2014
7/07/2014	4	DOC Yard	DOC	Unclear how and where the pipes from these manholes connect into the sewer	Identify and inspect the drains that connect the office building and workshop to sewer reticulation; Complete remedial work as required	Requires further inspection and possibly digging. CCTV would identify connections.		YES	
7/07/2014	5	Chateau - Workshop cnr Hepi Tce / SH48 (Dave's office)	Chateau	Stormwater from workshop roof flowing into gully trap (Refer figure 8)	Raise gully trap to 100mm above ground level	I don't believe that this pipe is storm water, however it should be changed and the gully repaired		YES	May 2015
7/07/2014	6	Hepi Tce - Steve Mananui's house	RAL	Gully trap outside residential dwelling Hepi Tce needs landscaping (Refer figure 7)	Raise gully trap to 100mm above ground level; Re-inspect all gully traps at Hepi Tce properties			YES	May 2015
7/07/2014	7	Fergusons Café	Chateau	Gully trap at back of Fergusson's Café just outside the kitchen is at the lowest point in the area. (Refer Figures 9 & 10)	Raise gully trap to 100mm above ground level	This could be fixed by bolting a steel plate on the concrete and sealing		YES	May 2015
7/07/2014	8	Singleman's quarters, Tawera Place	RAL	Stormwater ponding over sewer inspection point (Refer Figure 11)	Replace sewer inspection point with a waterproof cap or raise	While some work has been done here more needs doing including excavating material from the end of the building and replacing pipes			May 2015
7/07/2014	9	Staff Chalets	Chateau	Unraised gully traps with several stormwater inflow paths behind staff chalets (Refer figures 12, 13 & 14)	Raise gully traps to 100mm above ground level	This work is located behind the old house that is 2 flats belonging to the Chateau, there is one gully to be raised and two inspections to be replaced			May 2015
7/07/2014	10	Chateau Tongariro Hotel	Chateau	Unraised gully trap along south-western corner of the building (Refer figure 15)	Raise gully trap to 100mm above ground level	Once again the only way to repair this is with a concrete bund		YES	May 2015
7/07/2014	11	Skotel - Car park	Skotel	Gully trap at ground level in unpaved area beside carpark. (Refer figure 16 & 17)	Inspect all other gully traps and raise as required	Either a concrete bund or a plastic riser only one at this site		YES	May 2015
7/07/2014	12		Whakapapa Holiday Park		Inspect and raise gully traps as required	Either a concrete bund or a plastic riser there is only one gully to be raised		YES	May 2015
7/07/2014	13	VC Buildings - behind VC	DOC		Inspect and raise gully traps as required	There is no work required here			
7/07/2014	14		Fire Station		Inspect and raise gully traps as required	There is no work required here			
7/07/2014	15	Tussock Tavern	Chateau		Haunching around pump station to be raised 50mm above the top of the metal.	This needs the seal cutting back about 500mm on both sides & new sloping concrete so snow clearing equipment doesn't catch the lid		YES	May 2015
7/07/2014	16	Iwikau Sewer Manholes	CS Opex		Inspect all manholes & grease traps		Work completed (MM)	YES	Jan-15
13/03/2015	17	RAL (Dave Mazey's)	RAL	Gully trap flush with ground (Refer Fig 20)	Inspect and raise gully traps as required	Raise with concrete bund		YES	May 2015
13/03/2015	18	Chateau (Chalet 7)	Chateau	Gully trap flush with ground (Refer Fig 21)	Inspect and raise gully traps as required	Raise with concrete bund		YES	May 2015
13/03/2015	19	Chateau (Chalet 9)	Chateau	Gully trap flush with ground (Refer Fig 22)	Inspect and raise gully traps as required	Raise with concrete bund		YES	May 2015
13/03/2015	20	Chateau Staff quarters	Chateau	Gully trap flush with ground (Refer Fig 23)	Inspect and raise gully traps as required	Raise with concrete bund		YES	May 2015
13/03/2015	21	Chateau (Hotel)	Chateau	Gully traps flush with ground (Refer Fig 24)	Inspect and raise gully traps as required	Raise with concrete bund		YES	May 2015
13/03/2015	22	Chairmans (DOC)	DOC	Gully traps flush with ground (Refer Fig 25)	Inspect and raise gully traps as required	Raise with concrete bund		YES	May 2015
1/05/2015	23	Ngauruhoe Place, outside chalets near Bhrents house	Chateau		Raise concrete Manhole		Located during additional inspection		May 2015
1/05/2015	24	Brad McGlynns house, Ngauruhoe Place	Chateau	stormwater pipe directly into sewer main	Pipework adjustments	No charge - minor works	Located during additional inspection		May 2015
1/05/2015		Inspection fee to confirm sites from MWH report							May 2015
1/05/2015		Looking for water ingress Iwikau						YES	May 2015
1/05/2015		Looking for water ingress Whakapapa						YES	May 2015
1/05/2015		Bridges Hut, Iwikau	RAL	Stormwater overflow to sewer main	reroute overflow	No charge - minor works	Located during Iwikau inspection		

Appendix 12 - Proposed Ingression and Infiltration (I&I) Works on the Stormwater Network for Whakapapa Village 2017/18 – taken from Engineering Report prepared by Veolia

CCTV Footage and Recommendations - Summary

The following is a summary of findings from the CCTV work conducted in Whakapapa in April 2015. This assessment was undertaken following a proposal from Veolia to CCTV waste water mains in the Whakapapa Township and supports a programme of works for I&I works going forward to reduce ingress into the stormwater network which impacts on the volumes of effluent being received at the Wastewater Treatment Plant.

All 150mm diameter mains and above were inspected using a tractor CCTV unit. The smaller 100mm laterals to DOC properties have been inspected using a push rod camera and findings of these inspections will be provided in a separate report outlining any major defects that were identified.

The CCTV inspection was undertaken to determine long term planning in accordance with the New Zealand Pipe Inspection Manual (3rd Edition), which states;

3rd Edition New Zealand Pipe Inspection Manual		
Purpose of CCTV Programme	**Recommended Analysis**	**Comments**
To identify the general condition of the network for long term planning.	Carry out structural scoring analysis and determine general condition of pipe network. • Identify any pipes that may need immediate attention and review CCTV inspection in detail. • Estimate remaining life of pipe network. • Determine long-term asset management strategies and budgets	Pipes that may need immediate attention and require the CCTV inspection to be reviewed in detail may include: • Peak Scores greater than 50. • Pipes with high mean scores greater than 3. • Pipes with Pipe Collapsed (PX) defects. • Pipes with Tomo (TM) defects.

Due to the high priority of reducing water infiltration into the network some mains should be considered for relining or repairs where infiltration is present regardless of their mean scores. Historic records of blockages should be taken into account when considering where to carry out remedial work as some mains may appear to be in poor condition however are not causing any issues with blockages. Some mains that appear in good condition may be contributing towards ongoing operational costs if ongoing blockages are occurring.

The CCTV inspections highlighted a number of faults and signs of deterioration within the network, and have been used to determine the future recommended repair work and/or relining.

The following two tables are a summary of all mains that were inspected, with scoring as per the Pipe Inspection Manual. The summary then details the problems identified during the inspections, with subsequent recommendations. This document condenses the CCTV log sheets, and has been compiled for high level review recommendations only.
A full works proposal for the repair works and relining will be generated where applicable.

Due to no asset id's being available yet for each main prior to CCTV works being conducted, each main inspected has been issued a new asset id for the purpose of the CCTV works and subsequent reporting.

All CCTV Inspections in Whakapapa where completed during good weather conditions and the amount of water infiltration shown in the footage is not representative of the amount shown in wet weather conditions.

It has been identified that a substantial amount of infiltration is present during heavy rain events which cause substantial issues at the wastewater treatment plant.

Due to some remedial works being completed in close proximity to existing properties it is beneficial to replace the laterals to these properties if they are Earthenware to prevent water infiltration. A programme of works will be developed around these recommendations and undertaken according to priorities in 2017/18. The Asset Management Plan further support the future provision and funding of I&I works going forward.

Recommendations from CCTV for I&I works

Asset ID	Recommendation
1	Due to the shallow depth of this main and its minimal length and pipe type, it is recommended that this line is excavated and replaced.
2	Stage 1: Repair minor lateral defects to remove ingress. Stage 2: Recommend resurvey during heavy rain periods to determine infiltration levels through the earthenware joints. If large amount infiltration is found then replacement is recommended
3	Clear existing root infiltration with root cutter.
4	No further works required – recommendation to resurvey in 10 years' time
5	Stage 1: Clear existing root infiltration with root cutter Stage 2: Inspect main during wet weather events.
6	Clear existing root infiltration with root cutter and reline with Cure In Place CIPP liner.
7	Clear existing root infiltration with root cutter and reline with Cure In Place CIPP liner.
8	Recommendation to resurvey in 10 years' time
9	Recommendation to resurvey in 10 years' time
10	Recommendation to resurvey in 10 years' time
11	Recommendation to resurvey in 10 years' time
12	Reline with Cure In Place CIPP liner and trim protruding laterals. Recommended due to pipe being under the State Highway.
13	Recommendation to resurvey in 10 years' time

14	Recommendation to resurvey in 10 years' time
15	Recommendation to resurvey in 10 years' time
16	Recommendation to resurvey in 10 years' time
17	Excavate earthenware pipe and remove dip
18	Clear existing root infiltration with root cutter and reline with Cure In Place CIPP liner.
19	Reline with Cure In Place (CIPP) liner
20	Clear existing root infiltration with root cutter reline with Cure In Place CIPP liner.
21	Further investigation required. Excavation to repair dip in the main if found to be obstructing flow or causing blockages.
22	Clear existing root infiltration with root cutter reline with Cure In Place CIPP liner.
23	Further investigation required. Excavation to repair dip in the main if necessary.
24	Recommendation to resurvey in 5 years' time
25	Recommendation to resurvey in 10 years' time
26	Dipped pipe, some further investigation required with flushing to determine remedial works required
27	Recommendation to resurvey in 5 years' time
28	Excavation to remove the dip in pipe and repair displaced joints
29	Clear existing root infiltration with root cutter reline with Cure In Place CIPP liner.
30	Recommendation to resurvey in 10 years' time
31	Recommendation to resurvey in 5 years' time
32	Recommendation to resurvey in 5 years' time
33	Excavate and replace pipe to remove dip.
34	Clear existing root infiltration with root cutter reline with a Cure In Place (CIPP) Liner to eliminate the multiple infiltration points.
35	Recommendation to resurvey in 10 years' time
36	Recommendation to resurvey in 10 years' time
37	Clear existing root infiltration with root cutter. Investigate again with CCTV at ingress points to determine if relining is required.

Short Term I&I Solutions	
1	Due to the shallow depth of this main and its minimal length, it is recommended that this line is excavated and replaced.
2	Excavate main and repair existing lateral defects
3	Clear existing root infiltration with root cutter.
5	Clear existing root infiltration with root cutter and inspect main during wet weather events.
17	Excavate earthenware pipe and remove dip
26	Dipped pipe, some further investigation required with flushing to determine remedial works required

Smoke Testing and Proposed Recommendations - Summary

The following is a summary of findings from the smoke testing investigation completed at Whakapapa Village in February 2016. This smoke testing was completed over three days in an effort to further reduce stormwater infiltration into the wastewater network.

The scope of the smoke testing included all mains in the Whakapapa village and included carrying out an inspection of all properties to determine if any downpipes were plumbed into the wastewater system and contributing to the infiltration issues.

Most issues in the Village appear to have been resolved however some minor works still remain as listed below.

Smoke Testing Findings

Properties within the Whakapapa Village were inspected and the following issues were identified:

Location	Issue	Recommended Action
Forest and Bird Lodge	Exposed pipe work around building has potential to be damaged at any stage and allow direct infiltration	Replace as per CCTV recommendation.
Forest and Bird Lodge	Gully traps previously raised not sealed from all sides leaving the potential for infiltration.	Seal gully trap to prevent infiltration.

Chateau Lower Carpark	Covers to sewer manhole are not sealed and have the potential to allow storm water infiltration.	Seal covers to prevent infiltration
Chateau	Storm water and Sewer gully traps in close proximity, potential for overflow of storm water into the sewer.	Raise gully trap to prevent infiltration in heavy rain events.
Skotel	Manhole riser has chips below cover slab. No possibility of water infiltration, maintenance works only.	Patch manhole riser.
Camp Grounds	Steel cover over manhole rotten in one corner. No possibility of water infiltration, maintenance works only.	Replace steel cover
Chateau	Common manholes for both sewer and storm water. Possibility of overflows.	Monitor during heavy rain events. Works to repair this setup requires further investigation as costs are likely uneconomical in the short term.

APPENDIX 9

ECOLOGICAL MONITORING REPORT - AQUANET

Whakapapa Village WWTP: Summary of freshwater quality and ecological monitoring to January 2016

14 June 2016

Report Prepared for the Department of Conservation

Aquanet Consulting Ltd

441 Church Street
Palmerston North

06 3586581

Whakapapa Village WWTP:
Summary of freshwater quality and ecological monitoring to January 2016

14 June 2016

Report prepared for the Department of Conservation by:

Dr Olivier Ausseil

Fiona Death

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Aquanet Consulting Limited

Quality Assurance			
Role	Responsibility	Date	Signature
Prepared by	Olivier Ausseil Fiona Death Amy Feck	14/06/2016	
Approved for issue by:	Olivier Ausseil		
Status	Final		

This summary assessment has been prepared for the Department of Conservation by Aquanet Consulting Limited. No liability is accepted by this company or any employee or sub-consultant of this company with respect of its use by any other parties.

EXECUTIVE SUMMARY

Context

The Whakapapa wastewater treatment plant (WWTP) receives wastewater from Iwikau Village and Whakapapa Villages. Within Iwikau Village, there are 47 ski club lodges, and the Ruapehu Alpine Lifts Ltd (RAL) facilities. Whakapapa Village includes the Chateau Tongariro, Skotel, Whakapapa Holiday Park, DOC facilities (visitor centre, staff accommodation, etc.), RAL staff accommodation and a few club lodges. The numbers of visitors, and therefore the wastewater loads entering the WWTP, are highly seasonal, with a peak during the ski season (July-September).

Resource consents associated with the operation and discharges from the Whakapapa Village wastewater treatment plant (WWTP), operated by the Department of Conservation (DOC), expired on 1 December 2014. A resource consent application and Assessment of Environmental Effects (AEE) were lodged with, and accepted by, Horizons Regional Council (Horizons) on 25 August 2014. Horizons later issued a request for further information under S92 of the Resource Management Act (RMA). A response to the S92 request, compiled by Cheal and MWH, included water quality and aquatic ecology information from the Catalyst Group, and was submitted on 26 May 2015.

Since July 2015, the management of the WWTP has been transferred over to Ruapehu District Council. Veolia Water are contracted to carry out the day to day maintenance and management of the WWTP.

Potential Effects

This report only covers effects of the discharge of treated wastewater from the Whakapapa Village on freshwater quality and ecology. Aspects pertaining to effects on air, groundwater or cultural values are not specifically covered in this report.

Generally speaking, discharges of treated domestic wastewater to streams and rivers can, under some circumstances, give rise to a range of potential effects, which can affect aesthetic, ecological or recreational and cultural values of the waterways. These potential effects are considered in this report, on the basis of data available.

Assessment undertaken

Water quality and ecological monitoring were undertaken by DOC and the Catalyst Group (until June 2015), then Veolia (water quality) since July 2015 and Aquanet (ecology) since October 2015.

The aim and scope of this report is to provide an overall summary of the water quality and ecology data and information collected to date, and an assessment of effects of the historical and current operation of the plant to form part of a new resource consent application package.

The various water quality and ecological indicators have been summarised and compared with One Plan Schedule E Water quality targets. Where monitoring data were insufficient to provide a robust assessment additional monitoring was recommended. A separate “GAP Analysis” (Aquanet, March 2016) was undertaken to summarise the water quality and ecological information and data collected to date in relation to the Whakapapa WWTP and identify information gaps, as well as a programme of investigations starting in October 2015.

Monitoring results

Monitoring has been mainly undertaken on three streams, with a pair of upstream and downstream sites on each of these streams. A map of the streams and monitoring sites is provided on p 3 of this report. The intention of these is to measure (by difference between upstream and downstream) the effects of the discharges on in-stream water quality and ecology. The results of water quality and ecological monitoring at these sites indicates that:

The <u>Southern Tributary</u>

- Is understood to be the primary receiving environment for the discharges of treated wastewater from the emergency overflow pond into soakage trenches.
- Water quality sampling results indicate that the effects of these discharges on a number of water quality indicators are measurable, with some downstream concentrations exceeding One Plan targets at times (SIN and ammoniacal-N notably). Of particular notice are the unusually (compared with the rest of the data record) elevated concentrations of a range of contaminants measured at the downstream site in late 2015/early 2016. The possible causes of these unusual results are discussed below.
- Periphyton monitoring indicates that periphyton biomass and cover were at times increased compared with upstream, but not to levels such that overall compliance with One Plan targets is compromised. Similarly to water quality results, the largest increases in periphyton were measured in late 2015 to early 2016;
- Macroinvertebrate communities do not seem to be negatively affected by the discharge.

<u>The Northern Tributary</u>

- Is the receiving environment for the proportion of the discharges from the whole WWTP system that eventually reach surface water, from both the soakage trenches and the irrigation fields;
- Water quality sampling indicates that changes in the concentrations of a range of contaminants are generally measurable and statistically significant, although most One Plan targets seem to be met at the downstream site, with the notable exception of SIN. Similarly to what is noted above for the Southern Tributary, a high proportion of elevated results seem to have occurred in late 2015/early 2016;
- Periphyton sampling indicates a general increase in periphyton biomass and cover at the downstream site compared with upstream. Compliance with the periphyton biomass target at the downstream site is uncertain, and additional sampling would be required to provide a firm conclusion;
- There are indications that significant adverse effects on macroinvertebrate community health have occurred in 2014 and 2015, but not in 2012 and 2013.

<u>The Wairere Stream</u>

- Receives inputs from the Northern Tributary, and as such constitutes the secondary receiving environment for the proportion of the discharges from the whole WWTP system that eventually reach surface water. Monitoring in the Wairere Stream provides an indication of the downstream extent of any effects measured in the Southern or Northern Tributaries.

- Limited water quality data indicates that the only measurable changes in concentrations of contaminants are of ammoniacal nitrogen (and by extension SIN);
- Periphyton monitoring indicates a measurable increase in periphyton growth downstream compared with upstream, but not to a level where significant effects on ecological, aesthetic or recreational values would be expected;
- There are no indications of significant adverse effects on macroinvertebrate communities in the Wairere Stream, including as a food source for whio (blue duck), an endemic species classified as "nationally vulnerable";
- Only limited water quality and ecological data are available for the Wairere Stream, and it is recommended that regular monitoring be continued to confirm the above conclusions.

In all three streams, data indicates that DRP is in naturally moderately elevated supply; by contrast, "background" concentrations of SIN are very low. This means that inputs of SIN into the stream are the likely primary driver of the increased periphyton biomass observed in all three streams at the downstream sites.

With regards to the higher than usual concentrations of a range of contaminants measured in late 2015/early 2016 in both the Southern and Northern Tributaries, it is our understanding that the management of the WWTP during that period was characterised by intense investigations and repairs during which higher than normal volumes of treated wastewater were discharged to the soakage trenches, or on the surface of the irrigation fields, which is a plausible cause for the results obtained during that period. It is also noted that, to some extent, periphyton indicators have followed the same trend. The most recent macroinvertebrate samples were taken in October 2015. These results need to be considered in the context of the unusual management of the WWTP system at the time; in particular, it seems questionable whether these results provide a suitable representation of the effects of the WWTP under normal operating conditions.

On the basis of available data, there are indications of some degree of adverse ecological effects on the Northern Tributary, although data available are somewhat insufficient to reach firm conclusions and it is questionable whether the more recent results provide a good representation of the effects of the WWTP under normal operating conditions. These effects seem to be spatially limited to the Northern Tributary, and do not extend to the Wairere Stream.

Recommendations

It is recommended that additional monitoring be undertaken to confirm, or otherwise, these conclusions. In the event that significant adverse effects on the Northern Tributary (or any other stream) are identified or confirmed, and that improvements are required, then it is likely that reducing the inputs of SIN (including ammoniacal Nitrogen) into the surface water system should be the management target.

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Figures

1. Introduction

1.1. Background and scope

The Whakapapa WWTP receives wastewater from Iwikau Village and Whakapapa Villages. Within Iwikau Village, there are 47 ski club lodges, and the Ruapehu Alpine Lifts Ltd (RAL) facilities. Whakapapa Village includes the Chateau Tongariro, Skotel, Whakapapa Holiday Park, DOC facilities (visitor centre, staff accommodation, etc.), RAL staff accommodation and a few club lodges. The numbers of visitors, and therefore the wastewater loads entering the WWTP, are highly seasonal, with a peak during the ski season (July-September).

Resource consents associated with the operation and discharges from the Whakapapa Village wastewater treatment plant (WWTP), operated by the Department of Conservation (DOC), expired on 1 December 2014. A resource consent application and Assessment of Environmental Effects (AEE) were lodged with, and accepted by, Horizons Regional Council (Horizons) on 25 August 2014. Horizons later issued a request for further information under S92 of the Resource Management Act (RMA). A response to the S92 request, compiled by Cheal and MWH, included water quality and aquatic ecology information from the Catalyst Group, and was submitted on 26 May 2015.

Since July 2015, the management of the WWTP has been transferred over to Ruapehu District Council. Veolia Water are contracted to carry out the day to day maintenance and management of the WWTP.

Water quality and ecological monitoring was undertaken by DOC and the Catalyst Group (until June 2015), then Veolia (water quality) since July 2015 and Aquanet (ecology) since October 2015.

The aim and scope of this report is to provide an overall summary of the water quality and ecology data and information collected to date, and an assessment of effects of the historical and current operation of the plant to form part of a new resource consent application package.

1.2. Treatment Plant and discharge

The treatment process at the Whakapapa WWTP is currently composed of a coarse/primary screen, Pasveer ditch, sedimentation tanks, sand filters and UV treatment. Treated effluent from the WWTP is then piped to four irrigation fields (A to D). Based on information provided in the 2014 consent application, the WWTP is capable of treating up to 720 m^3/day. However, only up to 300 m^3/day can currently be discharged to the irrigation fields, with the balance of flow being discharged to the soakage trenches.

During high wastewater inflow events, flows that cannot be accommodated through the above treatment train are piped to the "emergency overflow pond". Wastewater from the emergency overflow pond is discharged to soakage trenches located immediately downgradient of the emergency overflow pond. These trenches are understood to flow towards the small tributary which runs along the southern edge of the WWTP site (described as the "Southern Tributary" in this report).

1.3. Structure of the report

This report is comprised of five sections. The sections following this introductory section are:

Section 2 presents a map of monitoring sites, outlines the data available for analysis and explains approaches used in data analysis. It also sets out the water quality and ecological targets or thresholds against which the monitoring data were assessed.

Sections 3 and 4 present an assessment of the current state of water quality and ecological indicators at the various monitoring sites.

Section 5 presents conclusions from the main findings of sections 2 to 4, as well as recommendations.

2. Data and methods

2.1. Receiving Environments and monitoring sites.

The various streams in the vicinity of the Whakapapa WWTP and the monitoring sites on these streams have, in past documents, been named or described in an inconsistent, and somewhat unclear or incorrect fashion. The comments below aim at setting out the nomenclature used in this report, as well as the reason and rationale for the selection of the various monitoring sites. Figure 1 shows the location of the different streams and monitoring sites. Photographs of the sites are presented in Plates 1 to 6.

A Gap Analysis was recently undertaken by Aquanet[1] to summarise the water quality and ecological information and data collected to date in relation to the Whakapapa WWTP and identify information gaps, as well as a programme of investigations which started in October 2015. The recent monitoring programme described below follows the recommendations of the Gap Analysis.

The receiving environment for the discharge from the soakage trenches is a small stream running along the southern edge of the WWTP site, called "Southern Tributary" in this report[2]. Water quality and ecological monitoring is undertaken at two sites on this tributary, respectively upstream and downstream of the WWTP and soakage trenches. Comparison of results collected at these two sites will enable an assessment of the effects of the discharge of treated effluent to and from the soakage trenches.

This "Southern Tributary" flows into another small (albeit slightly larger) stream, named the "Northern Tributary[3]" in this report, which runs along the northern edge of the WWTP and then along the four irrigation fields. Two main monitoring sites are located on this stream, one located upstream of the WWTP and the soakage trenches, and one located at the downstream end of the irrigation fields. Comparison of results collected at these two sites will enable an assessment of the effects of the proportion of the discharges of treated effluent from the whole WWTP system that eventually reach surface water discharge, including to and from the soakage trenches (conveyed by the Southern Tributary), and to and from the irrigation fields. An additional water quality monitoring site was recently added to the water quality monitoring programme at Horizons request, located immediately upstream of the confluence with the Southern Tributary. It is understood that the aim of this monitoring site is to assess whether any changes in water quality occur between the upstream site and this additional site, which could indicate some sub-surface inputs from the WWTP, emergency overflow pond and/or soakage trenches.

The Northern Tributary then reaches the Wairere Stream itself. Monitoring at sites located upstream and downstream of the confluence with the Northern Tributary have been monitored since October 2015[4]. The intention of these monitoring sites is to measure (by difference between upstream and downstream) the effects of the discharge from the whole WWTP system, as conveyed by the Northern Tributary, on the water quality and ecology of the Wairere Stream.

Following the recommendations of the Gap Analysis, a water quality monitoring site has been added on the Whakapapanui Stream (of which the Wairere Stream is a tributary) just above the Tawhai Falls, to assess the downstream extent of any measurable effects from the discharge.

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[1] Department of Conservation Whakapapa Village Wastewater Treatment Gap Analysis and recommended programme of investigations (2015-2016). Aquanet Consulting Ltd. January 2016.

[2] This stream has also been described as "Unnamed tributary of the Wairere Stream", or "" Tributary of the Wairere Stream" in various documents and reports.

[3] Note that this stream has been referred to as the "Tributary of the Wairere Stream", but also, and incorrectly, as the Wairere Stream itself in various documents and reports.

[4] Note that the downstream site was also monitored for water quality in 2014.

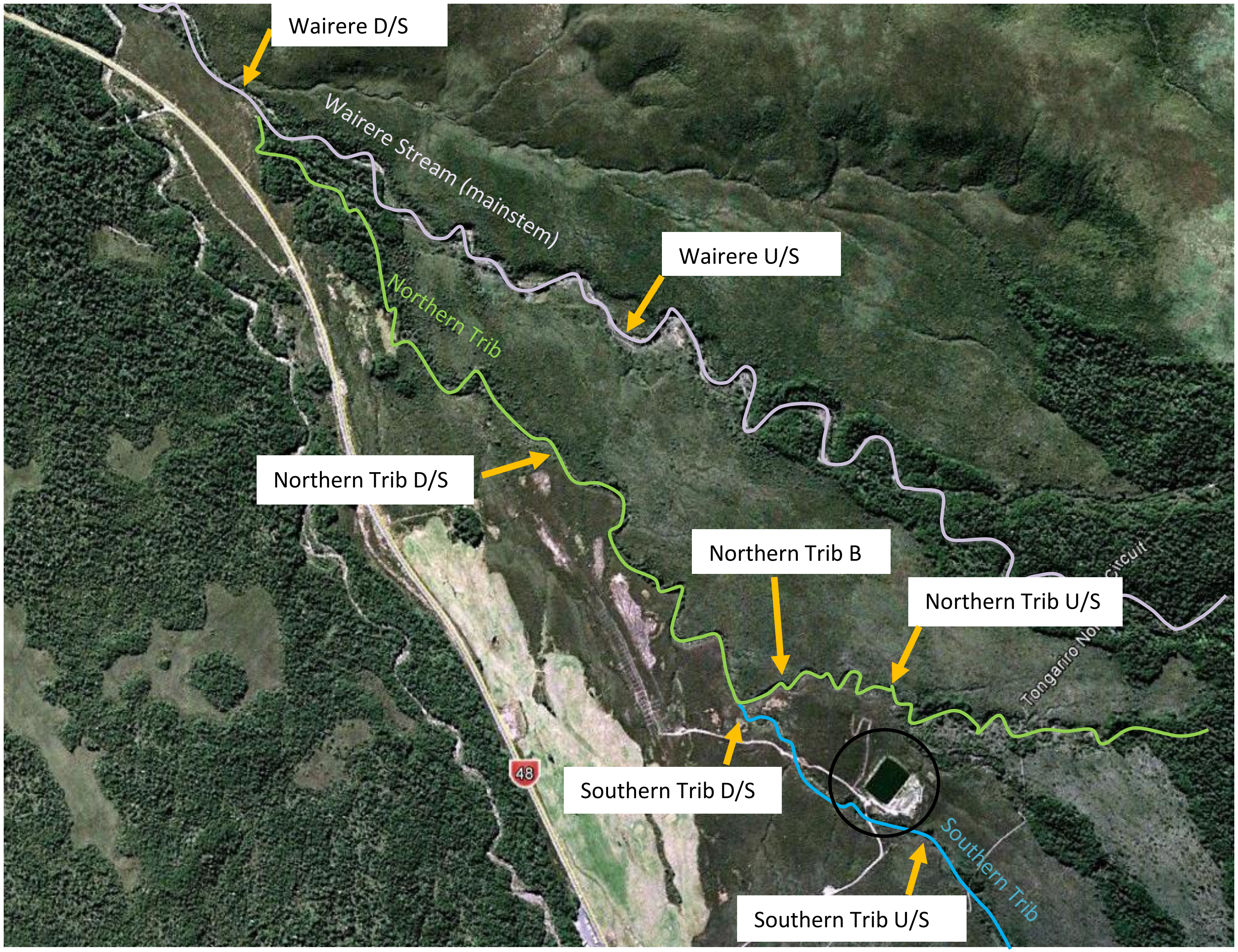


Figure 1: Location of monitoring sites in relation the Whakapapa WWTP, October 2015 to January 2016.

Plate 1: Wairere Stream upstream of confluence with Northern Tributary, February 2016.

Plate 2: Wairere Stream downstream of confluence with Northern Tributary, January 2016.

Plate 3: Upstream on Northern Tributary to Wairere Stream, January 2016.

Plate 4: Downstream on Northern Tributary to Wairere Stream, January 2016.

Plate 5: Upstream of Whakapapa WWTP on Southern Tributary, January 2016.

Plate 6: Downstream of Whakapapa WWTP on Southern Tributary, January 2016.

2.2. Available data and data preparation

Under the requirements of the existing resource consent conditions, monitoring of water quality (monthly) and macroinvertebrates (annually) has been undertaken at four sites (Northern and Southern Tributaries, upstream and downstream sites). Additional monitoring was also undertaken by DOC (water quality) and the Catalyst Group (ecology) in 2014. Since July 2015, water quality monitoring has been undertaken by Veolia and, since October 2015, ecological sampling has been undertaken by Aquanet.

Available water quality and ecological data used in this report are presented in Table 1 below.

The current consent does not define any in-stream water quality or ecological limits or thresholds. Water quality and ecological data were assessed against the water quality targets set out in Horizons One Plan Schedule E for the Upper Whakapapa (Whai_2b) sub-zone (Table 2). All references to the One Plan in this report are to the web-based Operative Version available on Horizons Regional Council's (Horizons) website, accessed on 1st February 2016.

2.3. Data analysis

Water quality data collected at sites upstream and downstream of the Whakapapa WWTP are presented in Section 3. Descriptive statistics, such as mean, median, distribution percentiles, standard error and confidence intervals, as well as the proportion of samples complying with the relevant guidelines or targets are presented in Appendix A.

Flow data were not available for the Wairere Stream or its tributaries, and therefore no flow-related analysis of the data could be carried out. This impeded the assessment of compliance with those of the One Plan targets that are flow-dependent.

Comparisons of upstream/downstream results were carried out using a Wilcoxon Signed Rank Test in Statistix 9, as recommended in Scarsbrook and MacBride (2007).

Assessments against the Attribute tables in Appendix 2 of the National Policy Statement for Freshwater Management 2014 (NPSFM 2014) were undertaken for Total ammoniacal nitrogen, Nitrate, *E.coli* and Periphyton biomass.

The NPSFM (2014) specifies that the numeric attribute states for ammoniacal nitrogen are based on pH 8 and temperature of 20°C and that compliance with the numeric attribute states should be undertaken after pH adjustment. This was undertaken by firstly calculating the proportion of unionised ammonia nitrogen at pH of 8 and 20°C, then calculating the unionised ammonia-nitrogen concentrations corresponding to each of the NPSFM thresholds. The unionised ammonia concentration in each in-river sample was calculated on the basis of water pH and temperature measured on-site on each day of sampling, then compared with the unionised ammonia nitrogen NPSFM thresholds.

For both NPSFM and DO (% saturation) calculations, where temperature data were missing, data from measured on-site records for the relevant months were substituted.

Ecological data collected at sites upstream and downstream of the Whakapapa WWTP are presented in Section 4. Differences in biotic indices between sites were assessed using ANOVA in Statistix 9. Values at $P < 0.05$ indicate a statistically significant change.

Table 1: Summary of data presented in this report.

Site	Type	Parameters	Frequency	Period	Source
Whakapapa WWTP effluent	Effluent water quality	pH, DO, Dissolved $cBOD_5$, TSS, DRP, DIN, TNH_3-N, *E. coli*	Monthly	October 2015 to January 2016	Veolia
Southern Tributary upstream of Whakapapa WWTP	River water quality	pH, DO, Dissolved $cBOD_5$, TSS, DRP, DIN, TNH_3-N, *E. coli*	Monthly	January 2012 to January 2015 August 2015 to January 2016	DOC Veolia
Southern Tributary downstream of Whakapapa WWTP					
Northern Tributary upstream of Whakapapa WWTP					
Northern Tributary downstream of Whakapapa WWTP					
Wairere Stream upstream of confluence with Northern Tributary					
Wairere Stream downstream of confluence with Northern Tributary					
Southern Tributary upstream of Whakapapa WWTP	Biological indicators	Macroinvertebrate indices (MCI, QMCI, %EPT taxa, %EPT individuals, No. of taxa, No. of individuals); Periphyton biomass (Chlorophyll *a*), %Periphyton cover	Annually	2012 & 2013 2014 2015	DOC Catalyst group Aquanet
Southern Tributary downstream of Whakapapa WWTP					
Northern Tributary upstream of Whakapapa WWTP					
Northern Tributary downstream of Whakapapa WWTP					
Wairere Stream upstream of confluence with Northern Tributary					
Wairere Stream downstream of confluence with Northern Tributary					

Table 2: Water quality targets as per One Plan Schedule E Water quality targets for the Upper Whakapapa (Whai_2b) Water Management Sub-Zone.

Parameter	Target as per Horizons One Plan Schedule E (Full Wording of the Target)
pH	The pH of the *water* must be within the range **7 to 8.2** unless natural levels are already outside this range.
	The pH of the *water* must not be changed by more than **0.5.**
Temp (^oC)	The temperature of the *water* must not exceed **19** degrees Celsius.
	The temperature of the *water* must not be changed by more than **2** degrees Celsius.
DO (% SAT)	The concentration of dissolved oxygen (DO) must exceed **80 %** of saturation.
sCBOD5 (g/m^3)	The monthly average five-days filtered soluble carbonaceous biochemical oxygen demand (sCBOD5) when the *river*^ flow is at or below the 20th *flow exceedance percentile** must not exceed **1.5 g/m^3**.
POM (g/m^3)	The average concentration of particulate organic matter (POM) when the *river*^ flow is at or below the 50^{th} *flow exceedance percentile** must not exceed **5** grams per cubic metre.
Periphyton (*rivers*^)	The algal biomass on the *river bed* must not exceed **50 mg** of chlorophyll *a* per square metre.
	The maximum cover of visible *river bed* by periphyton as filamentous algae more than 2 cm long must not exceed **30 %**.
	The maximum cover of visible river bed by periphyton as diatoms or cyanobacteria more than 0.3 cm thick must not exceed **60 %**.
DRP (g/m^3)	The annual average concentration of dissolved reactive phosphorus (DRP) when the *river* flow is at or below the 20^{th} *flow exceedance percentile** must not exceed **0.006 g/m^3,** unless natural levels already exceed this target.
SIN (g/m^3)	The annual average concentration of soluble inorganic nitrogen (SIN) when the *river* flow is at or below the 20^{th} *flow exceedance percentile* must not exceed **0.070 g/m^3**, unless natural levels already exceed this target.
Total Ammoniacal Nitrogen	The average concentration of ammoniacal nitrogen must not exceed **0.320 g/m^3**.
	The maximum concentration of ammoniacal nitrogen must not exceed **1.71 g/m^3**
Visual Clarity	The visual clarity of the *water* measured as the horizontal sighting range of a black disc must not be reduced by more than **20 %**.
	The visual clarity of the *water* measured as the horizontal sighting range of a black disc must equal or exceed **3** metres when the *river* is at or below the 50^{th} *flow exceedance percentile*
E. coli /100 ml	The concentration of *Escherichia coli* must not exceed **260** per 100 millilitres 1 November - 30 April (inclusive) when the *river* flow is at or below the 50^{th} *flow exceedance percentile*.
	The concentration of *Escherichia coli* must not exceed **550** per 100 millilitres year round when the *river* flow is at or below the 20^{th} *flow exceedance percentile**.

3. Results – Water Quality

Water quality data collected at sites upstream and downstream of the Whakapapa WWTP on the Wairere Stream and tributaries between January 2012 and February 2016 are presented in Figure 4 to 7. Detailed descriptive statistics, such as mean, median, distribution percentiles, standard error and confidence intervals, as well as the proportion of samples complying with the relevant guidelines or targets are presented in Appendix A. Water quality data collected at all sites for each parameter are presented in Appendix B.

3.1. *Escherichia coli (E. coli)*

The One Plan defines two *E. coli* concentration targets: 260 *E. coli*/100mL at flows below median flow during the main bathing season (November to April inclusive), and 550 *E. coli*/100mL at flows below the 20th Flow Exceedance Percentile (FEP). The technical report underpinning the definition of these targets recommends a compliance level of 95% for both these targets.

These targets were based on the New Zealand Microbiological water quality guidelines for marine and freshwater areas (MfE / MoH, 2002), which define a three tier surveillance mode. The "green mode" (single sample ≤ 260 *E. coli*/100mL) corresponds to a low level of health risk to recreational users of the water body. The "Amber" mode (single sample between 260 and 550 *E. coli*/100mL) indicates a more elevated, yet still acceptable, health risk. The "Red" mode (single sample in excess of 550 *E. coli*/100mL) means that the health risk to swimmers is unacceptable and the site should be considered unsuitable for swimming.

The concentration of *E.coli* in water is used as an indicator of health risks to recreational users of the waterbodies. The assessment presented in this report is purely made on the basis of water quality monitoring data, and does not incorporate the actual or potential use of the different streams for recreational activities – for instance, recreational use of the southern or northern tributaries seems rather unlikely given the very small size (width and depth) of these streams.

No flow data are available for the Wairere Stream or its tributaries, thus a direct, complete assessment of compliance with this target cannot be undertaken. The approach taken here is to compare the whole dataset with the year-round target (550 *E. coli*/100mL) and the data collected during the bathing season with the 260 *E. coli*/100mL target.

Monitoring results indicate that:

- In the Southern Tributary, *E.coli* concentration always complied with both *E.coli* targets at the upstream site. There is a statistically significant increase in *E.coli* concentrations between upstream and downstream. At the downstream site, the 260 *E.coli*/100mL target was exceeded once during the bathing season and the 550 *E.coli*/100mL target was exceeded twice. Overall both sites meet both One Plan targets (assessed at the 95% compliance level);
- In the Northern Tributary, There is a statistically significant increase in *E.coli* concentrations between upstream and downstream. *E.coli* concentrations exceeded the 260 *E.coli*/100ml target once upstream and twice downstream, without however exceeding the 550 *E.coli*/100mL target, which was always met both upstream and downstream. Overall, both sites meet the 550 *E.coli*/100mL target, the upstream site meets the 260 *E.coli*/100ml target, and it is uncertain whether the downstream site meets the 260 *E.coli*/100ml target (as stream flow data are not available to fully assess compliance with that target);

- In the Wairere Stream, only a very limited number of samples are available. *E.coli* concentrations were generally low at both the upstream and downstream sites, indicating a low level of health risk to water users, except in one single sample at the downstream site, which exceeded the 260 *E.coli*/100mL, but not the 550 *E.coli*/100mL, target.

Overall, the One Plan targets were generally met at all monitoring sites, apart maybe for the more stringent 260 *E.coli*/100mL bathing season target at the downstream Northern Tributary site, which may just be exceeded. However the occasional exceedances of the 550 *E.coli*/100mL at the downstream site of the Southern Tributary indicate a more elevated health risk to water users at times.

Table 3: Summary of compliance with the One Plan *E.coli* concentration targets at the different water quality monitoring sites upstream and downstream of the Whakapapa Village WWTP. Compliance is given as % samples complying with the target. Number of samples in brackets.

Site		Bathing season target (260 *E.coli*/100mL)	Year-round target (550 *E.coli*/100mL)	Comment
Southern Tributary	Upstream	100% (24)	100% (44)	
	Downstream	96% (23)	95% (43)	Single sample exceeded 260 *E.coli* /100mL in November 2013
Northern Tributary	Upstream	96% (23)	100% (43)	Single sample exceeded 260 *E.coli* /100mL in November 2014
	Downstream	92% (24)	100% (44)	Two sample exceeded 260 *E.coli* /100mL in April and November 2013
Wairere Stream	Upstream	100% (3)	100% (3)	Insufficient number of samples
	Downstream	83% (6)	100% (10)	Single sample exceeded 260 *E.coli* /100mL in November 2014

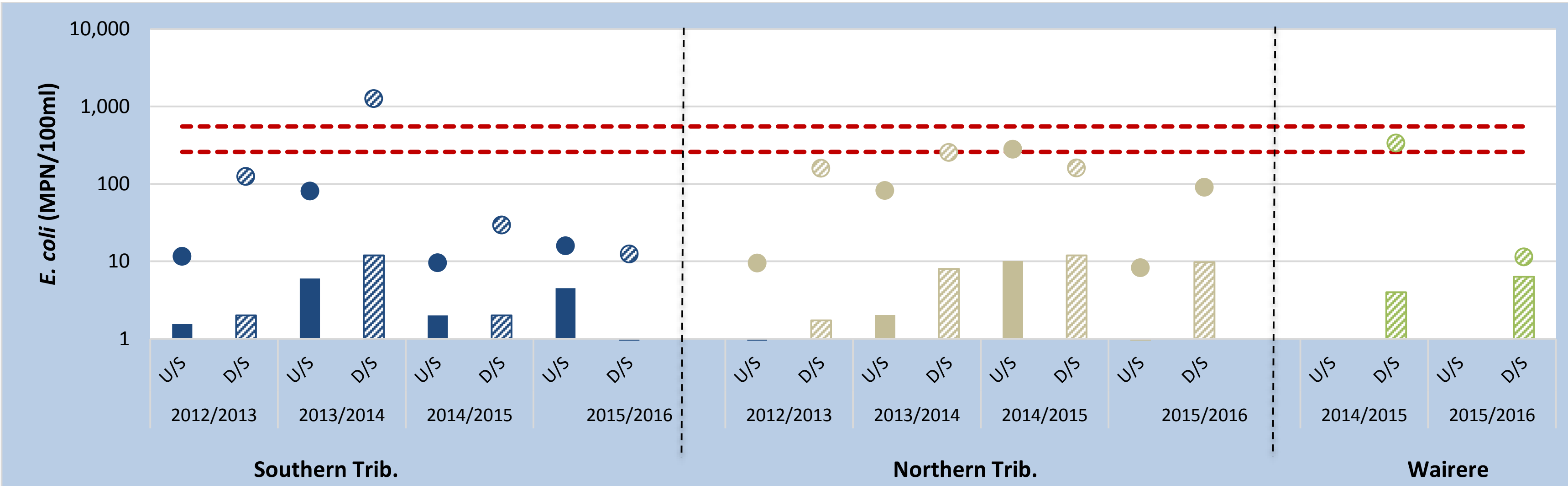


Figure 2: Median (bars) and 95th percentile (dots) *E. coli* concentrations (log scale) at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

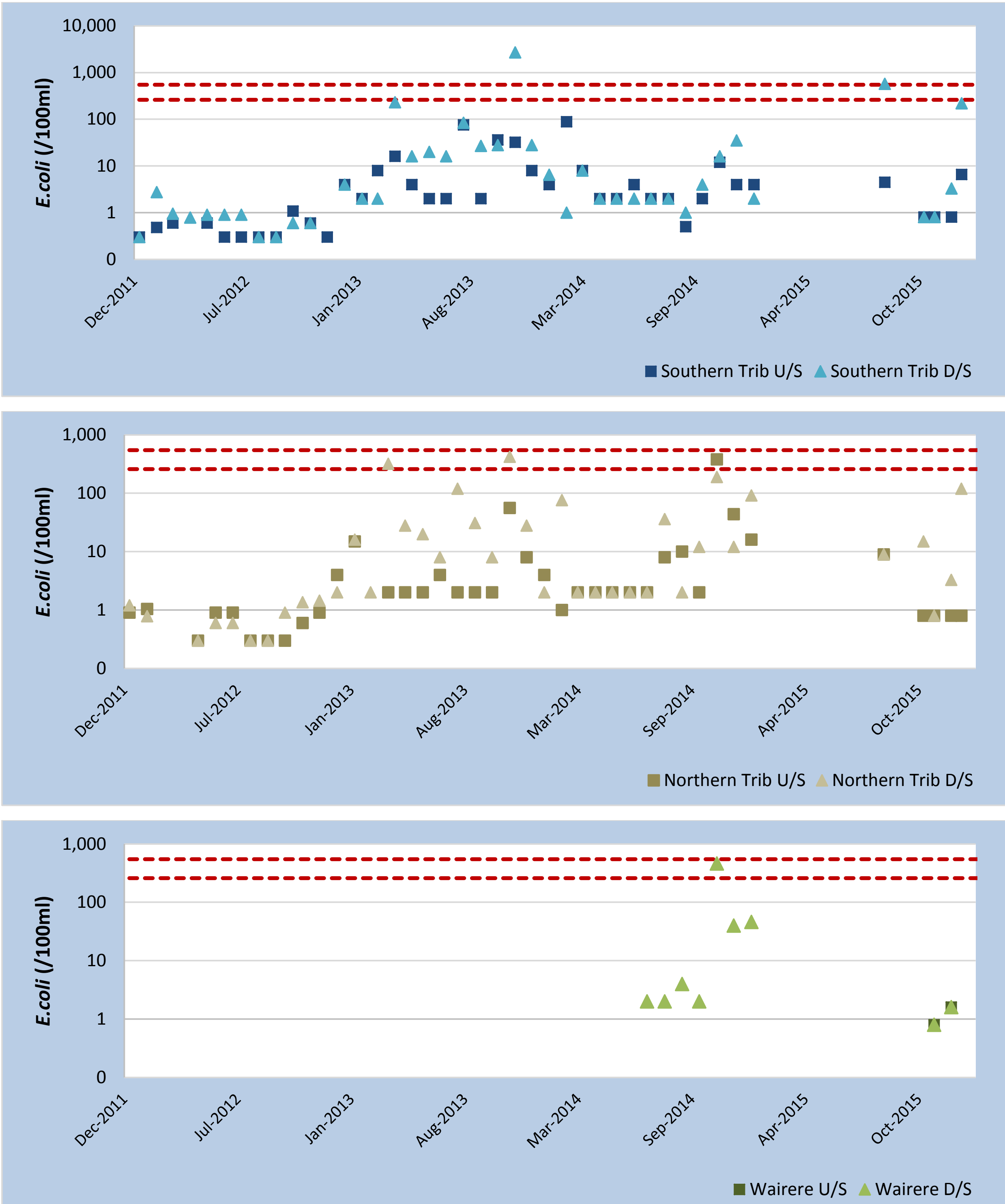


Figure 3*: E. coli* concentrations (log scale) at sites sampled in the A. Southern and B. Northern tributaries and C. Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

Assessment against NPSFM 2014 Attribute State

Data were assessed against the NPSFM (2014) Attribute States for *E.coli* concentrations (Appendix C, Table 3). Annual median concentrations were calculated for individual calendar years from July 2012 onwards, noting the limited data available in 2014-2016. The 95th percentile concentrations were only calculated on the basis of the whole dataset available (as opposed to on an annual basis), as calculating a 95th percentile *E. coli* concentration on the basis of only 12 samples (or less in some years) was considered inappropriate.

Annual median concentrations are used to define a grading relative to secondary contact recreation, i.e. water activities with occasional immersion and some ingestion of water (such as wading and boating), whilst 95th percentile concentrations are used to define a grading relative to primary contact recreation, i.e. activities likely to involve full immersion.

Both the Southern and Northern Tributaries fall into Band A for both annual median and overall 95th percentile concentrations (Table 4). Although only very limited data are available for the Wairere Stream, available data indicates that the upstream site falls into band A for both median and 95th percentile concentration, and the downstream site falls into band A for median concentration, but band B for 95th percentile concentration.

Band A signifies that people are exposed to a very low (secondary contact) or low (primary contact) risk of infection from water activities. Band B for primary contact means that people are exposed to a moderate risk of infection (less than 5% risk) when undertaking activities likely to involve full immersion.

Table 4: Annual Median and overall 95th Percentile *E. coli* Attribute States for sites monitored on the Southern and Northern Tributaries and Wairere Stream mainstem (July 2012– February 2016) upstream and downstream of the Whakapapa WWTP.

		Annual Median		Overall 95th Percentile	
		Upstream	Downstream	Upstream	Downstream
Southern Trib.	2012/2013	A	A	A	A
	2013/2014	A	A		
	2014 - Jan 2015	A	A		
	Aug 2015-Feb 2016	A	A		
Northern Trib.	2012/2013	A	A	A	A
	2013/2014	A	A		
	2014 - Jan 2015	A	A		
	Aug 2015-Feb 2016	A	A		
Wairere	Jul 2014 - Jan 2015	No data	A	A	B
	Nov 2015 - Feb 2016	A	A		

3.2. Total Ammoniacal Nitrogen

The One Plan defines two total ammoniacal nitrogen concentration targets: an average concentration of 0.320 mg/L (chronic exposure) and a maximum concentration of 1.7 mg/L (acute exposure).

Total ammoniacal nitrogen concentrations at all three “upstream” sites were generally at or below detection limits, reflecting the pristine nature of these streams upstream of the WWTP.

Statistically significant increases in Total ammoniacal nitrogen concentrations were apparent at all three “downstream” sites. These increases were generally small, apart from in the Southern Tributary and in the Northern Tributary in 2015/2016. Annual average concentrations met the One Plan “Chronic” toxicity target at all sites, indicating a low risk of toxic effect from ammonia, apart from the Southern Tributary in 2015/2016, where annual average concentrations largely exceed the target.

When considering concentrations on individual days of sampling (Figure 5), it becomes apparent that:

- Concentrations in the Southern Tributary downstream site were generally similar to those measured at the upstream site, apart from two values in 2013 and two values in 2015/2016. The One Plan acute exposure target of 1.7 mg/L was exceeded twice, in August 2015 (3.8 mg/L) and January 2016 (3.8 mg/L), indicating a potential risk of acute toxic effects on aquatic life at these times. However, once adjusted for pH and temperature (which were low on both occasions), the un-ionised ammonia concentrations were significantly lower than the corresponding One Plan acute toxicity target expressed as unionised ammonia, indicating that the actual risk of acute toxicity was low on both occasions. These two elevated values are the key driver for the annual average concentration exceeding the “chronic” One Plan target in 2015/2016;
- Concentrations at the Northern Tributary downstream site were also generally similar to those measured at the upstream site, apart from a few samples in 2013 and most samples in 2015/2016. The highest concentration, recorded in January 2016 (1 mg/L), was below the One Plan acute exposure target;
- In the Wairere Stream, data collected in 2014 show detectable ammoniacal nitrogen in about half of the samples collected at the downstream site. It should be noted that no upstream samples were taken in 2014, preventing any upstream/downstream comparison; however, one would expect very low (near or below detection limit) background ammoniacal nitrogen concentrations in a stream like the Wairere Stream. The maximum concentration measured in 2014 (0.2 mg/l) was well below both chronic and acute One Plan toxicity targets, indicating a low risk of toxic effects from ammonia (even without accounting for the low water temperature which would significantly lower the risk of ammonia toxicity). Both pairs of upstream/downstream samples collected in 2015/2016 show no material difference in concentration between the two sites. The overall conclusion is that the risk of ammonia toxicity in the Wairere stream is low.

Assessment against NPSFM 2014 Attribute State

Data, corrected for pH and temperature, were assessed against the NPSFM 2014 Attribute States for Ammonia (Toxicity) (Appendix C, Table 1). The methodology is described in Section 2.3. Annual median and annual maximum concentrations were calculated for individual calendar years from July 2012 onwards, noting however that only limited data are available in 2014-2016 (Appendix D). Results should therefore be considered preliminary.

Median ammoniacal nitrogen concentrations for sites upstream on both the Southern and Northern Tributaries fall within Attribute State A (Table 5) in all calendar years.

When considering annual maximums, sites downstream on both the Southern and Northern Tributaries are also assigned to Attribute State A for all years with the exception of 2015/2016 which falls within the Attribute State B. Insufficient data were available to provide an assessment for the Wairere Stream.

Table 5: Annual Median and Annual Maximum Ammonia nitrogen Attribute States for sites monitored on the Southern and Northern Tributaries (July 2012– February 2016) upstream and downstream of the Whakapapa WWTP.

		Annual Median		Annual Maximum	
		Upstream	Downstream	Upstream	Downstream
Southern Trib.	2012/2013	A	A	A	A
	2013/2014	A	A	A	A
	2014 - Jan 2015	A	A	A	A
	Aug 2015-Feb 2016	A	A	A	B
Northern Trib.	2012/2013	A	A	A	A
	2013/2014	A	A	A	A
	2014 - Jan 2015	A	A	A	A
	Aug 2015-Feb 2016	A	A	A	B

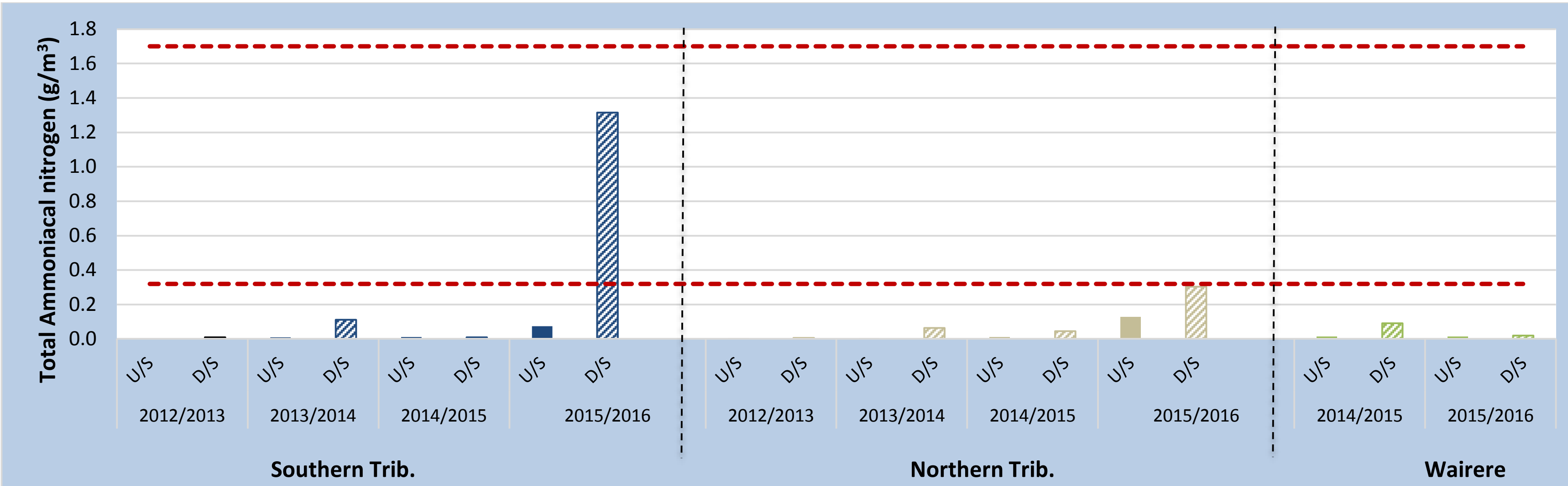


Figure 4: Annual average Total Ammoniacal Nitrogen concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

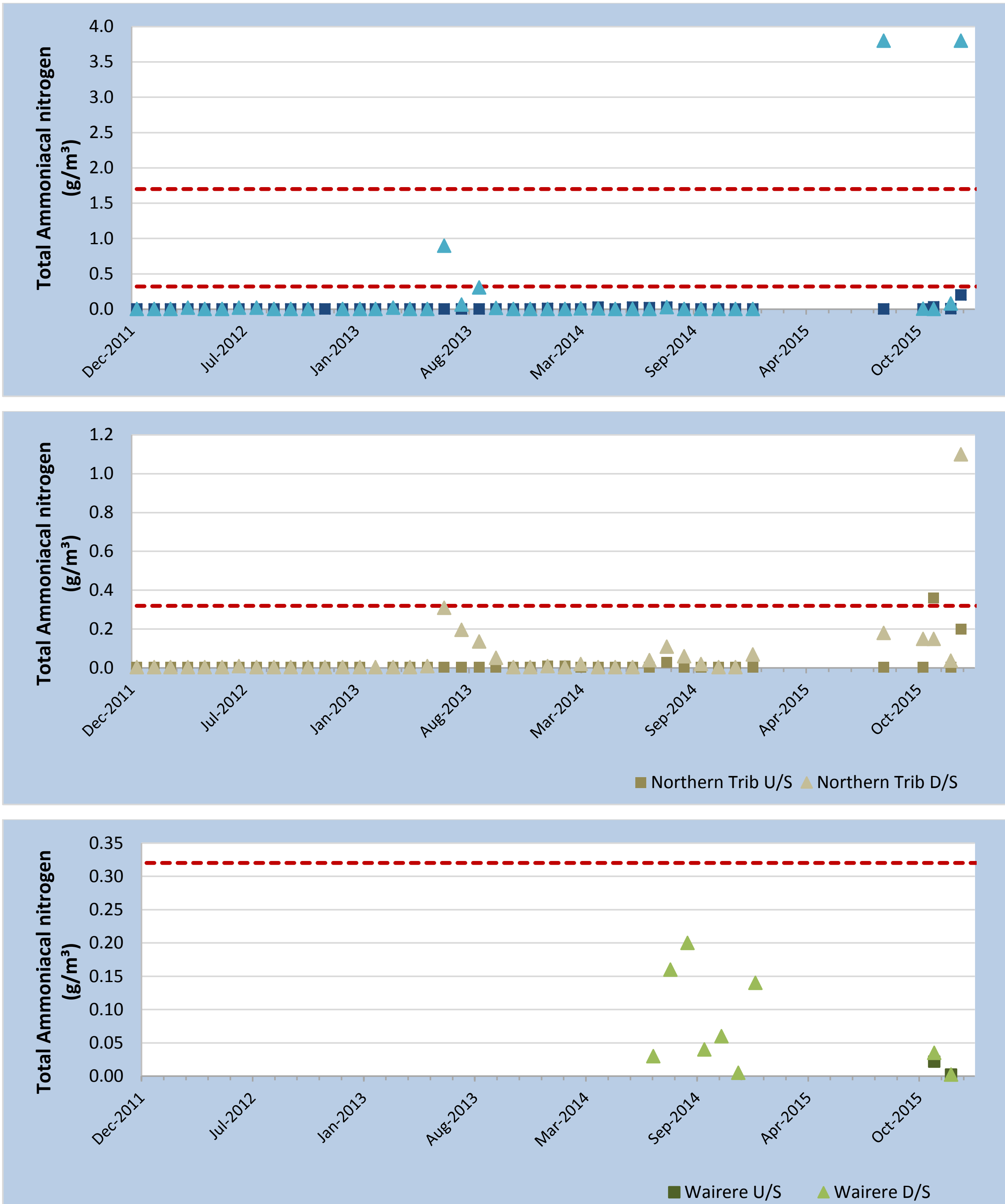


Figure 5: Total Ammoniacal Nitrogen concentrations at sites sampled in the A. Southern and B. Northern tributaries and C. Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets. Note: Ammoniacal-N scales differ on each figure above.

3.3. Soluble Inorganic Nitrogen (SIN) and Dissolved Reactive phosphorus (DRP)

3.3.1. One Plan targets

The One Plan defines the following targets in relation to dissolved nutrients:

- 0.006 mg/L for DRP, unless natural concentrations already exceed naturally; and
- 0.070 mg/L for SIN.

Both DRP and SIN targets are expressed as an annual average concentration at flows below the 20th FEP. No flow data are available for the Wairere Stream, thus a direct, complete assessment of compliance with these targets cannot be undertaken. The approach taken in this report is to compare overall annual average concentrations with the One Plan concentration targets.

It is important to note that, from a technical point of view, different One Plan Schedule E targets were defined for different reasons. In particular:

- Some of the targets directly relate to (i.e. are a measure of) the state of a given river value. For example, visual water clarity and periphyton cover directly relates to the aesthetic and recreational values of the river. Likewise, MCI provides a direct measure of the river's life-supporting capacity, and the change in QMCI provides a direct measure of the degree of effects of a specific activity on life supporting capacity;
- By contrast, other targets, such as DRP, SIN, $ScBOD_5$ or POM targets were defined as a means to control other factors that directly relate to management values (e.g. those listed above). Specifically it means that, from a technical point of view, in-stream nutrient (DRP and SIN) targets were defined in the One Plan primarily as a means to control periphyton rather than as an end by themselves.

3.3.2. SIN concentrations

Monitoring results indicate:

- <u>In the Southern Tributary</u>, an overall statistically significant increase in SIN concentration between upstream and downstream (Figure 6). The One Plan target is generally met upstream (apart maybe in 2015/2016) but exceeded downstream in 2013/2014 and 2015/2016. Interestingly, when considering individual sampling results (Figure 8A), it is apparent that upstream and downstream concentrations are comparable on the majority of sampling occasions, and that the increases in annual average concentrations are driven by a relatively small number of individual samples (particularly in 2016). This observation is consistent with the on/off nature of discharge to the soakage trenches;
- <u>In the Northern Tributary</u>, an overall statistically significant increase in SIN concentration between upstream and downstream (Figure 6). The One Plan target was exceeded at the upstream site on two of the four years on record, but exceeded on all four years on record at the downstream site. By contrast to the Southern Tributary, the overall increase in annual average concentrations appears to be driven by regular increases between upstream and downstream on most sampling occasions (Figure 8B). This is consistent with the more regular nature of the discharges to the irrigation fields.

- In the Wairere Stream, insufficient number of samples are available at the upstream Wairere Stream site to run any statistical comparison between the two sites. However, the SIN concentrations at the upstream site are expected (and this is supported by the two available samples) to be very low, at or below detection limits. By contrast, concentrations at the downstream site are generally moderately elevated. The One Plan target is likely to have been exceeded at the downstream site in 2014.

3.3.3. DRP concentrations

Monitoring results indicate:

- In the Southern Tributary, no apparent increase in the annual average concentrations measured at the upstream and downstream sites, apart from in 2015/2016. Overall there is no statistically significant difference in DRP concentration between upstream and downstream (Figure 7). The One Plan target is generally exceeded both upstream and downstream. When considering individual sampling results (Figure 9A), it is apparent that the increase in annual average concentrations in 2015/2016 is solely driven by two individual samples with high concentrations. This observation is consistent with the on/off nature of discharge to the soakage trenches;
- In the Northern Tributary, no apparent increase in the annual average concentrations measured at the upstream and downstream sites, apart from in 2015/2016 and, to a lesser extent, 2014/2015 (Figure 7). The One Plan target is generally exceeded both upstream and downstream, indicating that DRP is naturally present in moderately elevated concentrations in this stream. Similarly to the Southern Tributary, the overall increase in annual average concentration in 2015/2016 is driven by a couple of samples with high concentrations, on the same dates as those measured in the Southern Tributary (Figure 8B). It is plausible that the concentrations measured in the Northern Tributary were as a result of inputs from the Southern Tributary.
- In the Wairere Stream, the One Plan target was largely exceeded at the downstream site in 2014, with concentrations generally exceeding those measured in either tributaries during that same period. There are insufficient data at the upstream Wairere Stream site to run any statistical comparison between the two sites. However, given that no statistically significant increases in DRP concentrations were recorded in either tributary, and that concentrations in the Wairere Stream generally exceeded those measured in either tributary during that same period, it seems logical to conclude that the concentrations measured in the Wairere Stream are primarily a result of natural causes.

3.3.4. Nutrient ratios and likely nutrient limitation

Monitoring results for the Wairere Stream and tributaries consistently indicate:

- very low "background" (i.e. as measured at upstream sites) concentrations of SIN, often near or below detection limits;
- moderately elevated DRP "background" concentrations in all three streams , with annual average concentrations between 0.009 and 0.035 mg/L;
- Measurable and statistically significant increases in SIN concentrations at the downstream sites[5];
- Some possible but not statistically significant increase in DRP concentration in the tributaries (insufficient data in the Wairere Stream).

The natural supply of DRP and the low to very low SIN concentrations mean that periphyton growth in the Wairere Stream and its tributaries is likely to be naturally predominantly nitrogen-limited. These findings are consistent with those on other Central Plateau rivers, where phosphorus has been found to be naturally abundant (e.g. Aquanet 2015). This means that, provided other conditions are favourable to periphyton growth, inputs of SIN into these streams will pose a greater risk of increasing periphyton growth than inputs of DRP.

The increases in SIN concentrations caused by the discharge at the downstream sites mean that there is likely to be a risk of increased periphyton growth at these sites. The actual growth of periphyton at the different monitoring sites is discussed later in this report. It also means that measured increases in periphyton growth are likely to be associated with SIN, rather than DRP inputs from the WWTP, and that reductions in SIN inputs into the streams should constitute the primary management target should excessive periphyton growths be measured at the downstream sites.

[5] Noting that insufficient number of samples are available at the upstream Wairere Stream site to run any statistical analysis. However, the SIN concentrations at the upstream site are expected (and this is supported by the two available samples) to be very low, at or below detection limits.

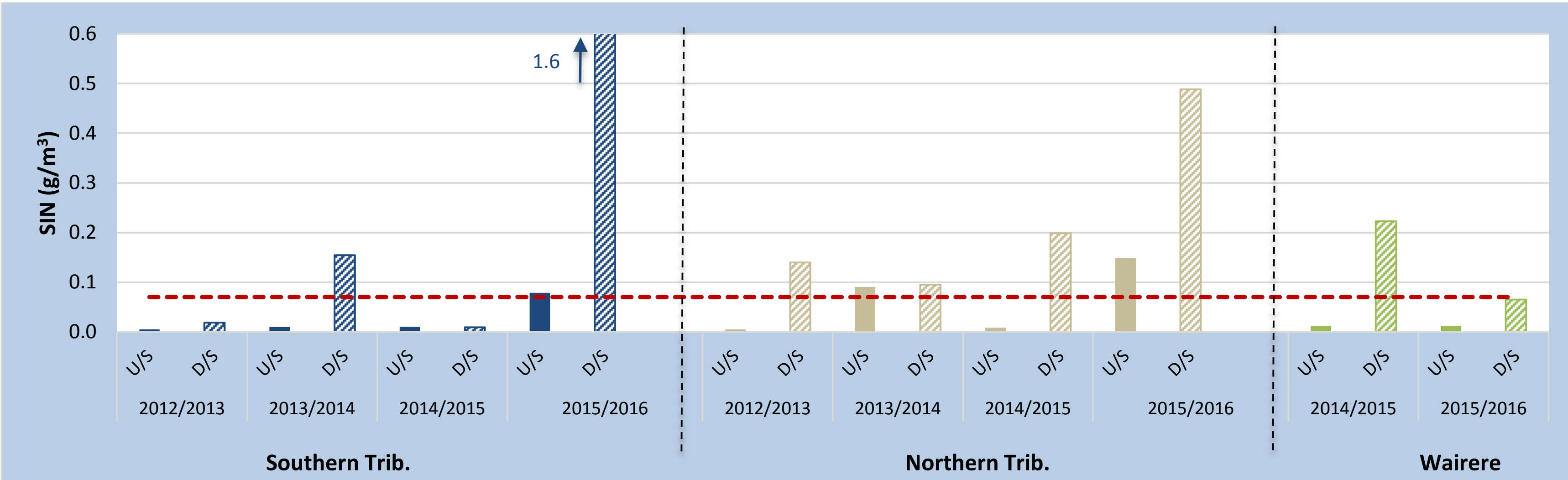


Figure 6: Annual average Soluble Inorganic Nitrogen (SIN) concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

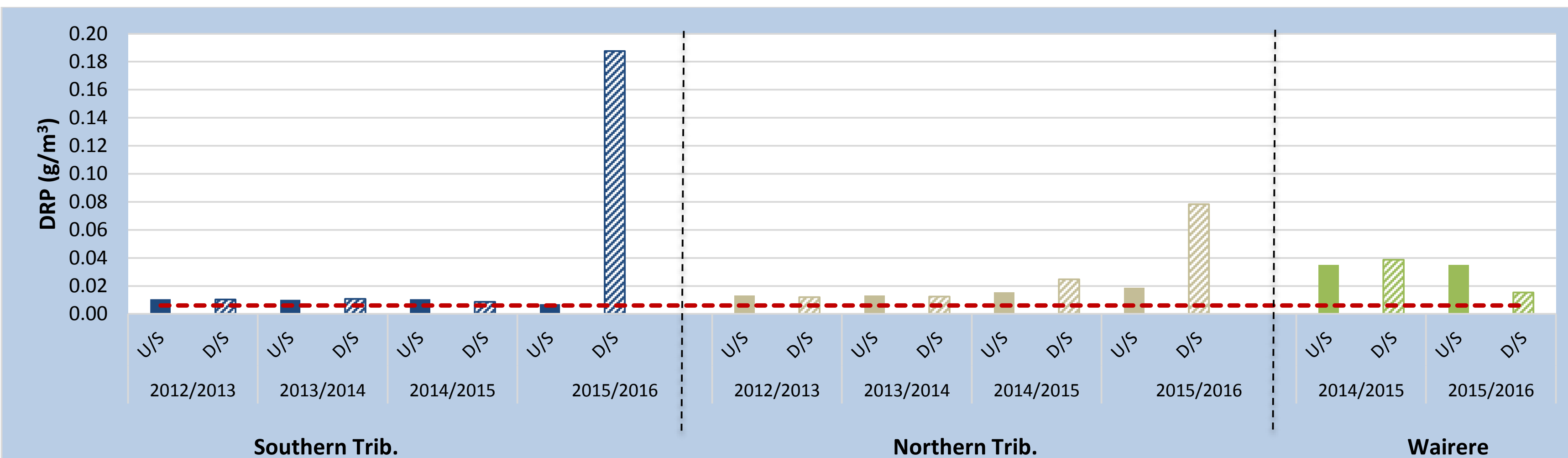


Figure 7: Annual average Dissolved Reactive Phosphorus (DRP) concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

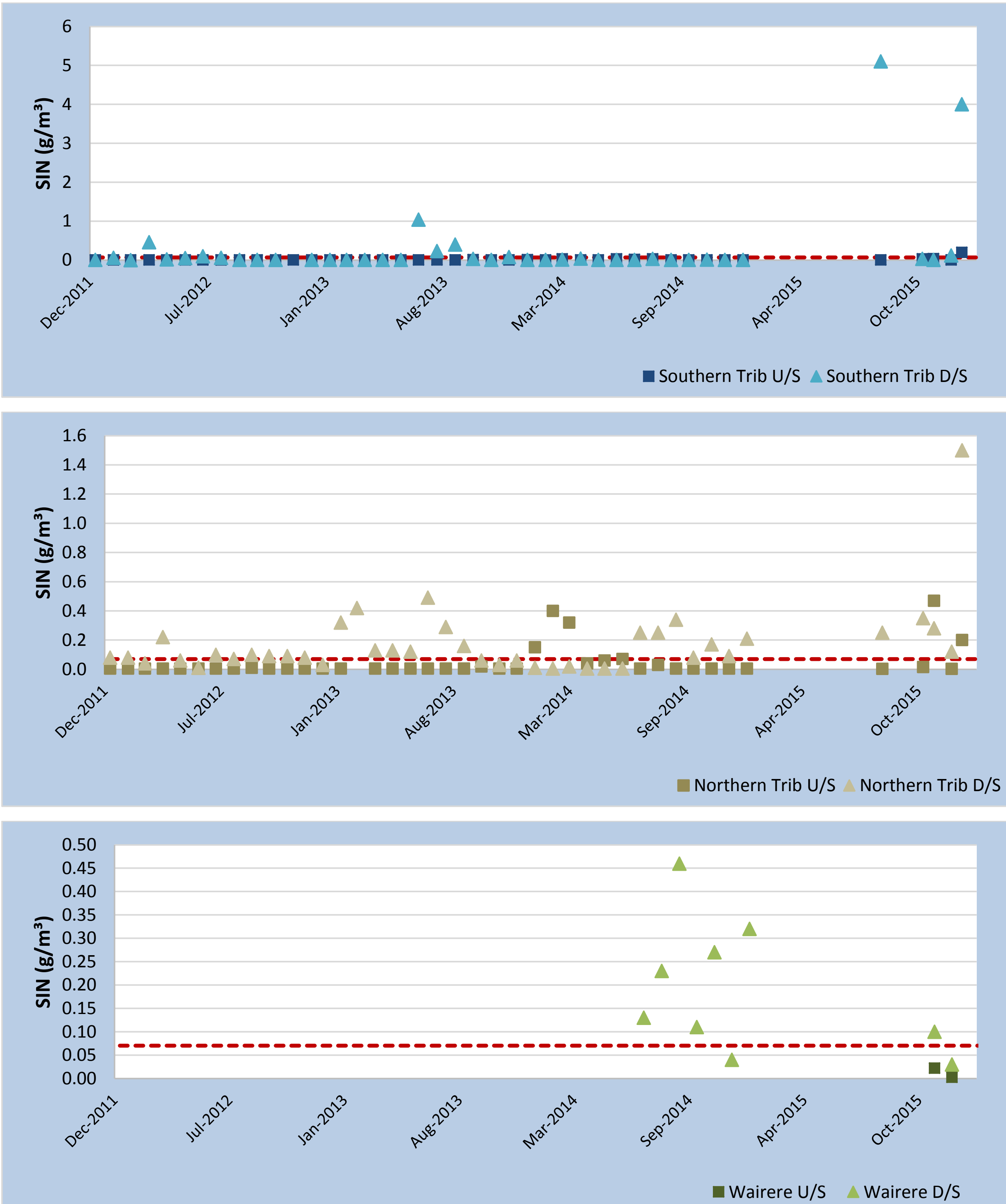


Figure 8: Soluble Inorganic Nitrogen (SIN) concentrations at sites sampled in the A. Southern and B. Northern tributaries and C. Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets. Note: SIN scales differ on each figure above.

Figure 9: Dissolved reactive Phosphorus (DRP) concentrations at sites sampled in the A. Southern and B. Northern tributaries and C. Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets. Note: DRP scales differ on each figure above.

3.4. Total Suspended Solids

Monitoring results do not indicate any material or statistically significant change in Total Suspended Solids (TSS) between upstream and downstream in either the Southern or the Northern Tributaries. There are insufficient data to draw a firm conclusion on effects on the Wairere Stream, but the lack of measurable effects on the tributaries provides a good indication that the same conclusion is probably valid for the Wairere Stream.

Although the effects on water clarity or colour are not directly measured, the lack of measurable effects on TSS concentrations provides an indication that these are likely to be no more than minor.

3.5. Biochemical Oxygen Demand (BOD)

The One Plan defines a five-day Soluble Carbonaceous BOD ($ScBOD_5$) concentration target of no more than 2 mg/L, defined as an average concentration at flows below the median flow. This target was set as a means of controlling the growth of heterotrophic assemblages on the stream bed, commonly known as “sewage fungus”.

As already commented in this report, no flow data are available for the Wairere Stream or its tributaries, thus compliance with this target cannot be directly assessed. Further, the One Plan target relates to the soluble fraction of the total carbonaceous BOD_5, whilst monitoring results are available as total BOD_5; in other words monitoring results are likely to overestimate actual concentrations of $ScBOD_5$.

With these limitations in mind, monitoring results indicate low “background” (i.e. upstream) BOD_5 concentrations, generally at or below the detection limits, and a significant increase in BOD_5 concentrations in the Southern, but not the Northern Tributary.

Overall average concentrations are well below One Plan target at the downstream sites on the Northern Tributary and the Wairere Stream, but in excess of 2 mg/L in the Southern tributary. In spite of these relatively elevated BOD_5 concentrations, no visible growths of sewage fungus were observed in the Southern Tributary.

3.6. Water pH, temperature and dissolved oxygen (DO)

In the Northern Tributary, monitoring results do not indicate any material or statistically significant change in water pH, temperature or DO between upstream and downstream sites.

The One Plan targets relative temperature (maximum of 19°C) and DO (80% saturation) were met at both sites. The water pH (6.1 to 7.4) was outside the range prescribed in the One Plan target (a range7 to 8.2), but that occurred at both sites with no difference in the degree of compliance with the target. A slightly acidic water is consistent with the local volcanic acidic geology.

In the Southern Tributary, there were significant differences in water pH between upstream and downstream. Similarly to the Northern Tributary, the measured pH range sat outside the One Plan target, but to the same degree at both sites.

There was a small, but statistically significant increase in water temperature in the Southern Tributary downstream compared with upstream, although this is based on a limited number of samples (7 samples collected in August 2015 to February 2016). It appears unlikely that the discharge from the trenches would be the cause of this apparent increase.

There was no difference in DO between upstream and downstream, and the One Plan target (80% saturation) was met at both sites.

4. Results - Ecological monitoring

Ecological monitoring for macroinvertebrates and/or periphyton is required by the current consent for the Whakapapa WWTP discharge.

Assessment of periphyton (percentage cover, biomass, Chlorophyll *a,* AFDW and community composition) was also required under consent conditions at 4 sites during the months of February, May, August and October (regardless of flows) during the first two years of the consent (2012 and 2013). Additional periphyton monitoring was undertaken by the Catalyst Group in 2014 (at the 4 sites required by the consent) and by Aquanet since October 2015 (at the 4 sites required by the consent, plus the upstream and downstream sites on the Wairere Stream).

Macroinvertebrates are required to be sampled at 4 sites, once annually between August and October (inclusive) during a period of at least three weeks without a significant flood event (defined as an instantaneous river flow exceeding 9.063 m^3/sec as recorded at the Genesis Energy flow site - Whakapapa at Footbridge).

4.1. Periphyton Communities

Periphyton is the brown or green slime coating on stones, wood or any other stable surfaces in streams and rivers. In some situations, it can proliferate to form thick mats of green or brown filaments on the river bed degrading the aesthetic and recreational qualities of the river. Periphyton growth is generally controlled by a number of physical (e.g. river flow, sunlight, temperature), chemical (e.g. bioavailable nutrient concentration – DRP and SIN) and biological (e.g. grazing by invertebrates) phenomena.

4.1.1. Data

Monitoring of periphyton biomass and cover has been undertaken:

- annually during the months of February, May, August and October in 2012 and 2013 at four sites (upstream and downstream on both the Southern and Northern Tributaries), as required by conditions of consent (monitoring by DOC)
- Monthly (excluding January 2015) from November 2014 to March 2015 at four sites (upstream and downstream on both the Southern and Northern Tributaries) (monitoring by the Catalyst Group); and
- Monthly since October 2015 at 6 sites, i.e. the four sites previously monitored by DOC, plus upstream and downstream on the Wairere Stream (monitoring by Aquanet).

A summary of the periphyton communities visually assessed at each site is presented in Appendix E.

4.1.2. One Plan targets

The One Plan defines the following targets in relation to periphyton:

- a periphyton <u>biomass</u> target of 50 mg Chlorophyll *a* /m^2. It is important to note that the technical report supporting the development of the Schedule E targets noted that this level of periphyton biomass is very stringent and that compliance with this target should be based on 80% of monthly samples (i.e. up to two monthly samples exceeding the target per year is acceptable (Ausseil and Clark, 2007a, p66);

- A periphyton cover by long (>2cm) filamentous algae of 30% of the visible stream bed;
- A periphyton cover by thick (>3mm) cyanobacteria or diatom mats of 60% of the visible stream bed.

The One Plan Schedule E and the technical report supporting its development are silent on the appropriate level of compliance that should be applied to the periphyton cover targets. A 95% compliance level has been applied in this report.

4.1.3. Data limitations

It is relevant to note that the physical characteristics of the upstream and downstream sites on the Southern and Northern tributaries are not fully comparable. For example, the upstream site on the Southern Tributary is relatively wide and open to sunlight, whilst the downstream site is very incised and much more shaded. This may affect how some of the effects of the discharge are expressed on ecological indicators. For example, effects on periphyton at the Southern Tributary downstream site may be less than they would otherwise have been had the site been wider and less shaded. However, these monitoring sites were set by consent conditions and were used in previous monitoring, and it was considered preferable to maintain them for consistency of the datasets overtime. More importantly, pretty much all of the reach of the Southern Tributary downstream of the soakage trenches is similarly deeply incised and shade – in other words the monitoring site is representative of this reach of the Southern tributary. The same comments apply to the Northern tributary.

An assessment of the available periphyton biomass data against the NPSFM (2014) Attribute for Trophic State (periphyton) was considered for inclusion in this report. However, the NPSFM indicates that at least three years of monthly data are required to undertake such assessment. The data available (8 individual sampling occasions spread over a period of 15 months) falls well short of these requirements; accordingly the assessment could not be undertaken.

Visual assessments prior to October 2015, undertaken by both DOC and the Catalyst Group did not differentiate between thin and thick diatom mats, nor between short and long filamentous algae, preventing a direct assessment against the One Plan periphyton cover targets when the target is apparently exceeded. Basically when the periphyton cover was reported to be less than the target, one can conclude that the target was met, but the converse is not true: when the cover was reported as exceeding the target, it only means that the target might have been exceeded.

We also note that in the report produced by the Catalyst Group, the periphyton cover category “sludge” was added to the “mats” category for comparison with the One Plan target for “thick mats”. In our view the One Plan target very specifically refers to cyanobacteria or diatom mats which are very distinct from the “sludge” typically observed in streams in this area during periods of low/stable flow, which is generally constituted of a loose matrix inorganic of iron/manganese and organic/bacterial flocs. In our opinion, whilst the “sludge” category is ecologically and visually/aesthetically relevant in its own right, it is not appropriate to include it into the “thick mats” category for assessment against the One Plan targets.

We also note that the Chlorophyll *a* results for the February sampling run were not available from the laboratory at the time of writing; however relatively low biomass is expected at all sites based on visual observations.

4.1.4. Periphyton biomass

Monitoring results (Figure 10) indicate that:

- In the Southern Tributary, the periphyton biomass was always relatively low at the upstream site, well below the One Plan target (max 22 mg/m^2). Biomass upstream and downstream were generally comparable in 2014 and October 2015, but material increases occurred in November and December 2015 and January 2016. The One Plan target of 50 mg/m^2 was exceeded once at the downstream site. Overall, one out of 8 samples (12.5%) exceeded the target at the downstream site, which tends to indicate that the target is met overall when assessed at the 80% compliance level (Table 6), although the strength of this conclusion is limited by the small number of samples;
- In the Northern Tributary, the periphyton biomass was always relatively low at the upstream site, except in November 2015 when it just exceeded the One Plan target. At the downstream site, the biomass was generally materially higher than at the upstream site, but also exceeded the target only once. However, the measured biomass was only very marginally under the target on two other occasions (October and November 2015). Overall, the data available indicates that the upstream site meets the One Plan target overall (at the 80% compliance level), although occasional exceedances do occur at that site, and it is uncertain whether the downstream site does or does not meet the target, the assessment being limited by the small number of samples available, and very marginal compliance on two occasions (Table 6);
- In the Wairere Stream, only a very limited number of samples are available (3 pairs of upstream/downstream samples). Periphyton biomass was always low upstream. At the downstream site, the biomass increased compared with upstream on all three sampling occasions, but remained low, well below the One Plan target (maximum of 16 mg/m^2). Overall, the very limited data available point to both sites meeting the One Plan target (Table 6).

4.1.1. Periphyton cover (thick cyanobacteria or diatom mats)

Monitoring results indicate that:

- In the Southern Tributary, the cover by thick mats was always below the One Plan target at both the upstream and downstream sites. Mat cover upstream and downstream were generally comparable in 2014 and to March 2015, but material increases occurred in October, November and December 2015, with two observation over 40% cover;
- in the Northern Tributary, the cover by thick mats was always well below the One Plan target at both sites, with no consistent pattern of increase or decrease between the two sites;
- In the Wairere Stream, the cover by thick mats was generally very low or absent at both sites, except at the downstream site in March and December 2015. All observations at both sites met the One Plan target.

4.1.2. Periphyton cover (long filamentous algae)

Monitoring results indicate that:

- In the southern tributary, the cover by long filamentous algae mats was always low, well below the One Plan target at both the upstream and downstream sites. The highest covers (only c. 5%) were observed at the upstream site in October 2015 and January 2016;
- In the Northern tributary, the cover by long filamentous algae was always very low, well below the One Plan target at the upstream site. Material increases occurred in November 2014 (just below the target) and October 2015 (more than twice the target). Overall, the upstream site easily complies with the One Plan target. At the downstream site, one out of 18 observations (5.5%) exceeded the target, i.e. the site currently just "sits" on the target (assessed at the 95% compliance level). Additional observations would be required in order to conclude with some degree of certainty whether the One Plan target is, or not, met at this site overall.
- In the Wairere Stream, the cover by long filamentous algae was generally low at both sites, except at the downstream site in March 2015, where it reached just under half the target. All observations at both sites met the One Plan target.

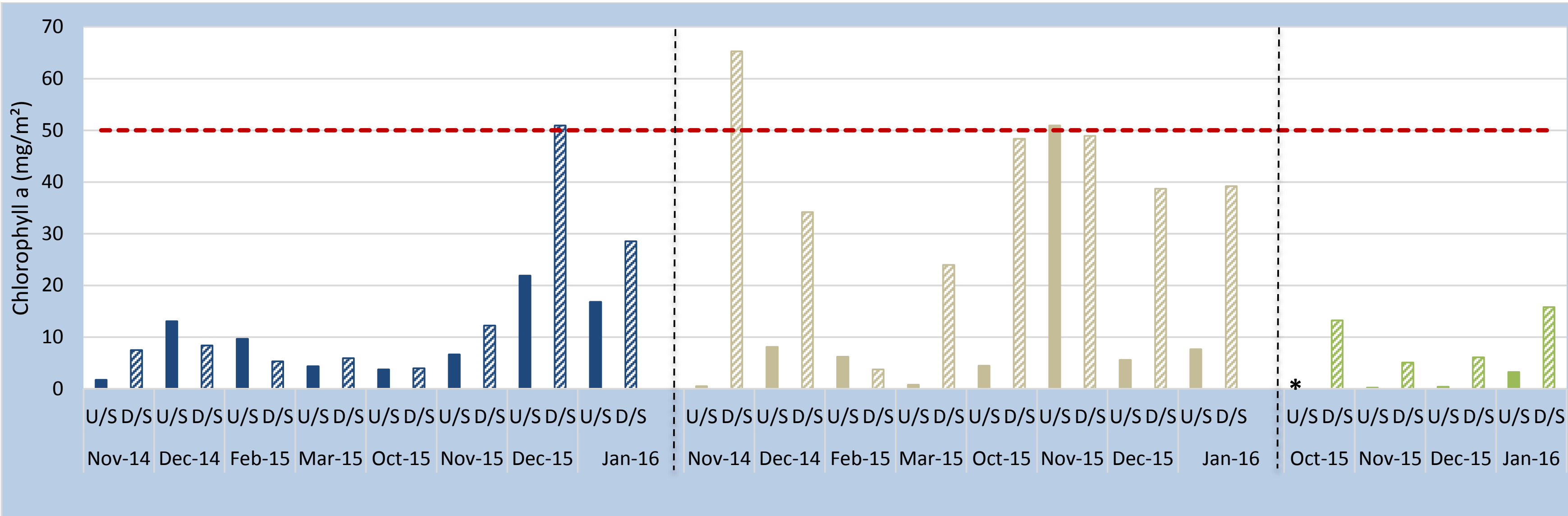


Figure 10: Mean periphyton biomass, measured as Chlorophyll *a* (mg/m^2) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP. * indicates no visual assessment undertaken.

Table 6: Summary of 80th percentile data for periphyton biomass measured as Chlorophyll *a* (mg/m^2) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP. Compliance with the One Plan target is also shown. Note that compliance with the One Plan target at the Northern Trib downstream site is uncertain.

	Southern Trib.		Northern Trib.		Wairere	
	U/S	D/S	U/S	D/S	U/S	D/S
No. of samples	8	8	8	8	3	4
80th percentile	15.3	22.0	7.9	48.7	2.1	14.3
One Plan target	50					
OP compliance?	√	√	√	√?	√	√

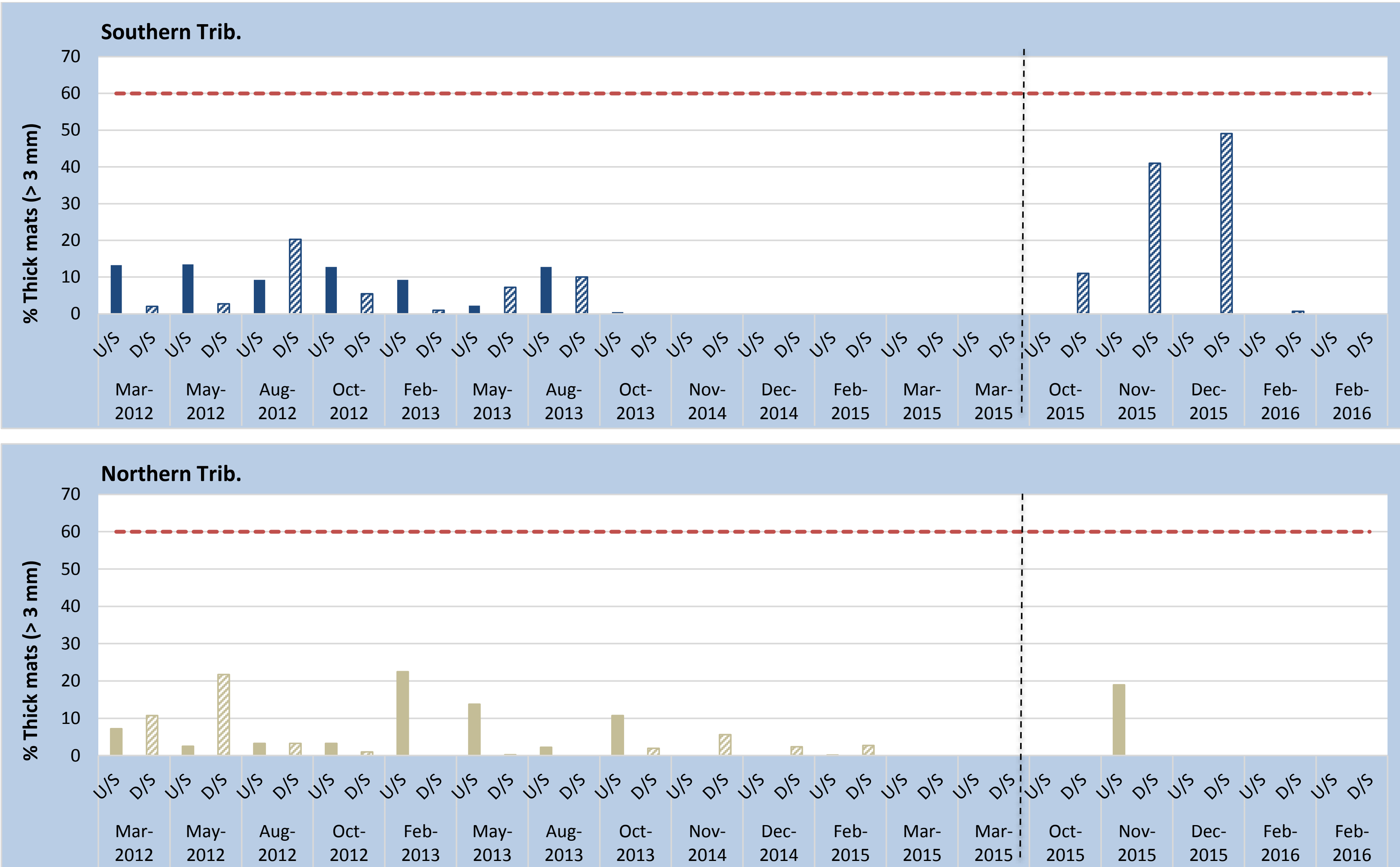


Figure 11: Percentage of substrate covered by Total diatom mats (March 2012-March 2015) and Thick diatom mats (October 2015 – February 2016) visually assessed at sites upstream and downstream on the Southern (upper) and Northern (lower) tributaries of the Wairere Stream. Red lines indicate the One Plan target applicable for thick diatom mats (> 3mm).

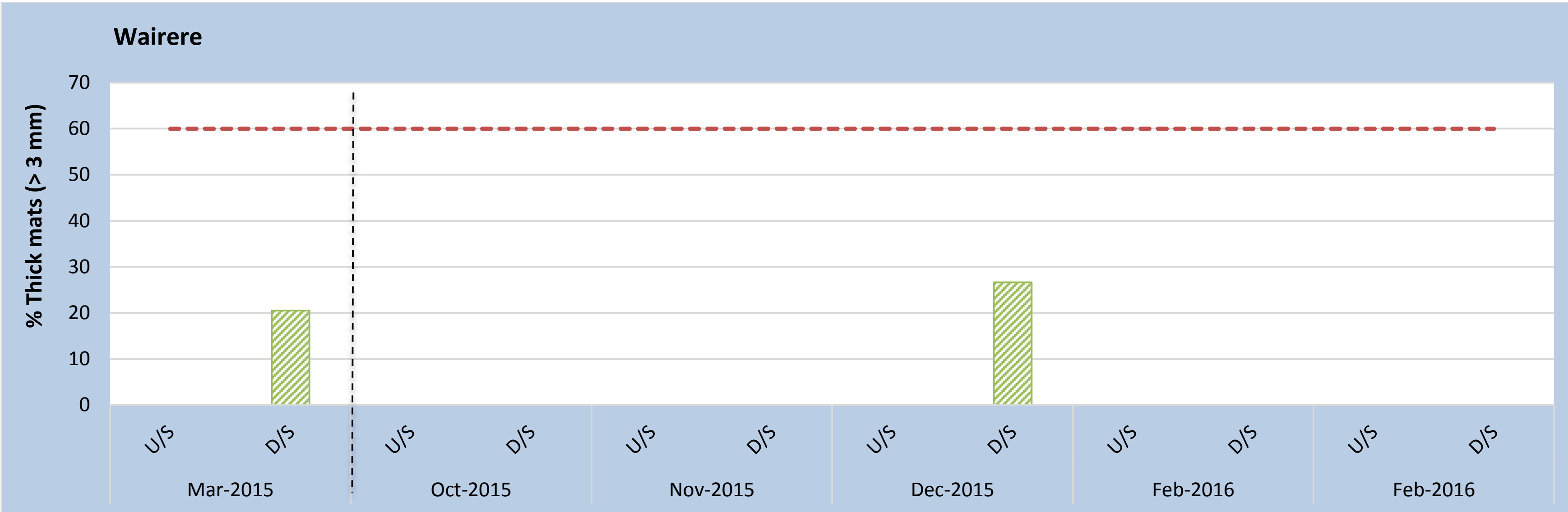
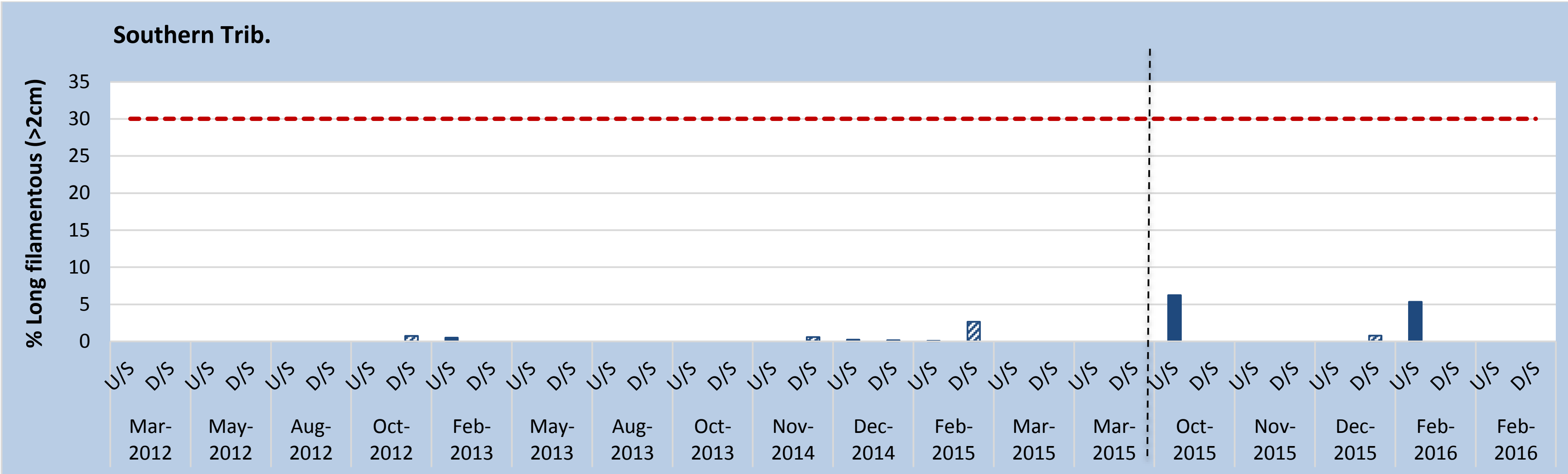


Figure 12: Percentage of substrate covered by Total diatom mats (March 2012) and Thick diatom mats (October 2015 – February 2016) visually assessed at sites upstream and downstream on the Wairere Stream, mainstem. Red lines indicate the One Plan target applicable for thick diatom mats (> 3mm).



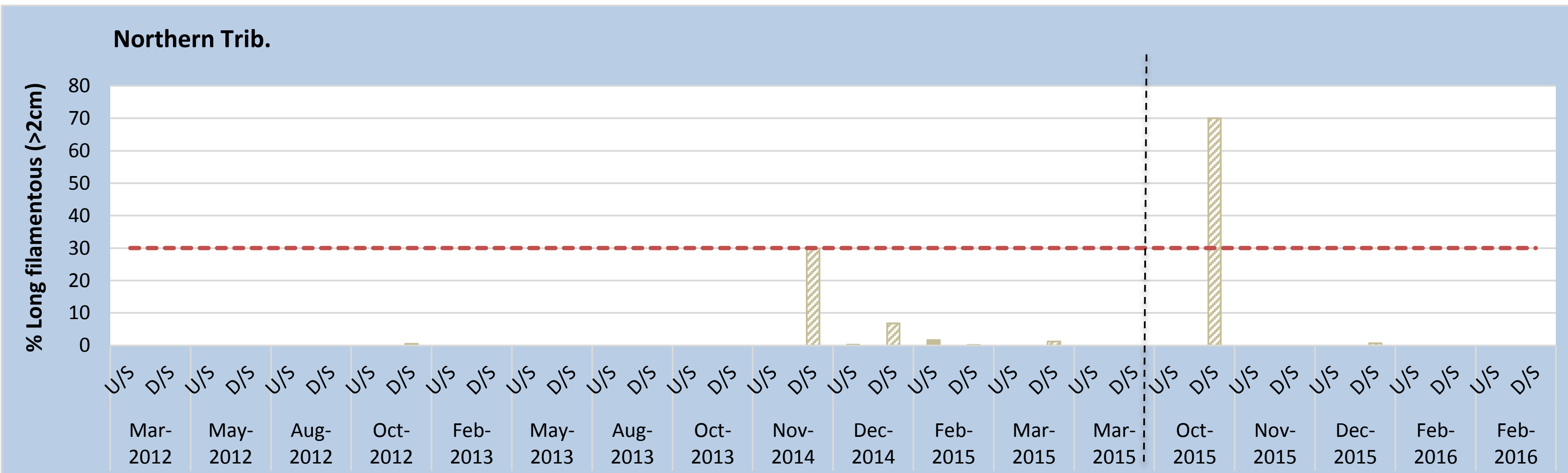


Figure 13: Percentage of substrate covered by Total filamentous algae (March 2012-March 2015) and Long filamentous algae (October 2015 – February 2016) visually assessed at sites upstream and downstream on the Southern (upper) and Northern (lower) tributaries of the Wairere Stream. Red lines indicate the One Plan target applicable for long filamentous algae (>2 cm).

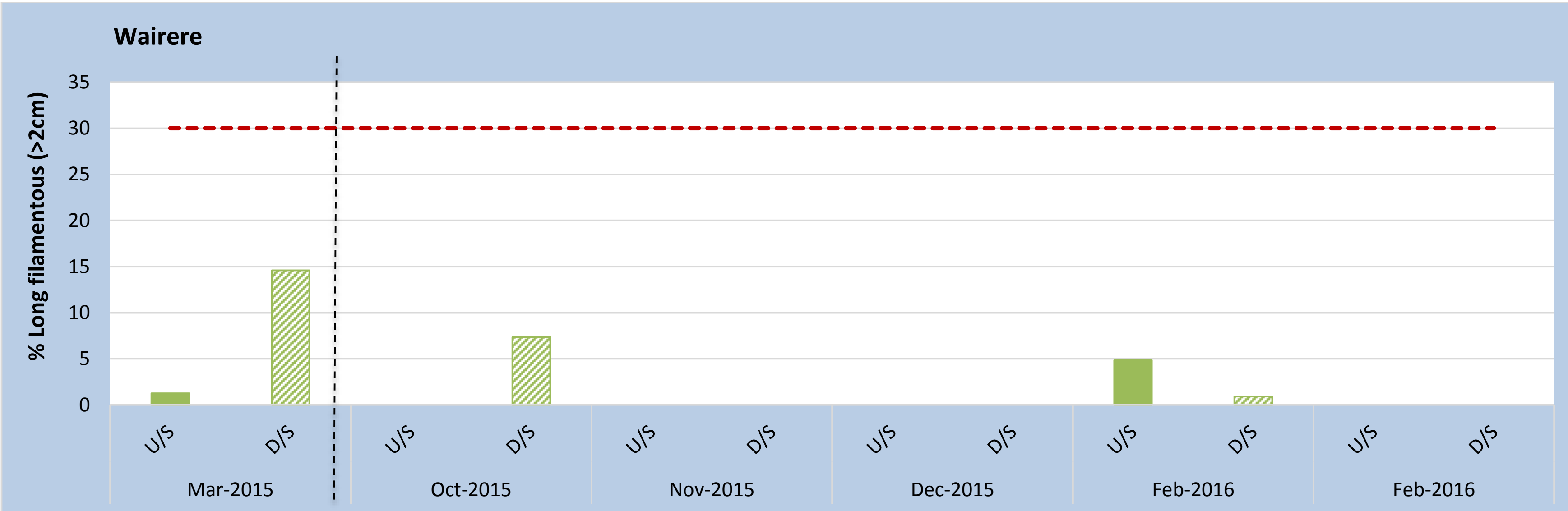


Figure 14: Percentage of substrate covered by Total filamentous algae (March 2015) and Long filamentous algae (October 2015 – February 2016) visually assessed at sites upstream and downstream on the Wairere Stream, mainstem. Red lines indicate the One Plan target applicable for long filamentous algae (>2 cm).

4.2. Macroinvertebrate Communities

Annual surveys of macroinvertebrate communities in relation to the Whakapapa WWTP have been undertaken at four sites on the Southern and Northern Tributaries of the Wairere Stream between 2012 and 2014 (DOC / Catalyst Group) and at six sites and on the Southern and Northern Tributaries and Wairere Stream mainstem (shown in Figure 1) on 16th October 2015 (Aquanet Consulting Ltd).

Macroinvertebrates are good indicators of water quality as they show a wide range of responses depending on their degree of sensitivity to pollution. For example, some taxa such as Gastropoda and Chironomidae are generally considered to be tolerant of poor quality water, while others such as Ephemeroptera and Plecoptera prefer good water quality. The macroinvertebrate community at a given site may be considered a result of the prevailing water quality at that site. Consequently, macroinvertebrates are used widely both in New Zealand (Stark 1985, Winterbourn 1999) and overseas (Rosenberg and Resh 1993, Hynes 1994) as indicators of water quality.

Biological indices can be calculated to assess relationships between macroinvertebrate communities and water quality at a study site. The Macroinvertebrate Community Index (**MCI**) (Stark 1985) considers the presence of macroinvertebrates based on an assigned score which is dependent on their tolerance to pollution (1= highly tolerant, 10 = highly sensitive). The Quantitative Macroinvertebrate Community Index (**QMCI**) is similar to the MCI, but also takes into account the number of individuals of each species collected. Ephemeroptera, Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies) (EPT) consist of insects which are generally sensitive to pollution. The percentage of **EPT taxa** is the proportion of all taxa collected that belong to one of these groups. The percentage of **EPT individuals** measures the proportion of the individual macroinvertebrates collected that are mayflies, stoneflies and caddisflies.

Values for the biotic indices discussed above indicative of various water quality categories are given in Table 7.

Table 7: Interpretation of MCI and QMCI values after values from Stark & Maxted (2007) for soft bottom streams.

Interpretation	MCI	QMCI
Excellent / Clean water	> 119	> 5.9
Good / Possible mild pollution	100 -119	5 – 5.9
Fair / Probable moderate pollution	80 - 99	4 – 4.9
Poor / Probable severe pollution	< 80	< 4

The One Plan (Dec 2014 Operative Version) requires that there should be no more than a 20% reduction in QMCI between upstream and downstream of a discharge to water and sets an MCI “State of the Environment” target of 120 for the Upper Whakapapa Sub-Management Zone, Whai_2b. These targets have been used in this report to provide some context around the scale of effects from the discharge.

Comparisons of biotic index scores over the years are presented in Figure 15 to Figure 17 and Table 8.

The One Plan "State of the Environment" target for MCI for the Upper Whakapapa sub-management zone (Whai_2b) of 120 was not met at the upstream or downstream sites on the Southern and Northern Tributaries between 2012 and 2014. It was however met in 2015 at the downstream site on the Southern Tributary, at the upstream site on the Northern Tributary, and at both sites on the Wairere Stream mainstem. An MCI score of 120 or more is indicative of "Excellent/clean water".

Number of Individuals and Number of Taxa (Figure 15) showed no significant differences between upstream and downstream sites on the Southern Tributary in any year. There were however, significant differences between upstream and downstream sites on the Northern Tributary for Number of Individuals in 2013 (decrease from upstream to downstream) and 2015 (increase from upstream to downstream); and in Number of Taxa in 2014 (decrease from upstream to downstream). No differences were observed between upstream and downstream sites on the Wairere mainstem in 2015.

%EPT Individuals (Figure 16) showed no significant differences between upstream and downstream sites on the Southern Tributary in any year. On the Northern Tributary however, there were significant differences between upstream and downstream sites in 2013 (increased), 2014 and 2015 (decreases). Significant increases in %EPT individuals were observed between upstream and downstream sites on the Wairere mainstem in 2015.

%EPT Taxa also showed no significant differences between upstream and downstream sites on the Southern Tributary in any year. However, on the Northern Tributary there were significant increases in 2013 and 2015. No differences were observed between upstream and downstream sites on the Wairere mainstem in 2015.

Table 8: Summary of annual biotic indices for upstream and downstream sites on the Southern and Northern Tributaries and the Wairere Stream mainstem, 2012-2015.

	Southern Tributary							
	2012		2013		2014		2015	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Number of Individuals	24	63	96	98	12	17	10	9
Number of Taxa	8	9	10	9	7	7	65	68
%EPT Individuals	32	43	34	46	39	31	21	59
%EPT Taxa	26	25	25	21	47	34	46	59
MCI	104	117	103	111	105	93	107	122
QMCI	4.24	4.12	4.27	3.56	4.97	4.31	4.03	5.52
% Change in QMCI	*-2.9*		*-16.7*		*-13.3*		*36.8*	

	Northern Tributary							
	2012		2013		2014		2015	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Number of Individuals	89	89	79	35	33	27	11	14
Number of Taxa	12	12	7	9	10	4	64	201
%EPT Individuals	50	50	30	49	53	10	57	34
%EPT Taxa	70	48	7	51	45	27	46	55
MCI	116	116	104	111	113	87	121	118
QMCI	5.42	5.42	2.95	5.58	5.65	3.42	6.11	4.72
% Change in QMCI	*0.0*		*88.9*		*-39.4*		*-22.8*	

	Wairere Stream							
	2012		2013		2014		2015	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Number of Individuals	No data						30	56
Number of Taxa	No data						7	8
%EPT Individuals	No data						46	55
%EPT Taxa	No data						51	55
MCI	No data						128	131
QMCI	No data						6.83	6.16
% Change in QMCI							*-9.9*	

The only significant change in MCI score (Figure 17) between upstream and downstream sites occurred on the Northern Tributary in 2014 (decreased) and on the Wairere Stream in 2015 (increased). MCI scores are indicative of indicate of moderate to good water quality in the Southern and Northern Tributaries and Excellent/clean water quality in the Wairere Stream mainstem.

The relevant One Plan target for QMCI (no more than a 20% reduction) was met in the Southern Tributary in all years (Table 9). In fact a significant increase between upstream and downstream was observed in 2015. The One Plan QMCI target was however nominally breached in the Northern Tributary in 2014 (with a 39% decrease from upstream to downstream) and again in 2015 (23% decrease from upstream to downstream). The One Plan target for QMCI (no more than a 20% reduction) was complied with in the Wairere Stream in 2015.

Table 9: Percent change in QMCI scores between upstream and downstream sites on the Southern and Northern tributaries and the Wairere Stream mainstem, 2012-2015. Significant differences are indicated in red.

% change in QMCI	2012	2013	2014	2015
Southern Tributary	-2.87	-16.66	-13.31	36.85
Northern Tributary	0.00	88.89	-39.44	-22.79
Wairere Stream	No data	No data	No data	-10

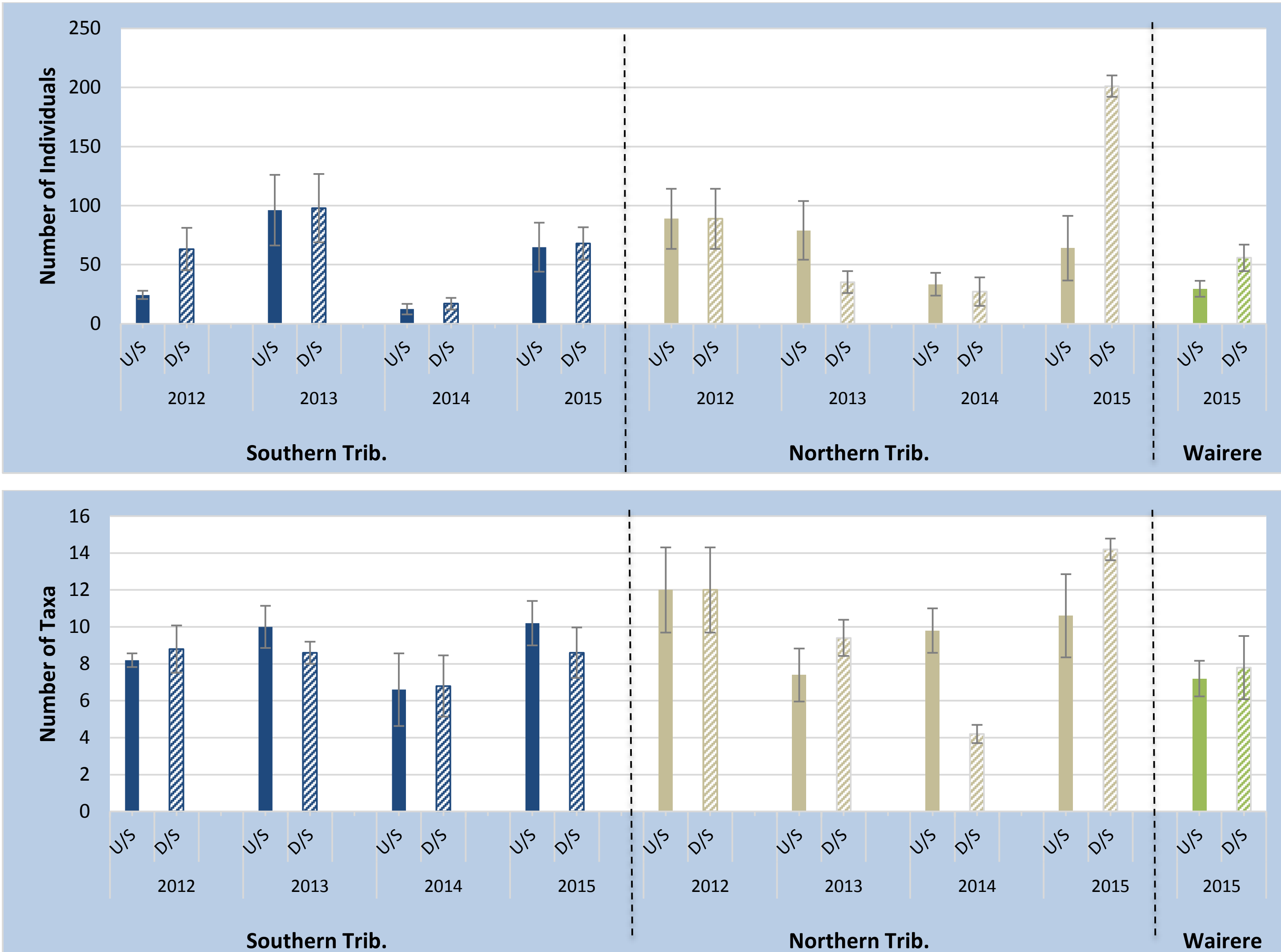


Figure 15: Mean (± 1 SE) Number of Individuals (upper) and Number of Taxa (lower) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP.

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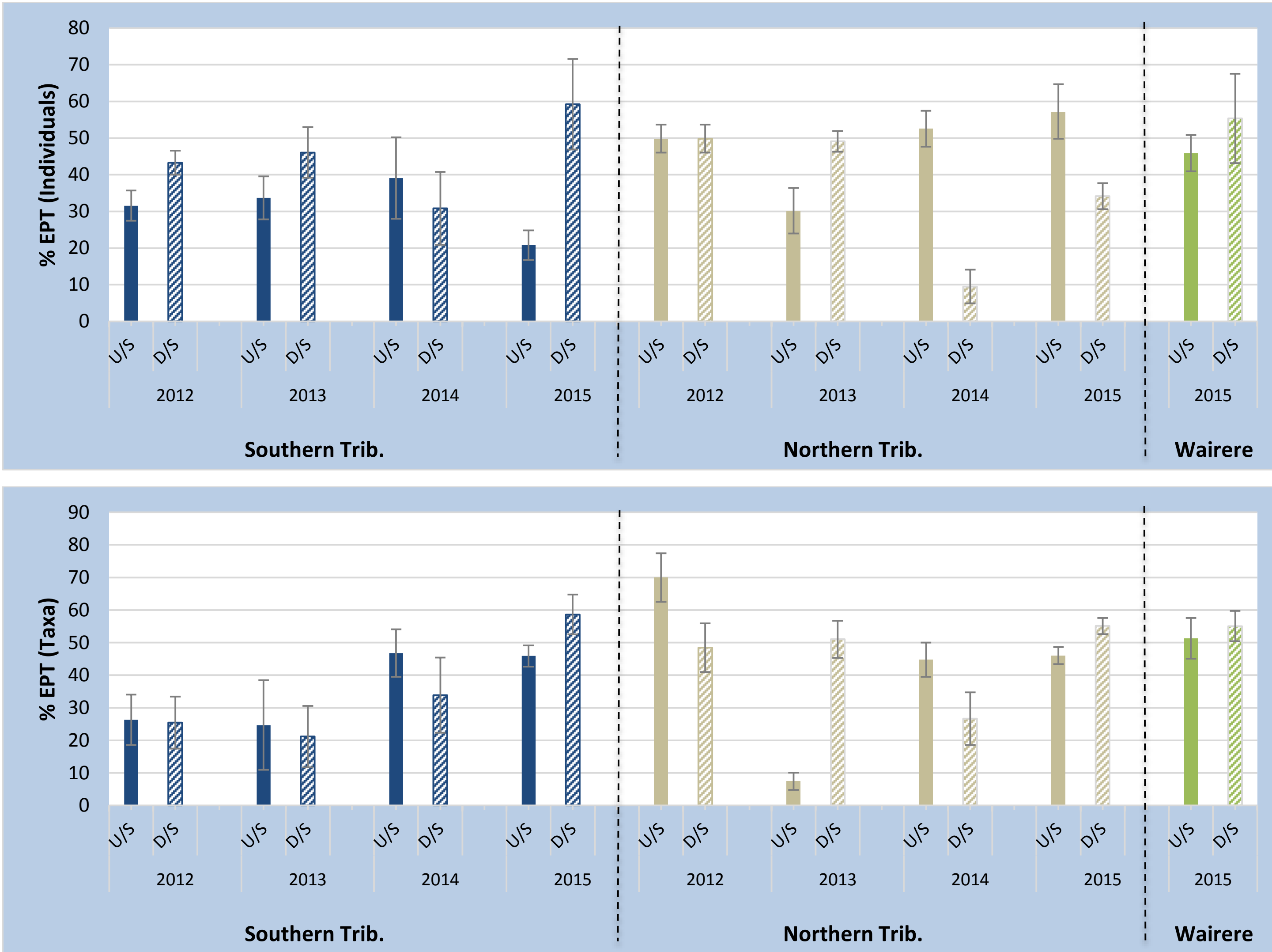

Figure 16: Mean (± 1 SE) %EPT (Individuals) (upper) and %EPT (Taxa) (lower) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP.

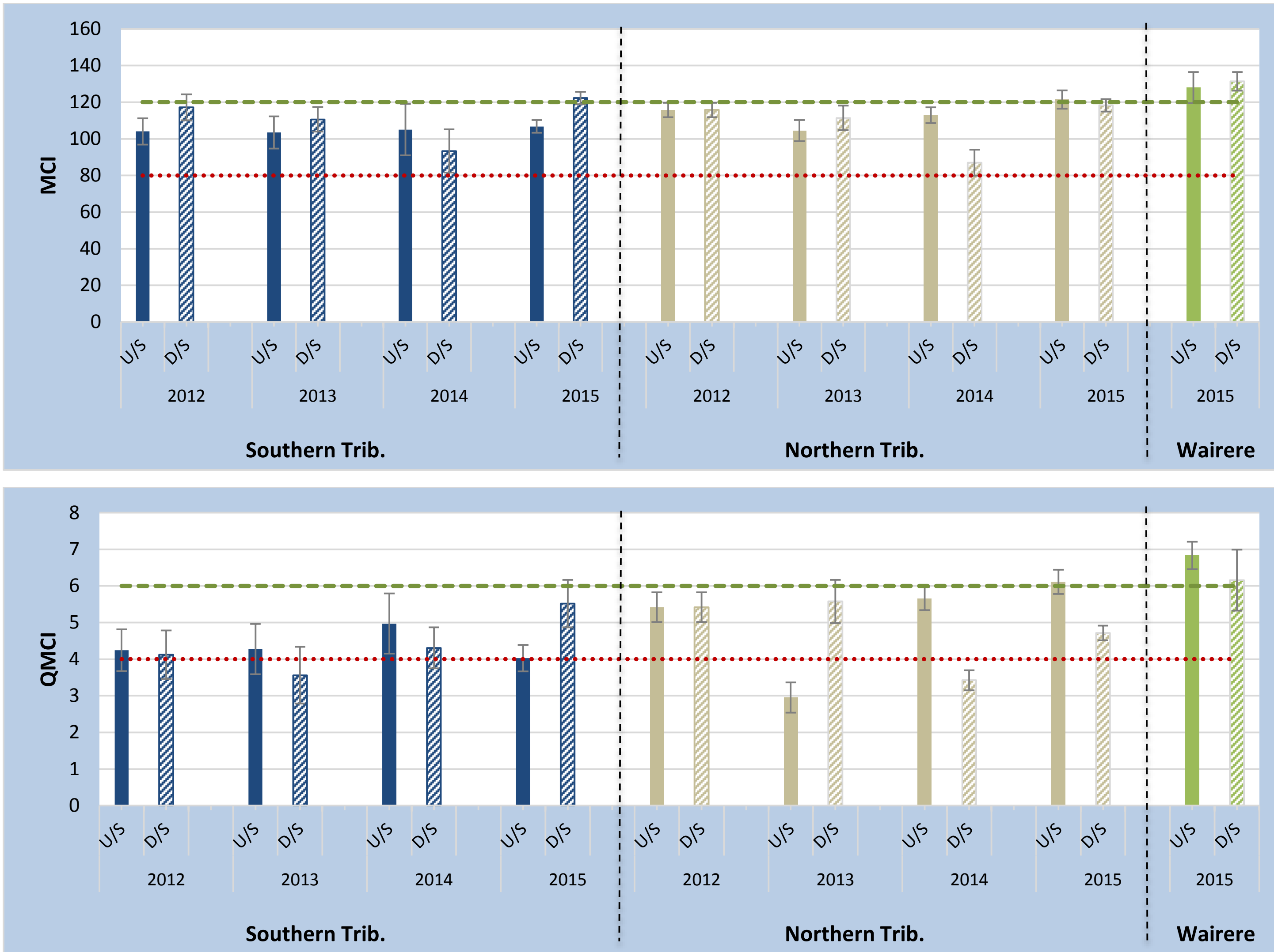

Figure 17: Mean (± 1 SE) MCI (upper) and QMCI (lower) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP.

Equivalence Testing

Equivalence Testing of the 2015 QMCI results showed the observed difference in average QMCI values between upstream and downstream sites on the Northern Tributary (1.4) and between upstream and downstream sites on the Southern Tributary (-1.5) to both fall outside the predetermined tolerance range (± 20% of the mean QMCI for the upstream site, in this case: -1.2 to 1.2). However in both cases part of the confidence interval range (± 0.88 for sites upstream and downstream on the Northern Trib. and ± 0.75 for sites upstream and downstream on the Southern Trib. extends outside the zone of indifference (i.e. beyond the ± 1.2 represented by the area between the dotted lines in Figure 18, suggesting some uncertainty in the results and the possibility that there is a difference of more than 20% change between upstream and downstream.

In short, it means that, on the balance of probabilities there was possibly a more than 20% decrease in QMCI in the Northern Tributary, and a more than 20% increase in the Southern tributary, although this conclusion remains somewhat uncertain.

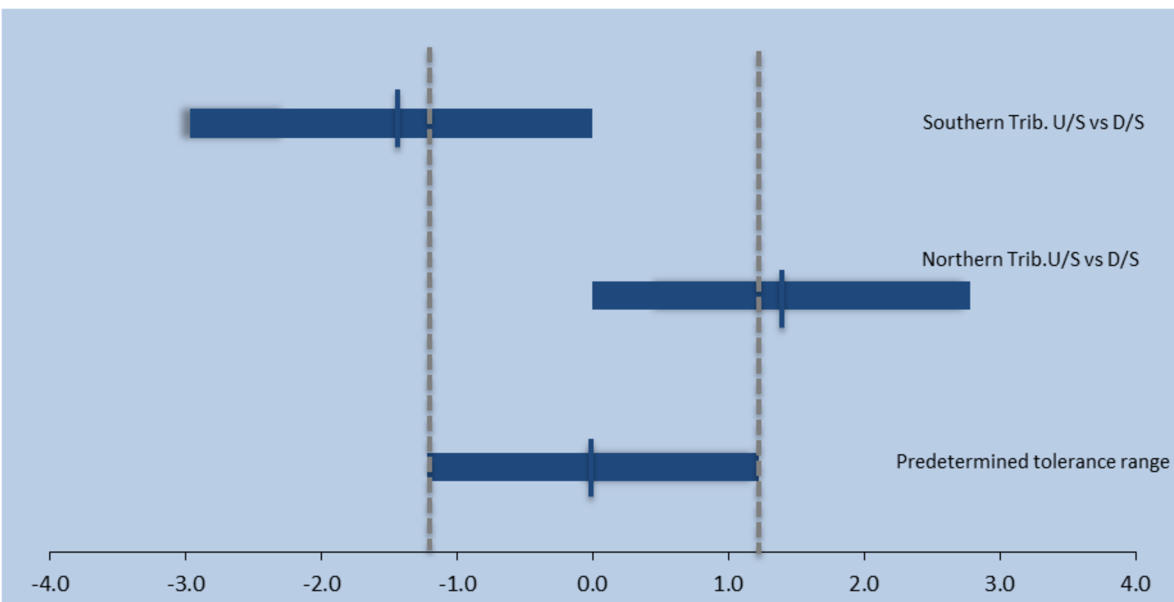

Figure 18: Results of equivalence testing of QMCI values for sites sampled upstream and downstream on the Northern tributary and the Wairere Stream mainstem in relation to discharges from the Whakapapa WWTP. The area between the dotted lines represents the zone of indifference.

Overall, the macroinvertebrate communities in the Southern Tributary did not indicate any significant adverse effects between upstream and downstream of the soakage trenches. In fact, the only significant differences point to some improvement in macroinvertebrate community productivity and health.

In the Northern Tributary, there are indications that significant adverse effects on macroinvertebrate community health have occurred in 2014 and 2015. This is evidenced by a reduction in QMCI by more than 20% in both years (39% reduction in 2014), but also by reduction in a number of other indicators, such as EPT individuals and EPT taxa. The reduction in these latter indices indicate that the quality of the macroinvertebrate communities as a food source, for example for the whio (blue duck) is likely to be negatively affected in the Northern Tributary (it is however unclear whether the whio do indeed utilise the Northern Tributary for foraging).

There is no indication of more than minor effects on macroinvertebrate communities in the Wairere Stream. In fact, the increases in some indicators (number of individuals, number of taxa, EPT taxa and EPT individuals) point to a possible improvement in the quality of the macroinvertebrate community as a food source downstream compared with upstream. This is particularly relevant given that indications of the presence of Whio in the lower reaches of the Wairere Stream have recently been documented[6].

4.3. Fish Communities

A search of the NZ Freshwater Fish database identified a number of fish species as being present in the Whakapapa River catchment, these are listed in Table 10. All existing fish records relate to monitoring in the Whakapapa River, the Whakapapaiti Stream and one of its tributary, and the Whakapapanui Stream. There are no records of fish species for the Wairere Stream in the national database.

We note that access to the upper catchment will be restricted for many migratory species by the presence of waterfalls (including the Tawhai Falls, located approximately 1 km downstream of the confluence between the Wairere and the Whakapapanui Stream). A small numbers of small salmonids, either rainbow or brook trout, were observed in the Northern Tributary during macroinvertebrate monitoring in October 2015. No other fish species were observed during any of the ecological sampling undertaken since October 2015, noting that species such as bullies, are often visible when present.

Table 10: Fish species occurring in the Whakapapa catchment, as identified from the NZ Freshwater Fish Database.

Scientific name	Common name
Paranephrops spp.	Koura
Anguilla dieffenbachii	Longfin eel
Anguilla australis	Shortfin eel
Gobiomorphus breviceps	Upland bully
Gobiomorphus basalis	Crans bully
Oncorhynchus mykiss	Rainbow Trout
Salmo trutta	Brown Trout

[6] Whakapapa wastewater treatment plant whio survey, 27th February 2016.

5. Conclusions and recommendations

The results of water quality and ecological monitoring undertaken at three pairs of upstream/downstream sites indicates that:

The Southern Tributary

- is understood to be the primary receiving environment for the discharges of treated wastewater from the emergency overflow pond into soakage trenches.
- Water quality sampling results indicate that the effects of these discharges on a number of water quality indicators are measurable, with some downstream concentrations exceeding One Plan targets at times (SIN and ammoniacal-N notably). Of particular notice are the unusually (compared with the rest of the data record) elevated concentrations of a range of contaminants measured at the downstream site in late 2015/early 2016. The possible causes of these unusual results are discussed below.
- Periphyton monitoring indicates that periphyton biomass and cover were at times increased compared with upstream, but not to levels such that overall compliance with One Plan targets is compromised. Similarly to water quality results, the largest increases in periphyton were measured in late 2015 to early 2016;
- Macroinvertebrate communities do not seem to be negatively affected by the discharge.

The Northern Tributary

- Is the receiving environment for the proportion of the discharges from the whole WWTP system that eventually reach surface water, both from the soakage trenches and the irrigation fields;
- Water quality sampling indicates that changes in the concentrations of a range of contaminants are generally measurable and statistically significant, although most One Plan targets seem to be met at the downstream site, with the notable exception of SIN. Similarly to what is noted above for the Southern Tributary, a high proportion of elevated results seem to have occurred in late 2015/early 2016;
- Periphyton sampling indicates a general increase in periphyton biomass and cover at the downstream site compared with upstream. Compliance with the periphyton biomass target at the downstream site is uncertain, and additional sampling would be required to provide a firm conclusion;
- There are indications that significant adverse effects on macroinvertebrate community health have occurred at the time of sampling in 2014 and spring 2015.

The Wairere Stream

- Receives inputs from the Northern Tributary, and as such constitutes the secondary receiving environment for the proportion of the discharges from the whole WWTP system that eventually reach surface water. Monitoring in the Wairere Stream provides an indication of the downstream extent of any effects measured in the Southern or Northern Tributaries.

- Limited water quality data indicate that the only measurable changes in concentrations of contaminants are of ammoniacal nitrogen (and by extension SIN)
- Periphyton monitoring indicates a measurable increase in periphyton growth downstream compared with upstream, but not to a level where significant effects on ecological, aesthetic or recreational values would be expected;
- There are no indications of significant adverse effects on macroinvertebrate communities in the Wairere Stream, including as a food source for the ecologically significant whio (blue duck);
- Only limited data are available for the Wairere Stream, and it is recommended that regular monitoring be continued to confirm the above conclusions.

In all three streams, data indicates that DRP is in naturally moderately elevated supply; by contrast, "background" concentrations of SIN are very low. This means that inputs of SIN into the stream are the likely primary driver of the increased periphyton biomass observed in all three streams at the downstream sites.

With regards to the higher than usual concentrations of a range of contaminants measured in late 2015/early 2016 in both the Southern and Northern Tributaries, it is our understanding that the management of the WWTP during that period was characterised by intense investigations and repairs during which higher than normal volumes of treated wastewater were discharged to the soakage trenches, or on the surface of the irrigation fields, which is a plausible cause for the results obtained during that period. It is also noted that, to some extent, periphyton indicators have followed the same trend. The most recent macroinvertebrate samples were taken in October 2015. These results need to be considered in the context of the unusual management of the WWTP system at the time; in particular, it seems questionable whether these results provide a suitable representation of the effects of the WWTP under normal operating conditions.

On the basis of available data, there are indications of some degree of adverse ecological effects on the Northern Tributary, although data available are somewhat insufficient to reach firm conclusions and it is questionable whether the more recent results provide a good representation of the effects of the WWTP under normal operating conditions. These effects seem to be spatially limited to the Northern Tributary, and do not extend to the Wairere Stream.

It is recommended that additional monitoring be undertaken to confirm, or otherwise, these conclusions. In the event that significant adverse effects on the Northern Tributary (or any other stream) are identified or confirmed, and that improvements are required, then it is likely that reducing the inputs of SIN (including ammoniacal Nitrogen) into the surface water system should be the management target.

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APPENDICES

Appendix A:

Summary of water quality data at sites sampled in the Southern and Northern Tributaries and Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP, 2012 to 2016.

Southern Tributary																
	Ammoniacal-N (g/m3)		Nitrate-N (g/m3)		Nitrite-N (g/m3)		NOX (g/m3)		SIN (g/m3)		DRP (g/m3)		E. coli (/100ml)			
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S		D/S	
Average	0.017	0.225	0.009	0.310	0.001	0.017	0.010	0.128	0.018	0.290	0.009	0.042	8.5		94.4	
Min	0.003	0.003	0.001	0.002	0.001	0.001	0.000	0.002	0.003	0.000	0.003	0.003	0.0		0.3	
5%ile	0.003	0.005	0.001	0.008	0.001	0.001	0.001	0.007	0.005	0.005	0.005	0.006	0.3		0.3	
10%ile	0.003	0.005	0.001	0.013	0.001	0.001	0.001	0.011	0.005	0.005	0.005	0.006	0.3		0.6	
20%ile	0.005	0.005	0.001	0.024	0.001	0.001	0.002	0.020	0.005	0.005	0.006	0.007	0.6		0.9	
25%ile	0.005	0.005	0.002	0.027	0.001	0.001	0.003	0.024	0.005	0.005	0.006	0.008	0.6		0.9	
50%ile (median)	0.005	0.005	0.004	0.093	0.001	0.007	0.004	0.035	0.005	0.005	0.008	0.011	2.0		2.0	
75%ile	0.005	0.020	0.012	0.300	0.001	0.025	0.015	0.200	0.005	0.060	0.011	0.014	7.0		16.0	
90%ile	0.030	0.188	0.022	0.825	0.001	0.044	0.023	0.308	0.030	0.383	0.015	0.065	17.4		74.2	
95%ile	0.032	0.870	0.026	1.063	0.001	0.051	0.026	0.344	0.035	1.011	0.017	0.215	35.4		229.0	
Max	0.200	3.800	0.029	1.300	0.001	0.058	0.029	0.380	0.200	5.100	0.026	0.700	88.0		2700.0	
StDev	0.042	0.822	0.011	0.502	0.000	0.023	0.012	0.161	0.042	0.989	0.004	0.119	18.0		418.2	
95% C.I.	0.012	0.249	0.009	0.402		0.018	0.010	0.141	0.012	0.299	0.001	0.036	7.2		170.9	
Guideline	**< 0.32**	**< 0.32**							**< 0.07**	**< 0.07**	**< 0.006**	**< 0.006**	**< 260 (Main bathing season)**	**< 550 (Year round)**	**< 260 (Main bathing season)**	**< 550 (Year round)**
%compliance	100	93							95	76	27	12	100	100	96	95
N. of Samples	43	42	6	6	6	6	5	5	43	42	44	43	24	44	23	43
Wilcoxon	*1.894*		*1.468*		*1.336*		*1.079*		***3.026***		*1.787*				***2.417***	
P Value	*0.0582*		*0.1422*		*0.1814*		*0.2807*		***0.0025***		*0.0740*				***0.0157***	

Southern Tributary (continued)

	TSS (g/m3)		BOD_5 (g/m3)		pH		Temp (ºC)		DO (g/m3)		DO (% sat)	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Average	1.6	1.8	0.5	5.7	7.0	7.0	8.3	9.3	10.5	10.3	99.3	99.1
Min	0.2	0.3	0.3	0.3	5.2	6.1	2.9	4.3	9.1	8.2	86.8	84.4
5%ile	0.5	1.2	0.3	0.3	6.3	6.4	3.9	4.8	9.3	8.8	93.2	89.1
10%ile	0.7	1.5	0.3	0.5	6.5	6.5	4.8	5.3	9.4	9.1	93.5	89.6
20%ile	1.5	1.5	0.5	0.5	6.8	6.8	6.5	6.5	9.8	9.4	94.3	93.3
25%ile	1.5	1.5	0.5	0.5	6.9	6.8	7.1	7.2	9.9	9.6	95.3	94.0
50%ile (median)	1.5	1.5	0.5	8.8	7.2	7.0	8.7	10.5	10.5	10.4	98.9	98.9
75%ile	1.5	2.0	0.5	10.1	7.4	7.2	9.9	11.1	11.0	11.0	103.6	103.9
90%ile	2.5	2.8	0.5	10.7	7.4	7.4	10.9	12.3	11.4	11.4	104.8	107.9
95%ile	2.5	3.0	1.0	11.3	7.5	7.4	11.5	13.2	11.5	11.5	107.6	110.5
Max	3.0	4.6	2.0	11.4	7.5	7.5	12.2	14.1	12.9	12.3	108.8	111.7
StDev	0.6	0.7	0.3	4.8	0.5	0.3	3.0	3.4	0.8	0.9	5.0	6.9
95% C.I.	0.2	0.2	0.1	1.5	0.1	0.1	2.2	2.5	0.3	0.3	1.6	2.2
Guideline			**< 1.5**		**7 - 8.2**		**< 19**				**> 80**	
%compliance			98	46	70	59	100	100.0			100	100
N. of Samples	44	44	44	39	44	44	7	7	38	38	38	38
Wilcoxon	*1.888*		***4.359***		***2.248***		***2.113***		***2.283***		*0.500*	
P Value	*0.0591*		***0.0000***		***0.0246***		***0.0346***		***0.0224***		*0.6168*	

Northern Tributary																
	Ammoniacal-N (g/m3)		Nitrate-N (g/m3)		Nitrite-N (g/m3)		NOX (g/m3)		SIN (g/m3)		DRP (g/m3)		E. coli (/100ml)			
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S		D/S	
Average	0.023	0.069	0.023	0.200	0.001	0.010	0.030	0.240	0.051	0.177	0.014	0.025	14.0		36.9	
Min	0.003	0.005	0.001	0.071	0.001	0.001	0.000	0.078	0.003	0.005	0.003	0.005	0.0		0.0	
5%ile	0.003	0.005	0.001	0.073	0.001	0.001	0.001	0.090	0.005	0.005	0.006	0.007	0.3		0.3	
10%ile	0.003	0.005	0.001	0.075	0.001	0.001	0.002	0.103	0.005	0.010	0.007	0.009	0.3		0.4	
20%ile	0.005	0.005	0.001	0.078	0.001	0.001	0.004	0.128	0.005	0.034	0.008	0.010	0.8		0.9	
25%ile	0.005	0.005	0.002	0.091	0.001	0.002	0.005	0.140	0.005	0.060	0.009	0.010	0.9		1.3	
50%ile (median)	0.005	0.005	0.010	0.165	0.001	0.005	0.016	0.210	0.005	0.100	0.012	0.013	2.0		2.7	
75%ile	0.005	0.057	0.018	0.283	0.001	0.014	0.018	0.340	0.019	0.250	0.017	0.022	4.0		22.8	
90%ile	0.010	0.174	0.059	0.360	0.002	0.023	0.073	0.394	0.195	0.348	0.021	0.037	14.0		111.6	
95%ile	0.191	0.200	0.080	0.385	0.003	0.026	0.092	0.412	0.314	0.429	0.025	0.087	41.2		179.5	
Max	0.360	1.100	0.100	0.410	0.004	0.029	0.110	0.430	0.470	1.500	0.074	0.250	380.0		420.0	
StDev	0.068	0.176	0.038	0.136	0.001	0.011	0.045	0.144	0.109	0.243	0.011	0.040	58.1		84.1	
95% C.I.	0.021	0.053	0.031	0.109	0.001	0.009	0.040	0.126	0.033	0.073	0.003	0.012	23.8		33.6	
Guideline	**< 0.32**	**< 0.32**							**< 0.07**	**< 0.07**	**< 0.006**	**< 0.006**	**< 260 (Main bathing season)**	**< 550 (Year round)**	**< 260 (Main bathing season)**	**< 550 (Year round)**
%compliance	98	98							86	33	9	5	96	100	92	100
N. of Samples	42	43	6	6	6	6	5	5	42	43	43	44	23	43	24	44
Wilcoxon	***2.918***		***2.097***		*1.643*		*1.888*		***3.739***		*1.109*		***3.008***			
P Value	***0.0035***		***0.0360***		*0.1003*		*0.0591*		***0.0002***		*0.2675*		***0.0026***			

Northern Tributary (continued)

	TSS (g/m3)		BOD5 (g/m3)		pH		Temp (ºC)		DO (g/m3)		DO (% sat)	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Average	1.7	1.7	0.5	0.5	7.0	7.1	8.6	8.5	10.7	10.6	102.0	102.5
Min	0.3	0.3	0.3	0.3	5.8	5.9	2.8	2.9	9.0	8.9	93.0	87.9
5%ile	0.5	0.5	0.3	0.3	6.1	6.6	3.8	3.9	9.5	9.1	93.4	91.9
10%ile	0.6	0.7	0.3	0.3	6.3	6.7	4.7	4.8	9.7	9.4	95.7	92.6
20%ile	1.5	1.5	0.5	0.5	6.9	6.9	6.4	6.3	9.8	9.7	96.9	94.9
25%ile	1.5	1.5	0.5	0.5	7.0	7.0	7.0	6.7	9.9	9.7	97.2	96.5
50%ile (median)	1.5	1.5	0.5	0.5	7.1	7.2	9.5	8.9	10.7	10.7	101.3	101.5
75%ile	1.8	1.6	0.5	0.5	7.2	7.3	10.4	11.3	11.4	11.5	106.3	106.5
90%ile	2.5	2.5	0.5	0.5	7.3	7.4	11.5	11.7	11.6	11.7	110.4	113.5
95%ile	3.0	2.9	0.5	0.5	7.4	7.5	12.2	11.8	12.0	12.0	112.7	117.3
Max	5.0	6.0	0.5	2.1	7.5	8.2	12.9	11.9	12.9	14.0	114.4	127.1
StDev	0.9	0.9	0.1	0.3	0.4	0.3	3.3	3.3	0.9	1.1	6.0	8.5
95% C.I.	0.3	0.3	0.0	0.1	0.1	0.1	2.5	2.5	0.3	0.4	1.9	2.7
Guideline			**< 1.5**		**7 - 8.2**		**< 19**				**> 80**	
%compliance			100	98	77	77	100	100			100	100
N. of Samples	43	44	43	43	44	44	7	7	37	38	37	38
Wilcoxon	*0.000*		*Too few samples untied*		*1.571*		*0.000*		*0.467*		*1.849*	
P Value	*1.0000*				*0.1162*		*1.0000*		*0.6402*		*0.0645*	

Wairere Stream

	Ammoniacal-N (g/m3)		Nitrate-N (g/m3)		Nitrite-N (g/m3)		NOX (g/m3)		SIN (g/m3)		DRP (g/m3)		E. coli (/100ml)			
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S		D/S	
Average	0.012	0.075	0.001	0.047	0.001	0.002		0.048	0.012	0.188	0.035	0.032	12.8		63.2	
Min	0.003	0.003	0.001	0.030	0.001	0.001		0.030	0.003	0.030	0.006	0.008	0.8		0.8	
5%ile	0.003	0.004	0.001	0.032	0.001	0.001		0.032	0.003	0.034	0.006	0.012	0.9		1.3	
10%ile	0.004	0.005	0.001	0.033	0.001	0.001		0.034	0.004	0.038	0.006	0.015	1.0		1.8	
20%ile	0.006	0.020	0.001	0.037	0.001	0.001		0.037	0.006	0.076	0.006	0.017	1.1		2.0	
25%ile	0.007	0.030	0.001	0.038	0.001	0.001		0.039	0.007	0.100	0.006	0.017	1.2		2.0	
50%ile (median)	0.012	0.040	0.001	0.047	0.001	0.002		0.048	0.012	0.130	0.006	0.021	1.6		4.0	
75%ile	0.017	0.140	0.001	0.055	0.001	0.002		0.057	0.017	0.270	0.050	0.038	18.8		40.0	
90%ile	0.020	0.168	0.001	0.060	0.001	0.002		0.062	0.020	0.348	0.076	0.049	29.1		128.8	
95%ile	0.021	0.184	0.001	0.061	0.001	0.002		0.064	0.021	0.404	0.084	0.075	32.6		294.4	
Max	0.022	0.200	0.001	0.063	0.001	0.003		0.066	0.022	0.460	0.093	0.102	36.0		460.0	
StDev	0.014	0.073	0.000	0.023	0.000	0.001		0.025	0.014	0.143	0.050	0.027	20.1		149.8	
95% C.I.	0.019	0.048		0.032		0.001		0.035	0.019	0.094	0.057	0.017	22.7		119.9	
Guideline	**< 0.32**	**< 0.32**							**< 0.07**	**< 0.07**	**< 0.006**	**< 0.006**	**< 260 (Main bathing season)**	**< 550 (Year round)**	**< 260 (Main bathing season)**	**< 550 (Year round)**
%compliance	100	100							100	22	67	0	100	100	83	100
N. of Samples	2	9	2	2	2	2	0	2	2	9	3	10	3	3	6	9
Wilcoxon	Too few samples															
P Value																

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Northern Tributary (continued)												
	TSS (g/m3)		BOD_5 (g/m3)		pH		Temp (ºC)		DO (g/m3)		DO (% sat)	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Average	0.6	1.4	0.3	0.8	6.6	7.0	9.4	10.5	10.2	10.4	100.1	100.7
Min	0.2	0.5	0.3	0.3	6.3	6.3	7.4	7.0	9.4	9.3	97.1	91.0
5%ile	0.3	0.5	0.3	0.3	6.3	6.4	7.6	7.5	9.5	9.4	97.2	91.7
10%ile	0.3	0.5	0.3	0.3	6.4	6.5	7.8	8.0	9.6	9.5	97.4	92.5
20%ile	0.4	0.5	0.3	0.5	6.4	6.9	8.2	9.0	9.9	9.7	97.8	95.9
25%ile	0.5	0.8	0.3	0.5	6.4	7.0	8.4	9.5	10.0	9.8	98.0	97.2
50%ile (median)	0.8	1.5	0.3	0.5	6.4	7.1	9.4	11.9	10.6	10.3	98.9	101.6
75%ile	0.8	1.5	0.3	0.5	6.8	7.2	10.4	12.3	10.6	11.2	101.6	104.9
90%ile	0.9	2.1	0.3	0.8	7.0	7.2	11.0	12.5	10.6	11.6	103.3	107.5
95%ile	0.9	2.6	0.3	2.2	7.0	7.2	11.2	12.6	10.6	11.8	103.8	107.8
Max	0.9	3.0	0.3	3.5	7.1	7.2	11.4	12.7	10.6	11.9	104.3	108.0
StDev	0.4	0.8	0.0	1.0	0.4	0.3	2.0	3.1	0.7	0.9	3.8	5.9
95% C.I.	0.4	0.5		0.6	0.5	0.2	2.3	3.5	0.8	0.6	4.3	3.6
Guideline			**< 1.5**		**7 - 8.2**		**< 19**				**> 80**	
%compliance			100	90	33	100	100	100			100	100
N. of Samples	3	10	3	10	3	10	3	3	3	10	3	10
Wilcoxon	Too few samples											
P Value												

Appendix B:

Summary of water quality data collected at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

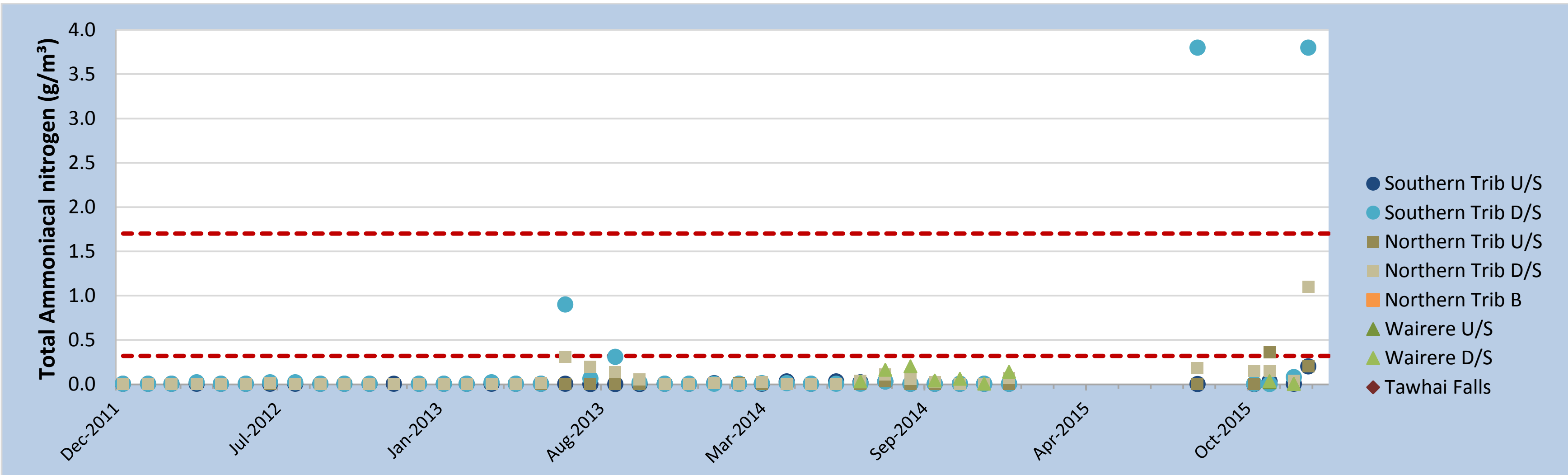


Figure 1: Total Ammoniacal Nitrogen concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

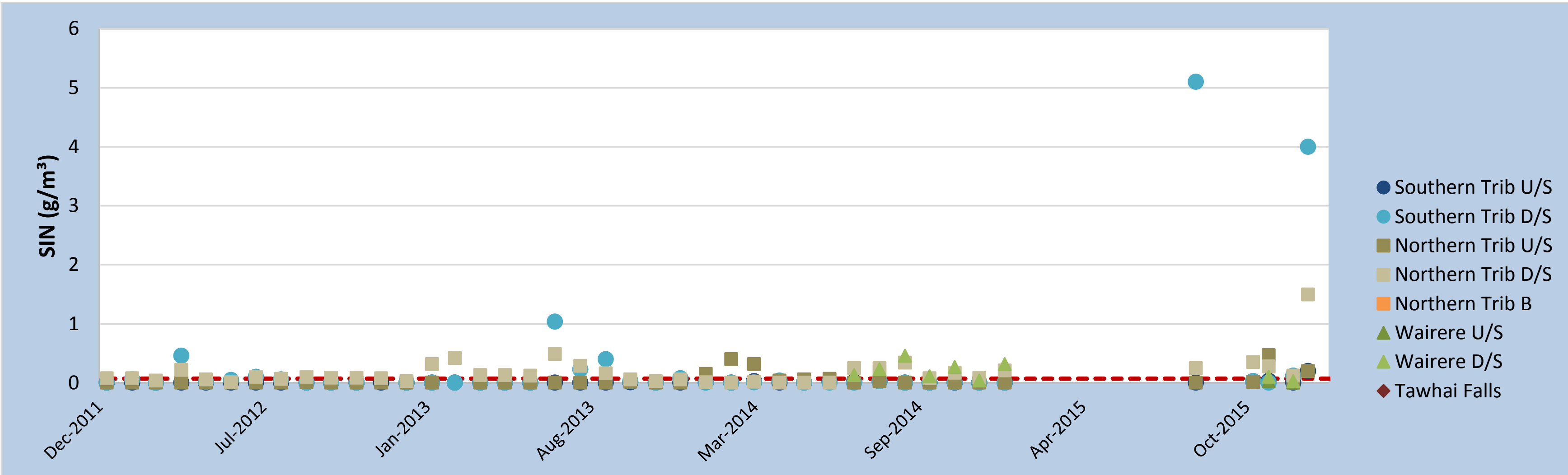


Figure 2: Soluble Inorganic Nitrogen (SIN) concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

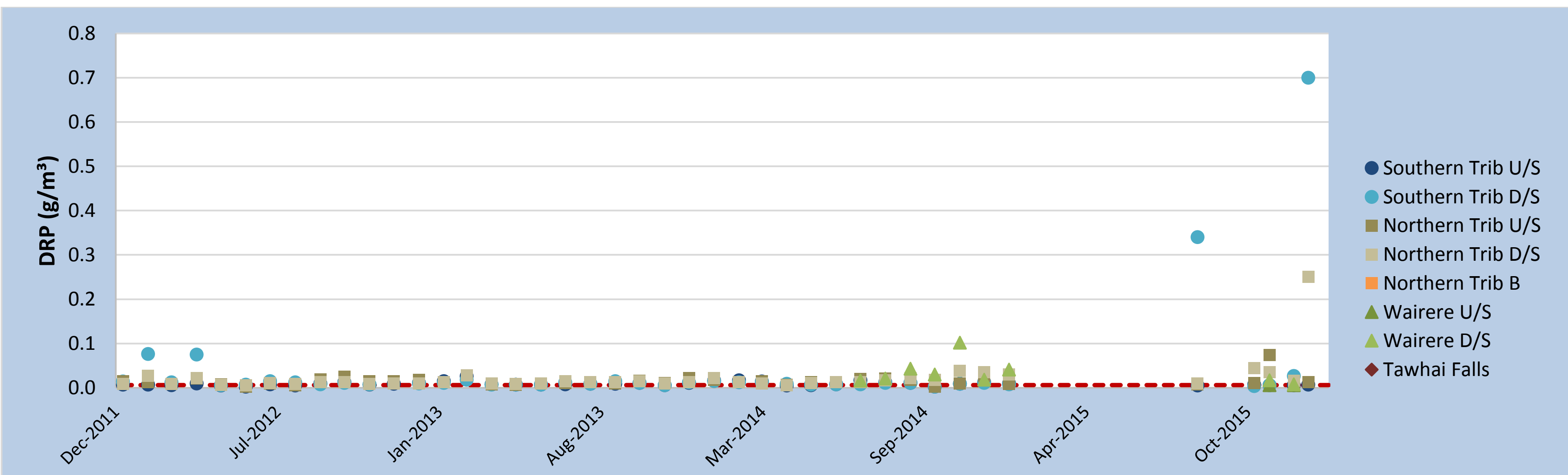


Figure 3: Dissolved reactive Phosphorus (DRP) concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.

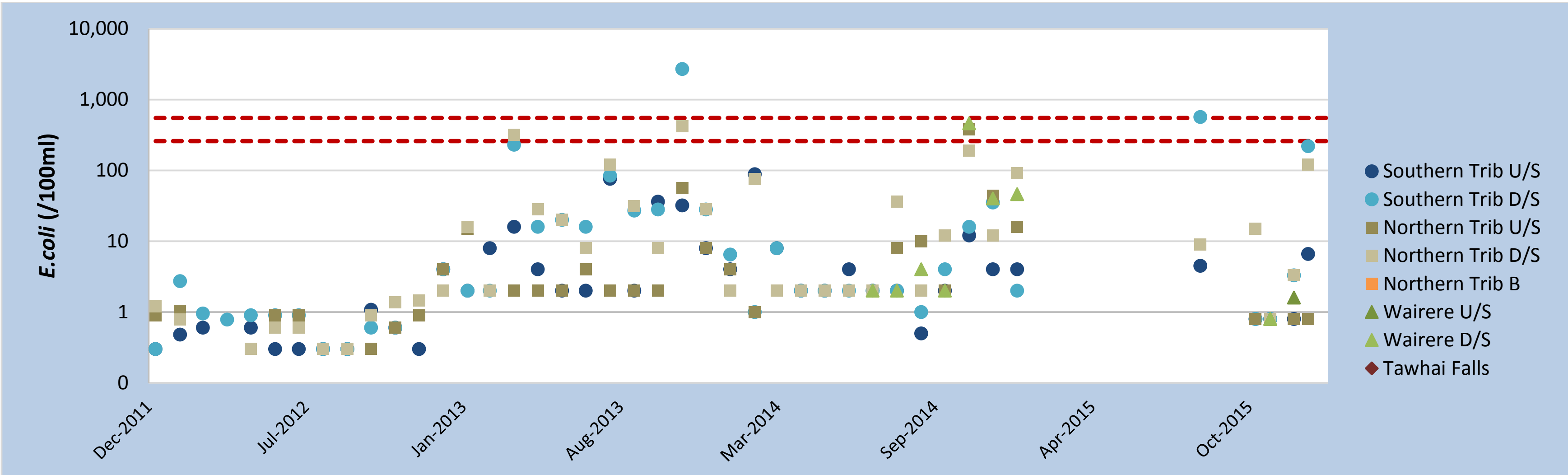


Figure 4: ***E. coli*** **concentrations (log scale) concentrations at sites sampled in the Southern and Northern tributaries and Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.**

Appendix C:

Summary of Attribute States for Total Ammoniacal Nitrogen, copied from Appendix 2 of the National Policy Statement for Freshwater Management (2014).

Table 1: Attribute states for Ammonia (Toxicity) taken from Appendix 2 of the National Policy Statement for Freshwater management (2014).

Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median*	Annual 95th Percentile*	
A	≤ 0.03	≤ 0.05	99% species protection level. No observed effect on any species.
B	>0.03 and ≤ 0.24	>0.05 and ≤ 0.40	95% species protection level. Starts impacting occasionally on the 5% most sensitive species.
C	>0.24 and ≤ 1.30	>0.40 and ≤ 2.20	80% species protection level. Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).
National Bottom Line	1.30	2.20	
D	>1.30	>2.20	Starts approaching acute impact level (i.e. risk of death) for sensitive species.

Table 2: Attribute states for Nitrate (Toxicity) taken from Appendix 2 of the National Policy Statement for Freshwater management (2014).

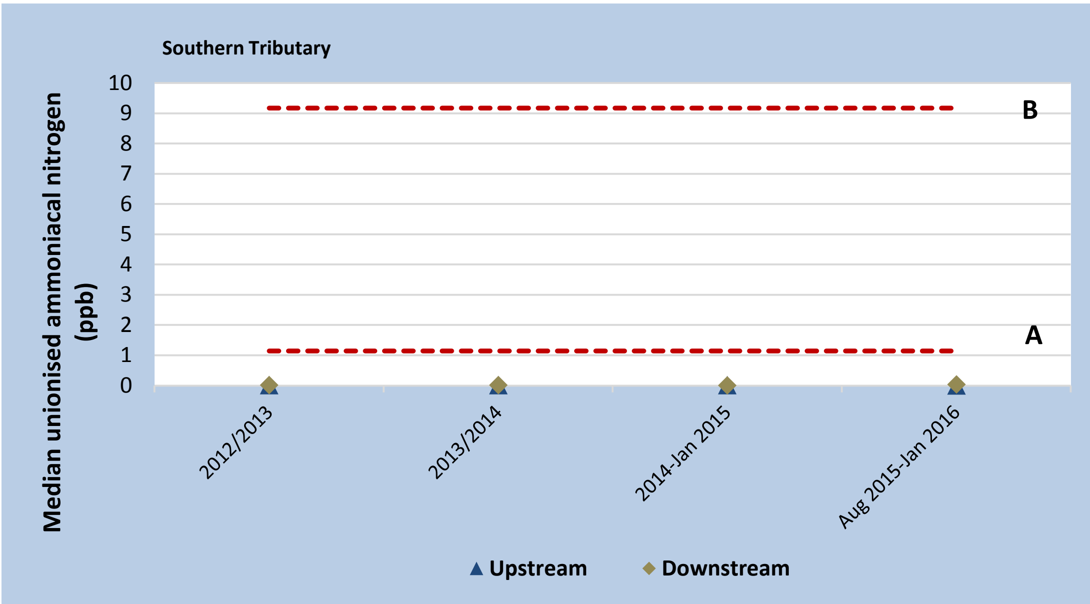
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual 95th Percentile*	
A	≤ 1.0	≤ 1.5	High conservation value system. Unlikely to be effects even on sensitive species.
B	>1.0 and ≤ 2.4	>1.5 and ≤ 3.5	Some growth effect on up to 5% of species.
C	>2.4 and ≤ 6.9	>3.5 and ≤ 9.8	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.
National Bottom Line	6.9	9.8	
D	>6.9	>9.8	Impacts on growth of multiple species, and starts approaching acute impact level (i.e. risk of death) for sensitive species at higher concentrations (> 20 mg/L).

Table 3: Attribute states for *E.coli* taken from Appendix 2 of the National Policy Statement for Freshwater management (2014).

Attribute State	Numeric Attribute State	Sampling Statistic	Narrative Attribute State
A	≤ 260	Annual median	People are exposed to a very low risk of infection (less than 0.1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).
		95th percentile	People are exposed to a low risk of infection (less than 1% risk) when undertaking activities likely to involve full immersion.
B	>260 and ≤ 540	Annual median	People are exposed to a low risk of infection (less than 1% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).
		95th percentile	People are exposed to a moderate risk of infection (less than 5% risk) when undertaking activities likely to involve full immersion. 540/100 ml is the **minimum acceptable state** for activities likely to involve full immersion.
C	>540 and ≤ 1,000	Annual median	People are exposed to a moderate risk of infection (less than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating). People are exposed to a high risk of infection (greater than 5% risk) from contact with water during activities likely to involve full immersion.
National Bottom Line	**1,000**	**Annual median**	
D	>1,000	Annual median	People are exposed to a high risk of infection (greater than 5% risk) from contact with water during activities with occasional immersion and some ingestion of water (such as wading and boating).

Appendix D:

Summary of Annual Median and Annual Maximum Unionised Ammoniacal nitrogen concentrations in the Southern and Northern Tributaries.



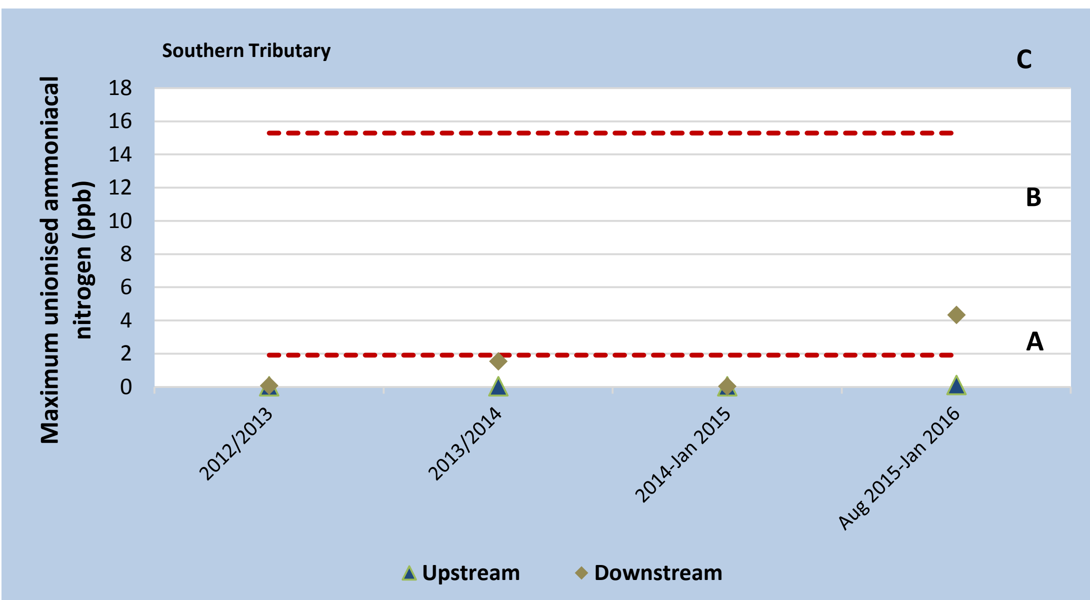
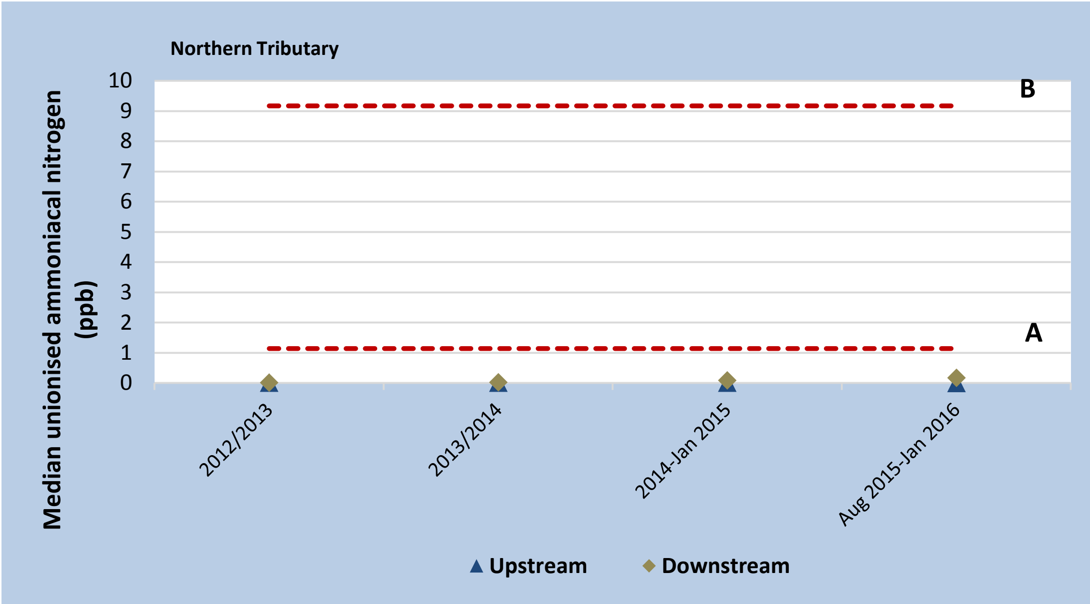


Figure 19: Annual Median (upper) and Annual Maximum (lower) of unionised ammoniacal nitrogen concentrations in the Southern Tributary upstream and downstream of the Whakapapa WWTP. NPSFM 2014 Attribute States (A, B & C) are indicated by the red lines (July 2012 – Feb 2016 data).



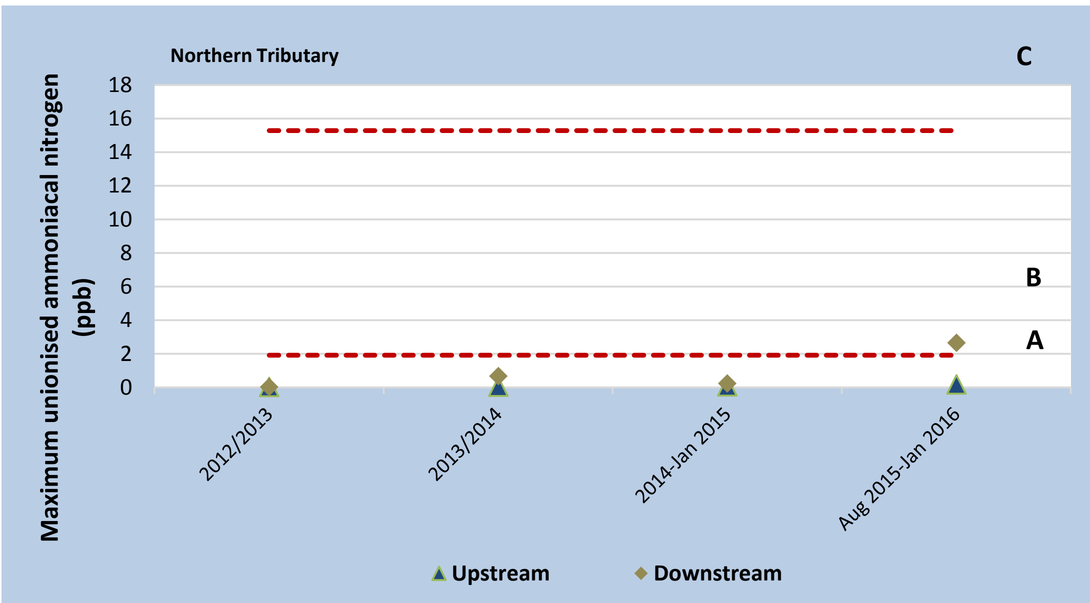
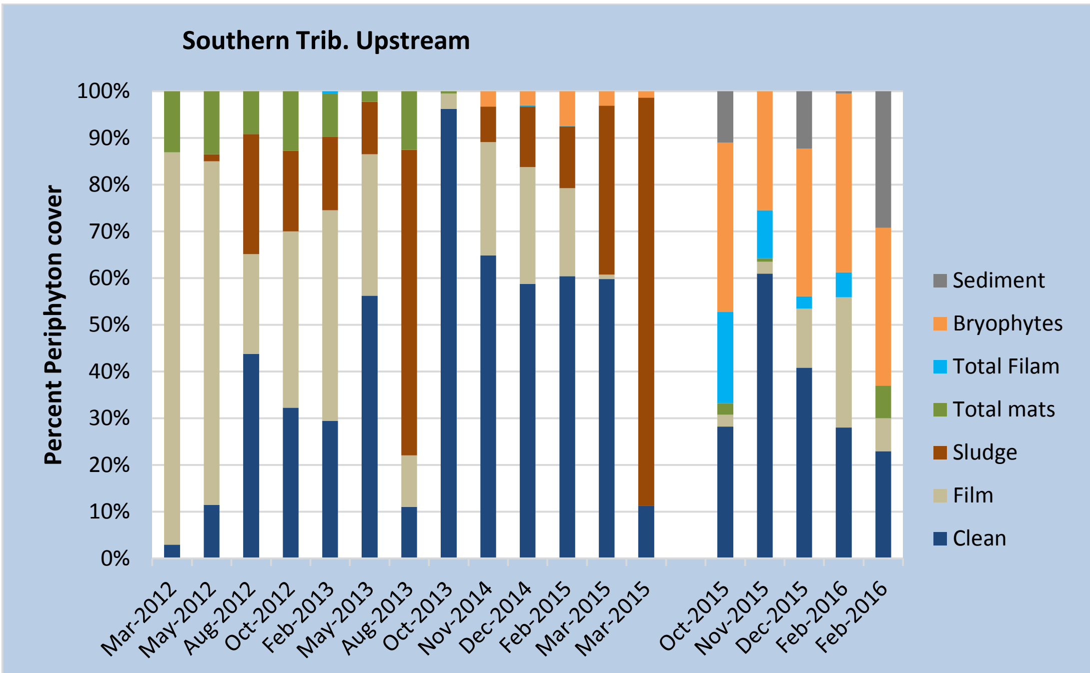


Figure 20: Annual Median (upper) and Annual Maximum (lower) of unionised ammoniacal nitrogen concentrations in the Northern Tributary upstream and downstream of the Whakapapa WWTP. NPSFM 2014 Attribute States (A, B & C) are indicated by the red lines (July 2012 – Feb 2016 data).

Appendix E:

Summary of periphyton communities visually assessed at site upstream and downstream on the Southern and Northern Tributaries and Wairere Stream mainstem, 2012-2016.



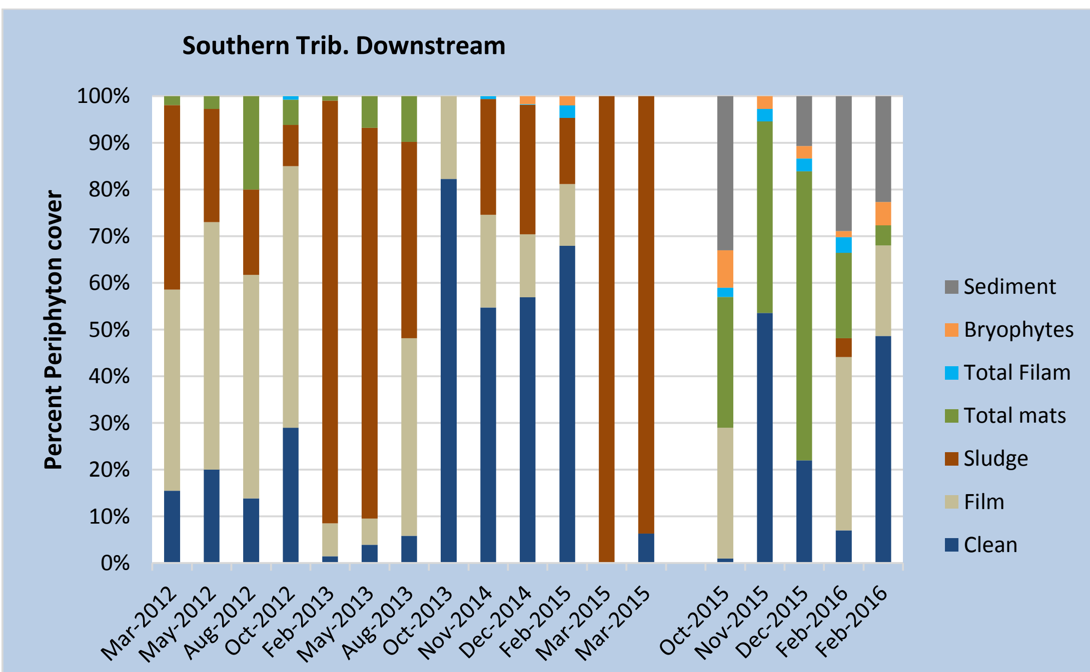


Figure 1: Periphyton communities visually assessed at sites upstream (upper) and downstream (lower) on the Southern Tributary of the Wairere Stream, 2012-2016. (Data in 2012 and 2013 were collected by DOC, data in 2014 by the Catalyst Group and data from October 2015 onwards were collected by Aquanet Consulting Ltd).

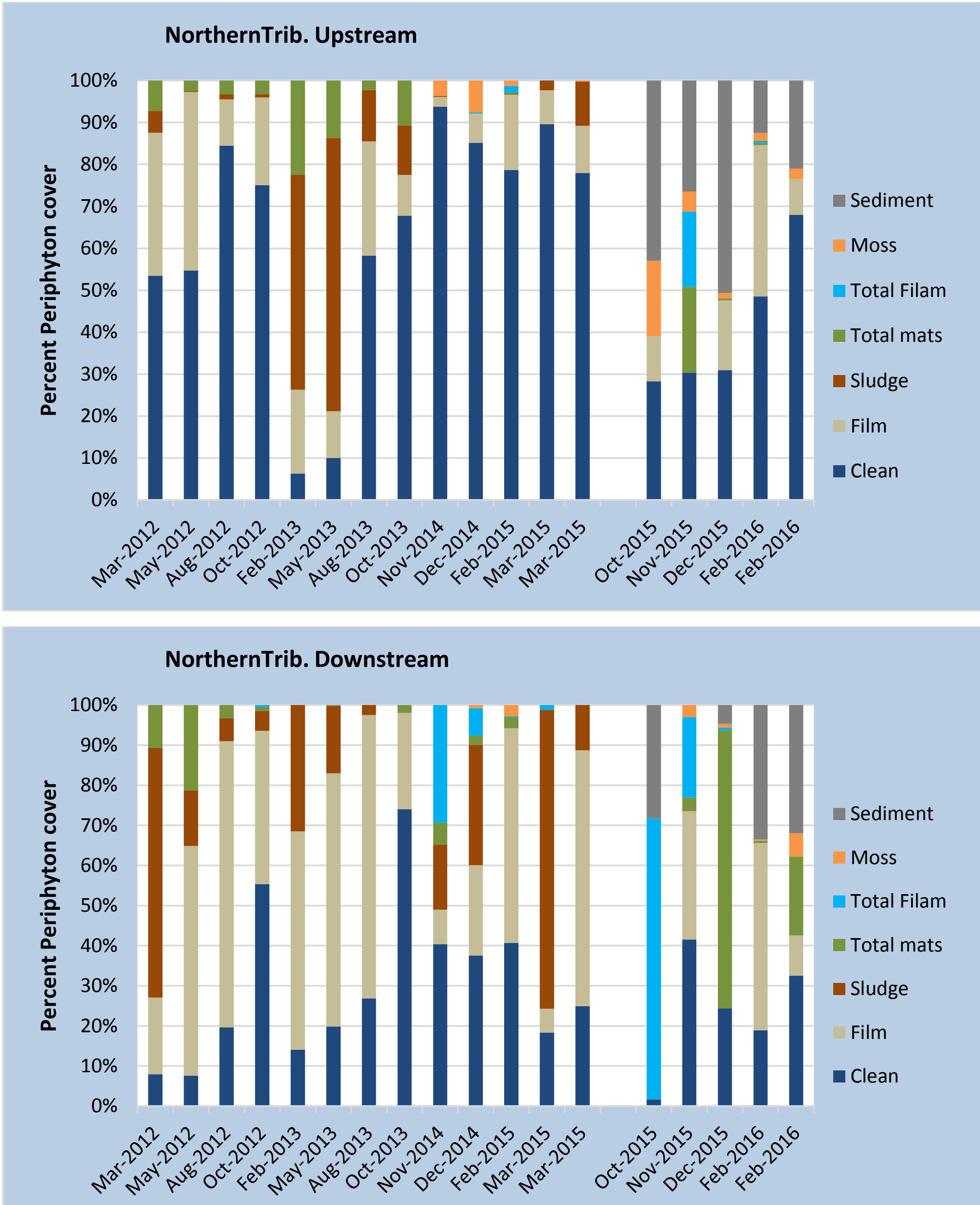
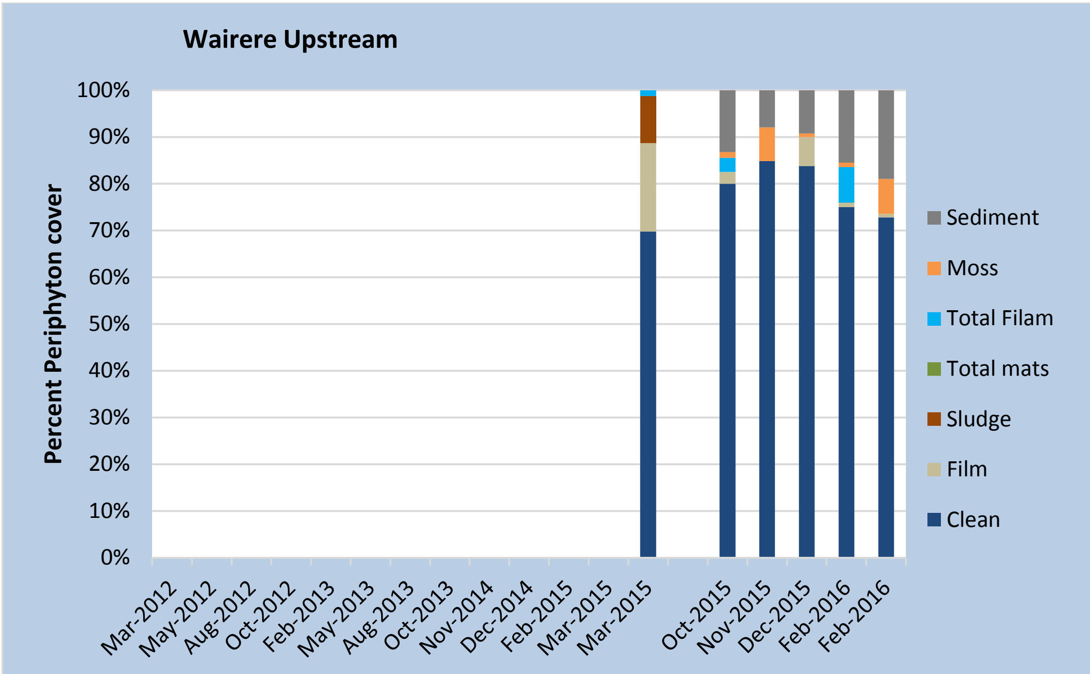


Figure 2: Periphyton communities visually assessed at sites upstream (upper) and downstream (lower) on the Northern Tributary of the Wairere Stream, 2012-2016. (Data in 2012 and 2013 were collected by DOC, data in 2014 by the Catalyst Group and data from October 2015 onwards were collected by Aquanet Consulting Ltd).



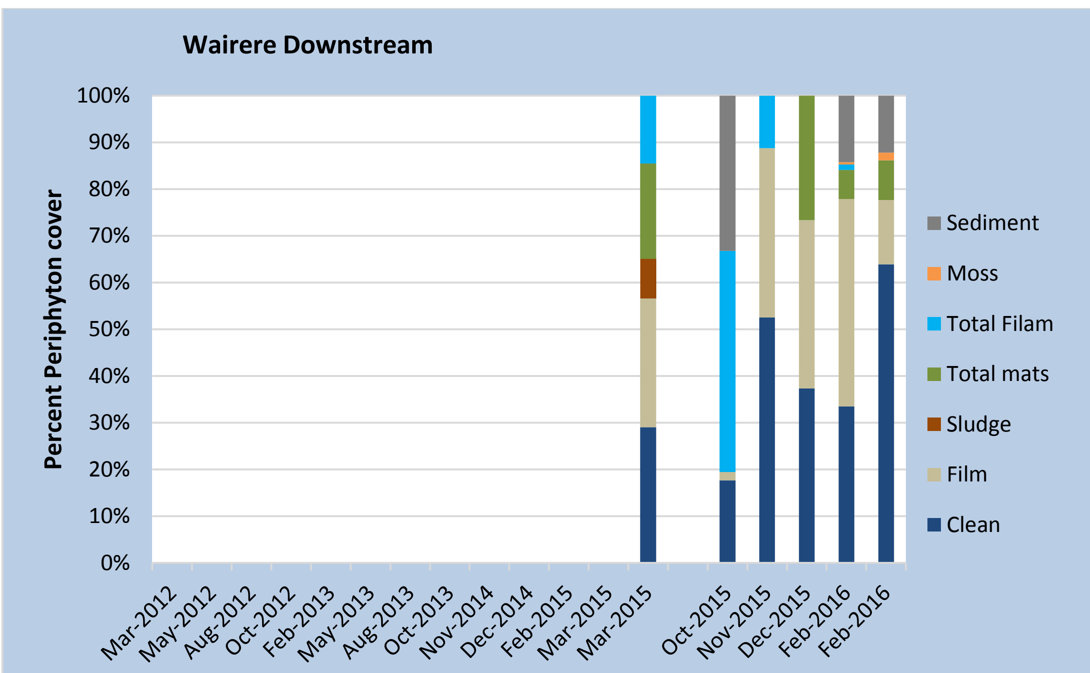


Figure 3: Periphyton communities visually assessed at sites upstream (upper) and downstream (lower) on the Wairere Stream mainstem, 2012-2016. (Data in 2012 and 2013 were collected by DOC, data in 2014 by the Catalyst Group and data from October 2015 onwards were collected by Aquanet Consulting Ltd).

aquanet consulting ltd

30th September 2016

To: Anne-Marie Westcott
Ruapehu District Council

Whakapapa Wastewater Treatment Plant

Water Quality, Periphyton and Macroinvertebrate monitoring - Update

Dear Anne-Marie

Please find attached a memo outlining the results of water quality, periphyton and macroinvertebrate monitoring undertaken to 30th June 2016, upstream and downstream of the wastewater discharge from the Whakapapa WWTP.

Please do not hesitate to contact me if you have any questions.

Yours sincerely,

Olivier Ausseil (PhD)
Principal Scientist – Water Quality

Aquanet Consulting Ltd
Land & Water House
441 Church Street
Palmerston North

Whakapapa Wastewater Treatment Plant

Update on Water Quality, Periphyton and Macroinvertebrate communities

This memo presents updated results for water quality, periphyton and macroinvertebrate monitoring undertaken to date to 30 June 2016, upstream and downstream of the wastewater discharge from the Whakapapa WWTP.

Table 1: Summary of water quality and biological indicators presented in this analysis.

Site	Type	Parameters	Frequency	Period	Source
Whakapapa WWTP effluent	Effluent water quality	pH, DO, Dissolved $cBOD_5$, TSS, DRP, DIN, TNH_3-N, *E. coli*	Monthly	October 2015 to June 2016	Veolia
Southern Tributary upstream of Whakapapa WWTP	River water quality	pH, DO, Dissolved $cBOD_5$, TSS, DRP, DIN, TNH_3-N, *E. coli*	Monthly	January 2012 to January 2015 August 2015 to June 2016	DOC Veolia
Southern Tributary downstream of Whakapapa WWTP					
Northern Tributary upstream of Whakapapa WWTP					
Northern Tributary downstream of Whakapapa WWTP					
Wairere Stream upstream of confluence with Northern Tributary					
Wairere Stream downstream of confluence with Northern Tributary					
Southern Tributary upstream of Whakapapa WWTP	Biological indicators	Macroinvertebrate indices (MCI, QMCI, %EPT taxa, %EPT individuals, No. of taxa, No. of individuals);	Annually	2012 & 2013 2014 Oct 2015 April 2016	DOC Catalyst group Aquanet
Southern Tributary downstream of Whakapapa WWTP					
Northern Tributary upstream of Whakapapa WWTP					
Northern Tributary downstream of Whakapapa WWTP					
Wairere Stream upstream of confluence with Northern Tributary		Periphyton biomass (Chlorophyll *a*), %Periphyton cover	Monthly	October 2015 – July 2016	Aquanet
Wairere Stream downstream of confluence with Northern Tributary					

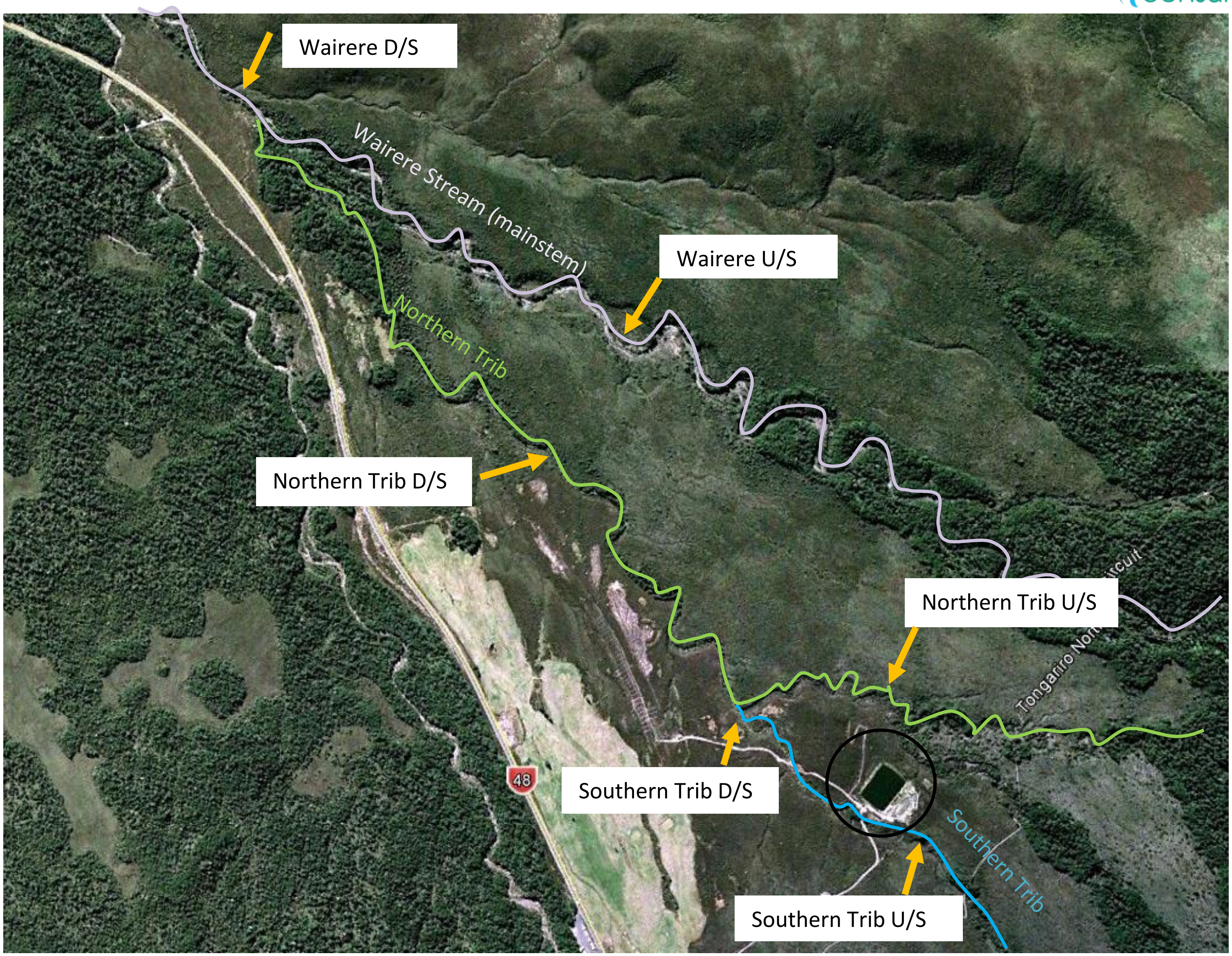


Figure 1: Location of monitoring sites in relation the Whakapapa WWTP.

Results

1 Water Quality

Water Quality results to 30 June 2016 are presented in Figure 2 to Figure 5.

Comparison of water quality data from the last four months (March – June 2016) with previous monitoring shows:

Total ammoniacal nitrogen concentrations were generally below the detection limit of 0.005 g/m^3, and always below the One plan target, in the Southern and Northern Tributaries and Wairere Stream main stem as well as at Tawhai Falls.

The highest concentrations at all sites in the past four months were recorded in April 2016 (0.012 g/m^3 upstream in the Southern and Northern Tributaries; 0.0052 g/m^3 and 0.0073 g/m^3 downstream in the Southern and Northern Tributaries, respectively). The Wairere Stream had ammoniacal-N concentrations of 0.0052 g/m^3 upstream and 0.0069 g/m^3 downstream in April 2016.

Soluble Inorganic Nitrogen (SIN) was always below detection limits upstream in the Southern and Northern Tributaries, but was higher downstream in both tributaries (maximum of 0.11 g/m^3 in the Southern Trib. in June 2016; maximum of 0.091 g/m^3 in Northern Trib. in April 2016).

SIN concentrations in the Wairere Stream were slightly higher than those in the tributaries and decreased from upstream to downstream.

Dissolved Reactive Phosphorus (DRP) concentrations although low, did exceed the One plan target at all sites (maximum DRP concentrations of: 0.008 g/m^3 upstream and 0.045 g/m^3 downstream on Southern Trib.; 0.009 g/m^3 upstream and 0.013 g/m^3 downstream on the Northern Trib.; and 0.013 g/m^3 upstream and 0.027 g/m^3 downstream on the Wairere Stream).

E. coli concentrations over past four months remained low and well below the One plan targets at all sites (maximum of 44 /100ml upstream on the Northern Trib. in March 2016).

1.1 Total Ammoniacal Nitrogen

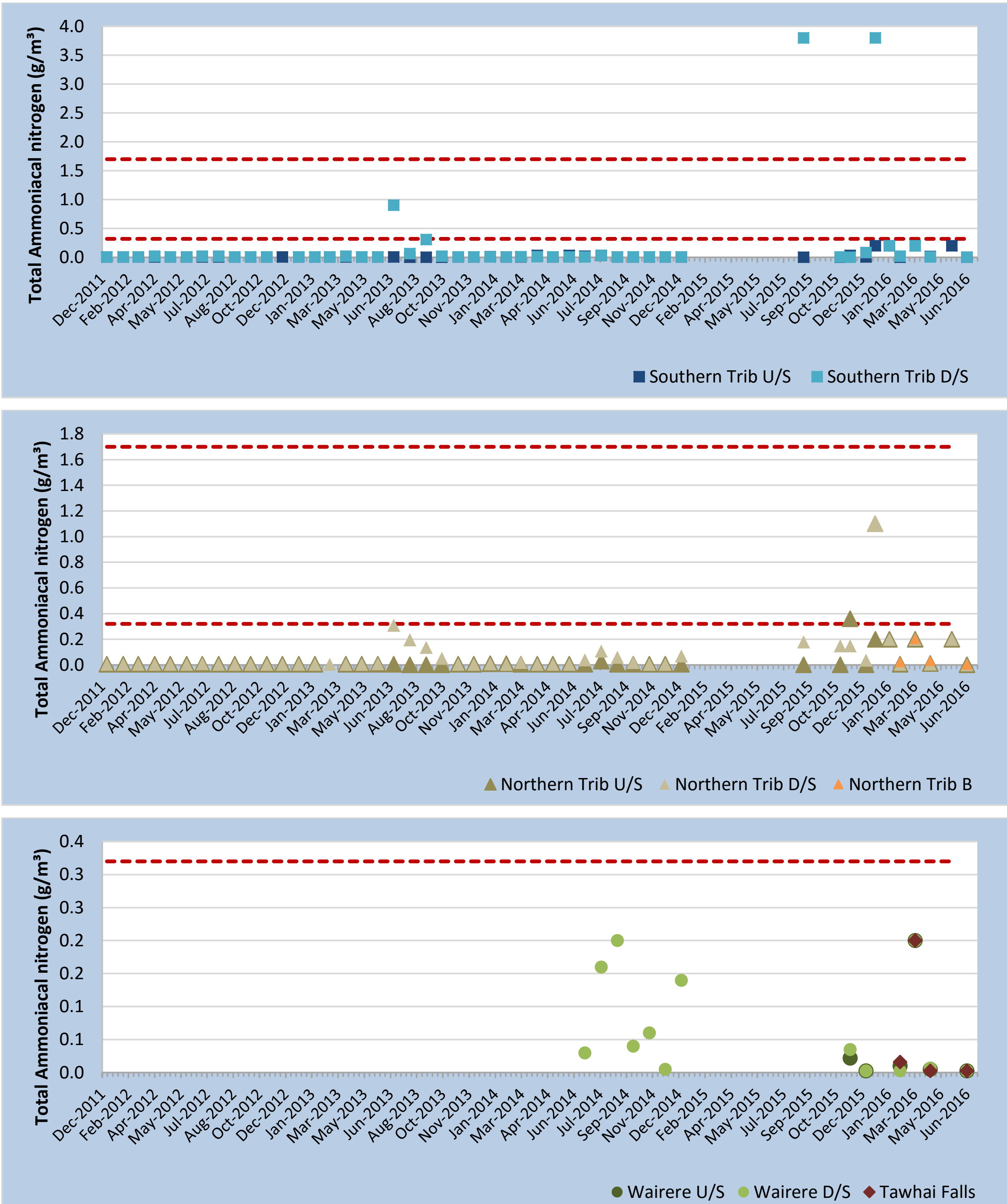


Figure 2: Total Ammoniacal Nitrogen concentrations at sites sampled in the Southern (upper) and Northern (middle) tributaries and Wairere Stream mainstem (lower), upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets. Note: Scales differ on each figure above.

1.2 Soluble Inorganic Nitrogen (SIN)

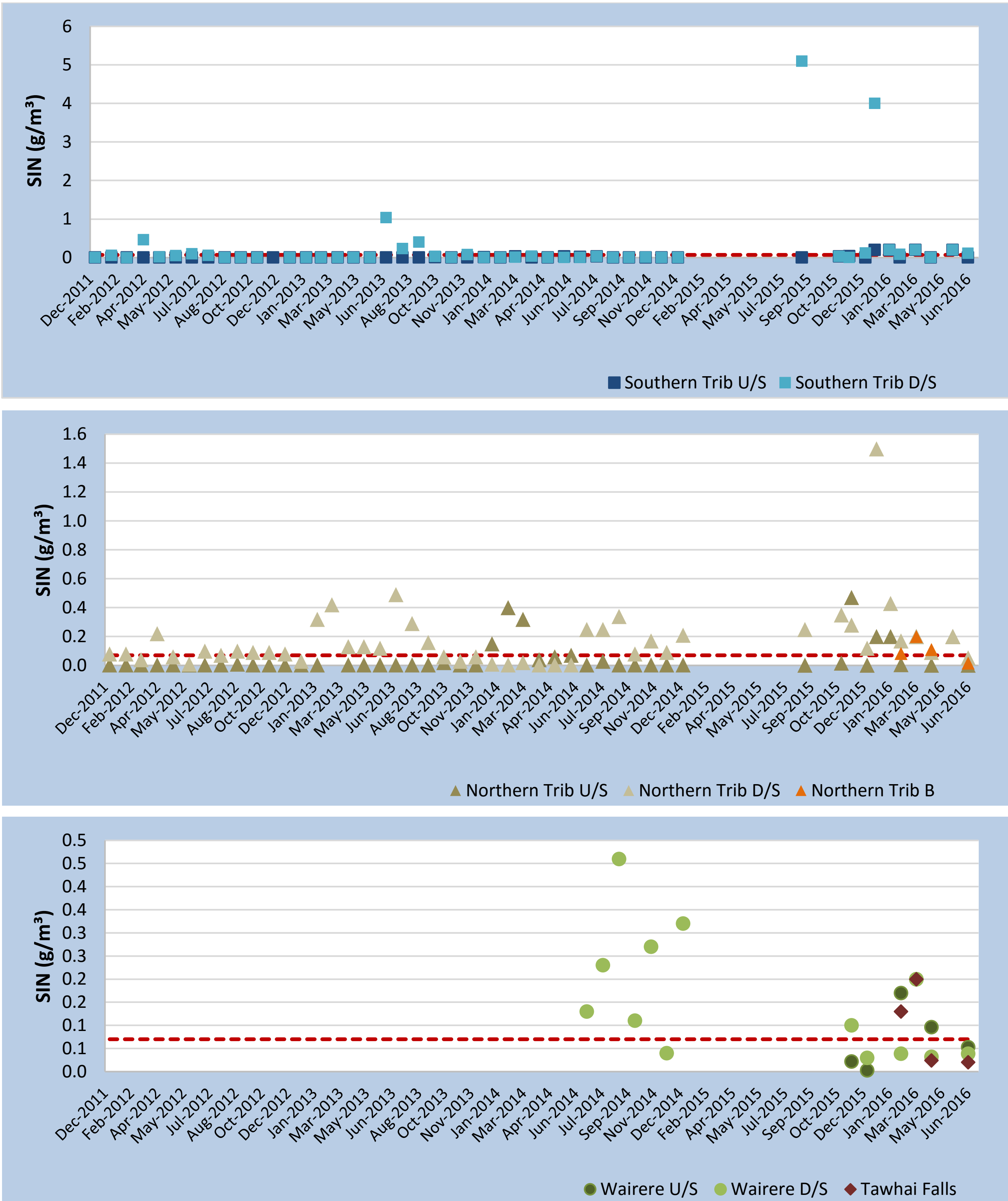


Figure 3: Soluble Inorganic Nitrogen (SIN) concentrations at sites sampled in the Southern (upper) and Northern (middle) tributaries and Wairere Stream mainstem and Tawhai Falls (lower), upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets. Note: Scales differ on each figure above.

1.3 Dissolved Reactive Phosphorus (DRP)

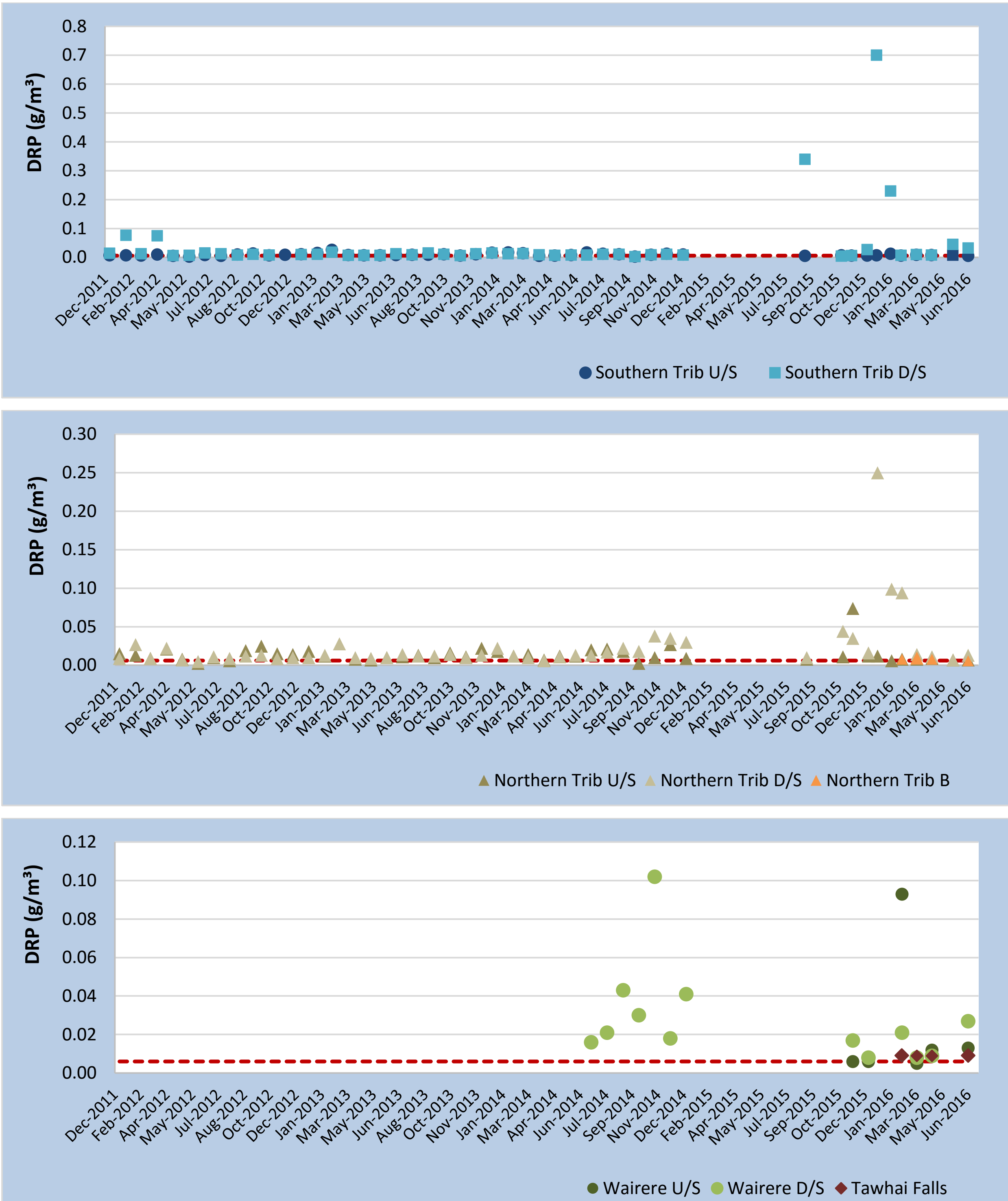


Figure 4: Dissolved Reactive Phosphorus (DRP) concentrations at sites sampled in the Southern (upper) and Northern (middle) tributaries and Wairere Stream mainstem and Tawhai Falls (lower), upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets. Note: Scales differ on each figure above.

1.4 E. coli

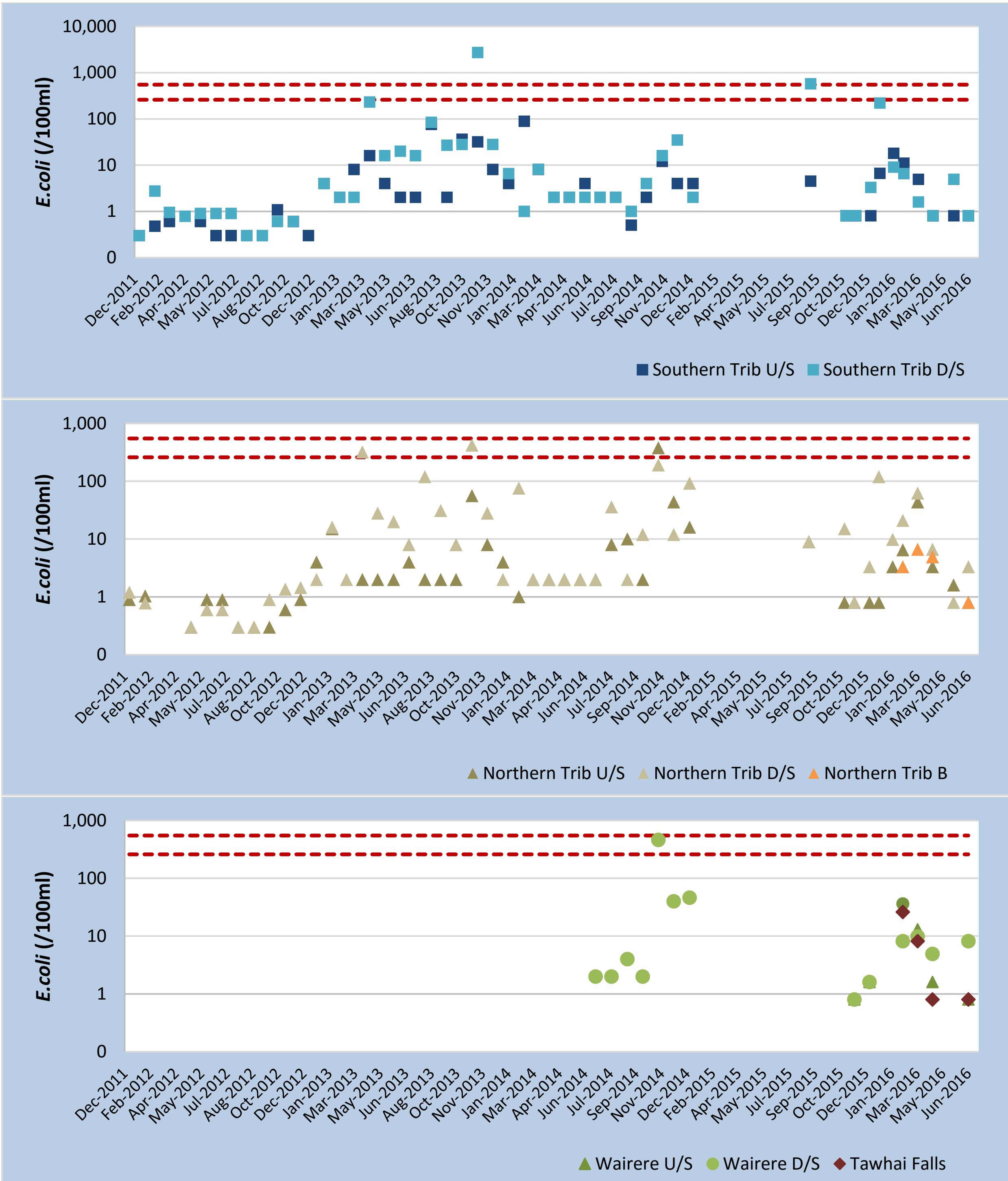


Figure 5: ***E. coli*** **concentrations at sites sampled in the Southern (upper) and Northern (middle) tributaries and Wairere Stream mainstem and Tawhai Falls (lower), upstream and downstream of the Whakapapa WWTP, 2012 to 2016. Red lines represent One Plan targets.**

2 Periphyton Communities

2.1.1 Periphyton biomass

Monitoring results (Figure 6 -7, Table 2) indicate that:

- In the Southern Tributary:
  - Periphyton biomass was always relatively low at the upstream site, and well below the One Plan target, with a maximum of 22 mg/m^2 in December 2015.
  - Periphyton biomass increased significantly at the downstream site in December 2015, January 2016 and March – July 2016.
- In the Northern Tributary:
  - Periphyton biomass was always relatively low at the upstream site, except in November 2015 when it just exceeded the One Plan target.
  - Biomass was higher downstream compared with the upstream site, exceeding the One Plan target three times, and only very marginally under the target on two other occasions (October and November 2015).
- In the Wairere Stream:
  - Periphyton biomass was always low upstream.
  - Downstream, the biomass increased compared with upstream on all sampling occasions, but remained low, well below the One Plan target (maximum of 16 mg/m^2).

Figure 6: Mean periphyton biomass, measured as Chlorophyll *a* (mg/m²) for sites sampled on the Southern (upper) and Northern (middle) tributaries and the Wairere Stream mainstem (lower) upstream and downstream of the Whakapapa WWTP. Red lines indicate the MfE guidelines (Refer Error! Reference source not found.**) * indicates no assessment undertaken.**

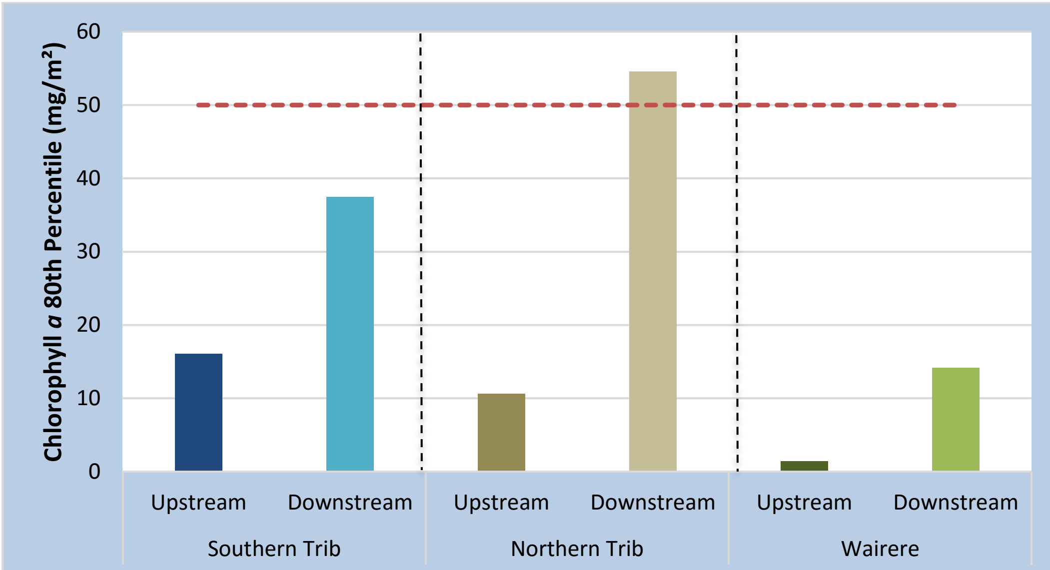


Figure 7: 80th percentile data for periphyton biomass measured as Chlorophyll *a* (mg/m^2) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP. The red line indicates MfE guidelines (Refer Error! Reference source not found.**).**

Table 2: Summary of 80th percentile data for periphyton biomass measured as Chlorophyll *a* (mg/m^2) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP. Compliance with the One Plan target is also shown.

	Southern Trib.		Northern Trib.		Wairere	
	U/S	D/S	U/S	D/S	U/S	D/S
No. of samples	12	12	12	12	7	8
80th percentile	16.06	37.48	10.58	54.60	1.43	14.16
One Plan target	50					
OP compliance?	√	√	√	x	√	√

2.1.2 Periphyton cover (thick diatom or cyanobacteria mats)

Monitoring results (Figure 8) indicate that:

- In the Southern Tributary:
  - Periphyton cover by thick diatom mats (> 3 mm) was generally higher downstream compared with upstream, particularly over summer months. Cover at both sites remained below the One Plan target of 60%.
- In the Northern Tributary:
  - Periphyton cover by thick diatom mats (> 3 mm) was similar at the upstream and downstream sites in most months, although higher upstream in November 2015 and higher downstream in April 2016. The percentage of substrate covered by thick mats at both sites on the Northern Tributary also remained below the One Plan target of 60%.
- In the Wairere Stream:
  - Periphyton cover by thick diatom mats (> 3 mm) was generally higher downstream in the Wairere mainstem (November 2015 and March to July 2016), although still below the One Plan target.

2.1.3 Periphyton cover (long filamentous algae)

Monitoring results (Figure 9) indicate that:

- In the Southern Tributary:
  - Periphyton cover by long filamentous algae (> 2 cm) was similar at upstream and downstream sites with the exceptions of October 2015 and February 2016 (when % cover was higher upstream on both occasions). In all months periphyton cover by long filamentous algae was well below the One Plan target of 30%.
- In the Northern Tributary:
  - While long filamentous algae (> 2 cm) covered 70% of substrate at the downstream site in October 2015, exceeding the One Plan target, very little or no long filamentous algae were observed at upstream and downstream sites in the Northern Tributary in subsequent months.
- In the Wairere Stream:
  - Periphyton cover by long filamentous algae (> 2 cm) was higher downstream in the Wairere mainstem in October 2015, March and April 2016. Both sites had cover below the One Plan target for long filamentous algae on all monitoring occasions.

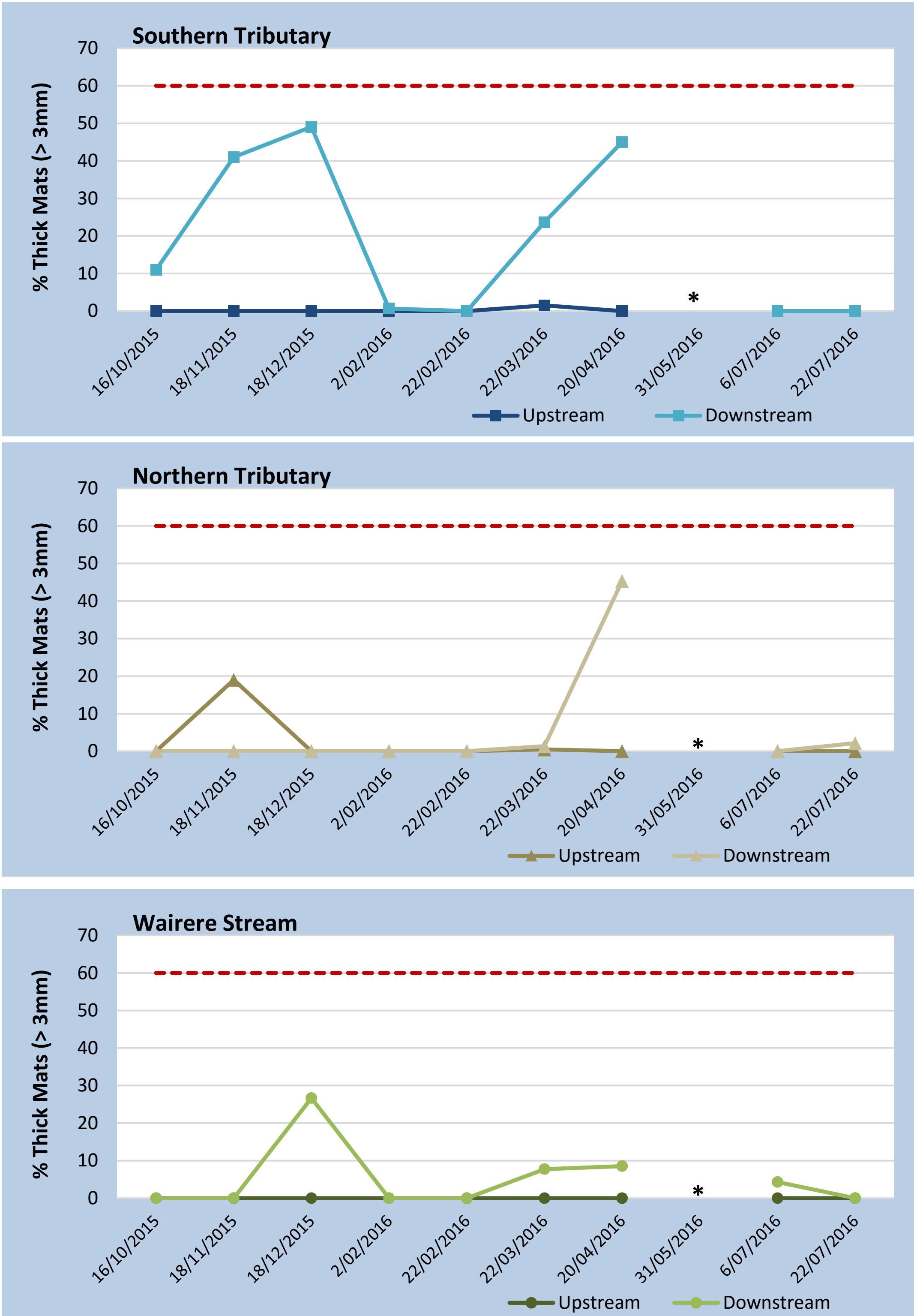


Figure 8: Percentage of substrate covered by thick diatom mats (> 3 mm), visually assessed at sites sampled on the Southern (upper) and Northern (middle) tributaries and the Wairere Stream mainstem (lower), upstream and downstream of the Whakapapa WWTP. Red lines indicate the One Plan target applicable for thick diatom mats. * indicates no assessment undertaken.

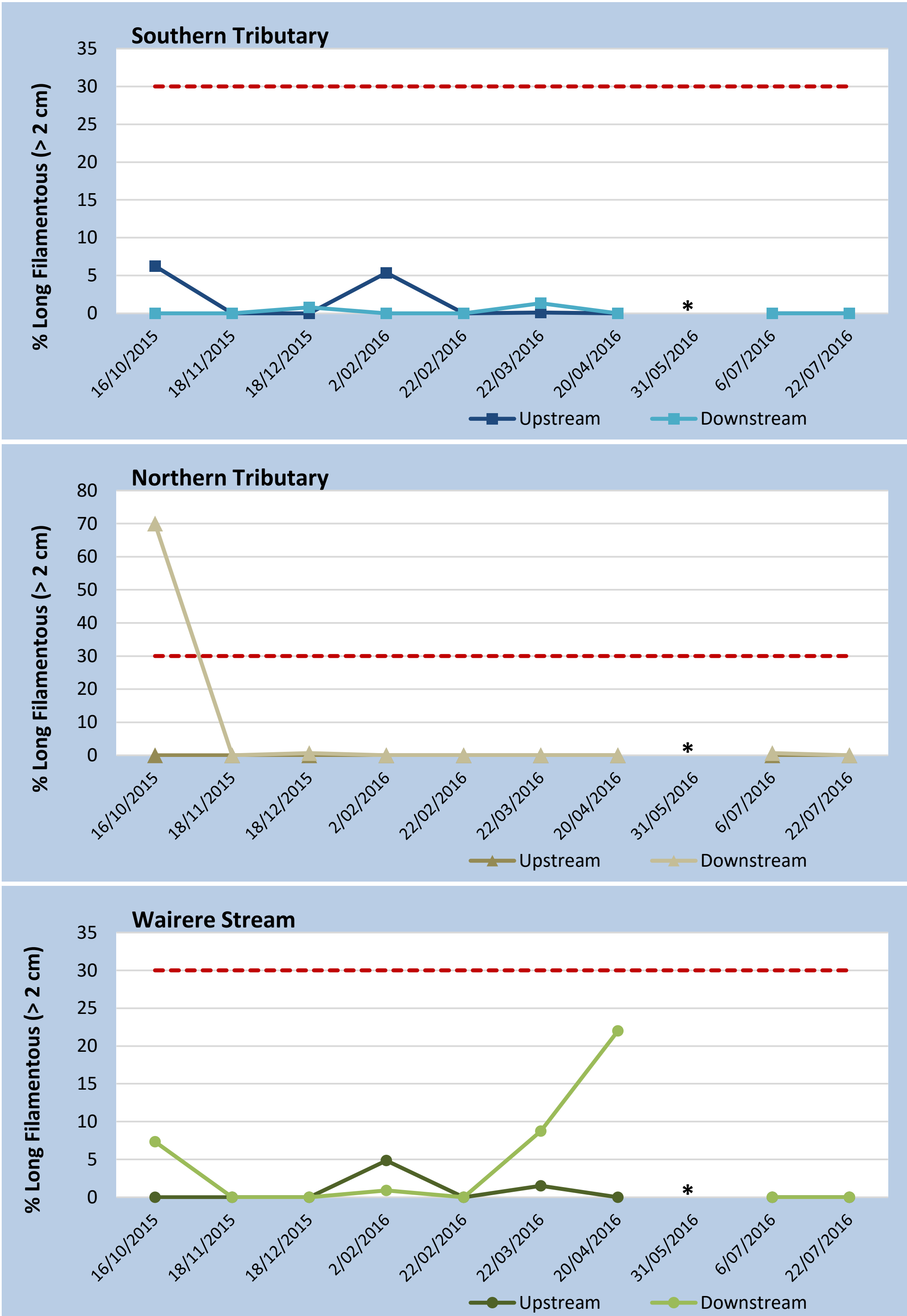


Figure 9: Percentage of substrate covered by long filamentous algae (> 2 cm), visually assessed at sites sampled on the Southern (upper) and Northern (middle) tributaries and the Wairere Stream mainstem (lower), upstream and downstream of the Whakapapa WWTP. Red lines indicate the One Plan target applicable for long filamentous algae. * indicates no assessment undertaken.

<u>SUMMARY: Periphyton cover by thick mats and long filamentous algae – all streams</u>

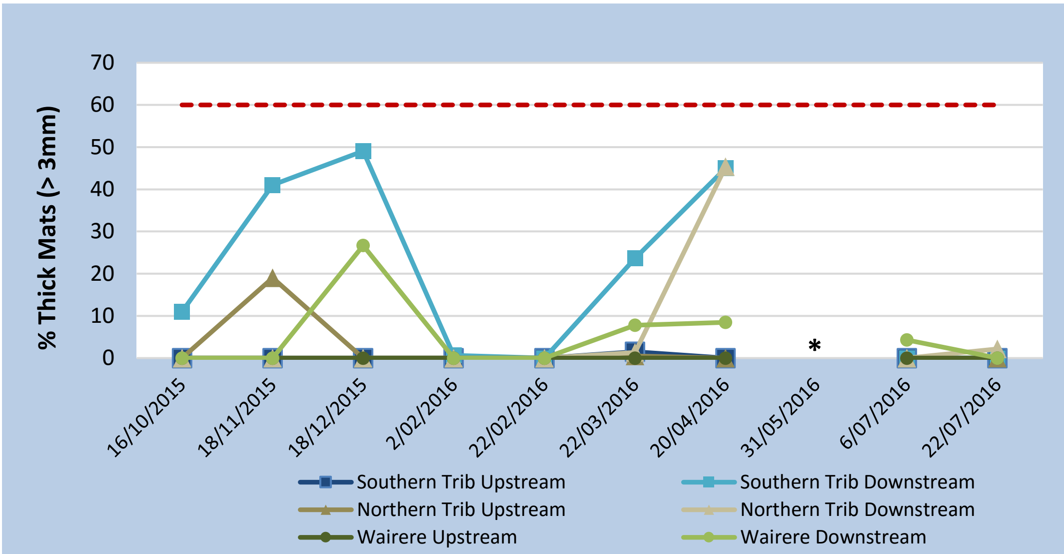


Figure 10: Percentage of substrate covered by thick diatom mats (> 3 mm), visually assessed at sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP. Red lines indicate the One Plan target applicable for thick diatom mats. * indicates no assessment undertaken.

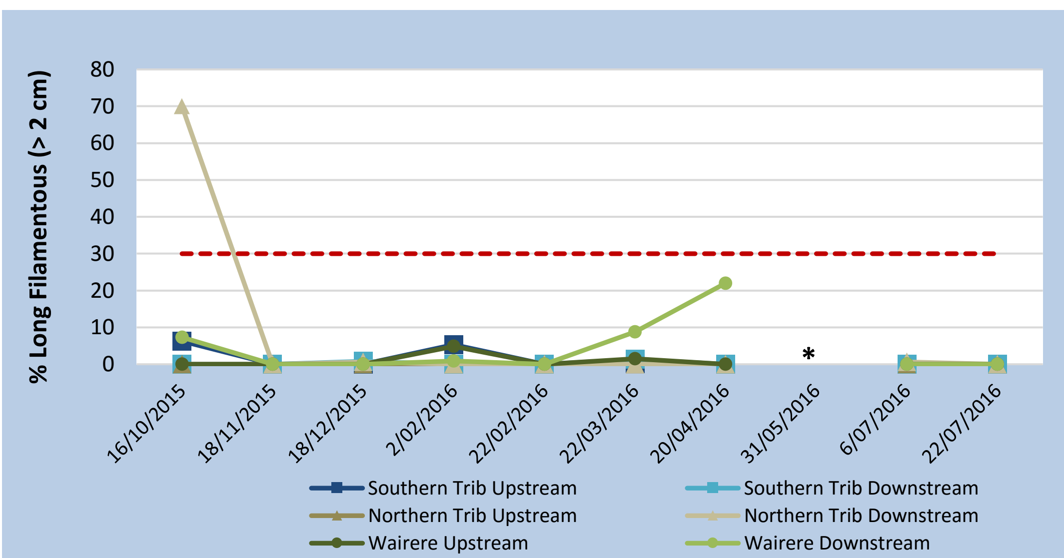


Figure 11: Percentage of substrate covered by long filamentous algae (> 2 cm), visually assessed at sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem, upstream and downstream of the Whakapapa WWTP. Red lines indicate the One Plan target applicable for long filamentous algae. * indicates no assessment undertaken.

2.2 Macroinvertebrate Communities

Comparisons of biotic index scores over the years are presented in Figure 12 to 14 and Table 5.

Number of Individuals and Number of Taxa (Figure 12) showed no significant differences between upstream and downstream sites on the Southern Tributary in any year, except 2016 where numbers of both individuals and taxa increased downstream. There were however, significant differences between upstream and downstream sites on the Northern Tributary for Number of Individuals in 2012 and 2015 (increases from upstream to downstream); and in Number of Taxa in 2014 (decrease from upstream to downstream). No differences were observed between upstream and downstream sites on the Wairere mainstem in 2015 or 2016.

%EPT Individuals (Figure 13) showed no significant differences between upstream and downstream sites on the Southern Tributary in any year, except 2015 when there was an increase. On the Northern Tributary however, there were significant differences between upstream and downstream sites in 2013 (increased), 2014 and 2015 (decreases), and 2016 (increased). No significant differences in %EPT individuals were observed between upstream and downstream sites on the Wairere mainstem in 2015 or 2016.

%EPT Taxa also showed no significant differences between upstream and downstream sites on the Southern Tributary in any year, except 2016 when there was an increase. However, on the Northern Tributary there were significant increases in 2013, 2015 and 2016. No differences were observed between upstream and downstream sites on the Wairere mainstem in 2015 or 2016.

The only significant changes in MCI score (Figure 14) between upstream and downstream sites occurred on the Southern Tributary in 2015 (increased), the Northern Tributary in 2014 (decreased) and on the Wairere Stream in 2016 (decreased). MCI scores are indicative of moderate to good water quality in the Southern and Northern Tributaries and Excellent/clean water quality in the Wairere Stream mainstem.

The relevant One Plan target for QMCI (no more than a 20% reduction) was met in the Southern Tributary in all years (Table 3). In fact, a significant increase between upstream and downstream was observed in 2015. The One Plan QMCI target was however breached in the Northern Tributary in 2014 (with a 39% decrease from upstream to downstream) and again in 2015 (23% decrease from upstream to downstream). The One Plan target for QMCI (no more than a 20% reduction) was complied with in the Wairere Stream in 2015 and 2016.

Comparison of Monitoring results from April 2016 with October 2015:

- In the Southern Tributary:
  - Similar patterns in both months, with increases in Number of Individuals, Number of Taxa, %EPT Individuals, %EPT Taxa and MCI from upstream to downstream;
  - QMCI decreased slightly downstream in April 2016 (2.3% decrease).
- In the Northern Tributary:
  - Similar patterns in both months, with increases in Number of individuals, Number of Taxa, %EPT Individuals, %EPT Taxa and MCI from upstream to downstream;
  - QMCI increased downstream in April 2016 (29% increase), compared with a 23% decrease from upstream to downstream in October 2015.
- In the Wairere Stream:
  - Similar patterns in both months for Number of individuals and Number of Taxa, which increased from upstream to downstream;
  - Opposite patterns for %EPT Individuals, %EPT Taxa and MCI which all decreased from upstream to downstream;
  - QMCI also decreased downstream in April 2016 (9% decrease), similar to results observed in October 2015 (10% decrease).

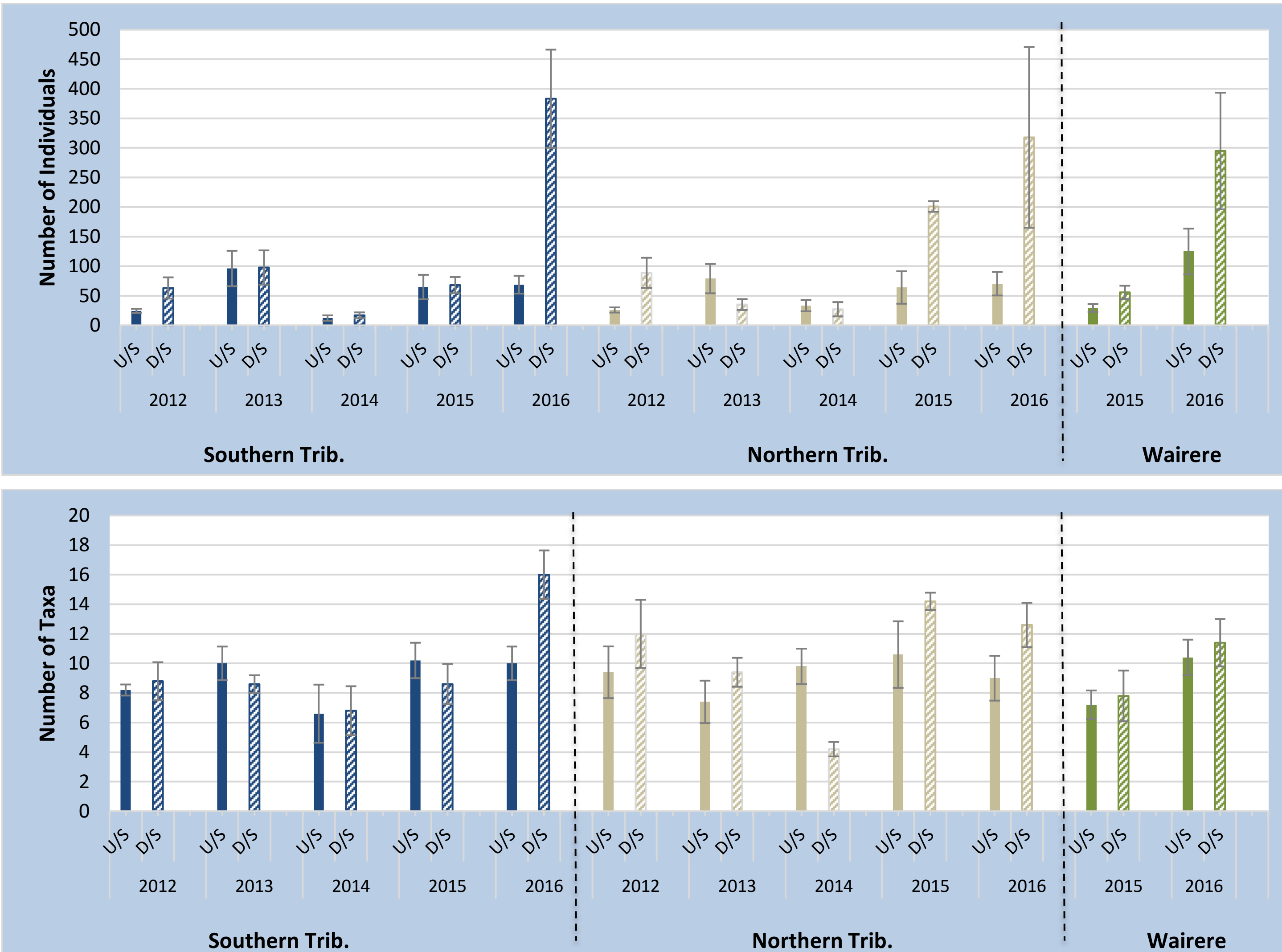


Figure 12: Mean (± 1 SE) Number of Individuals (upper) and Number of Taxa (lower) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012-2016.

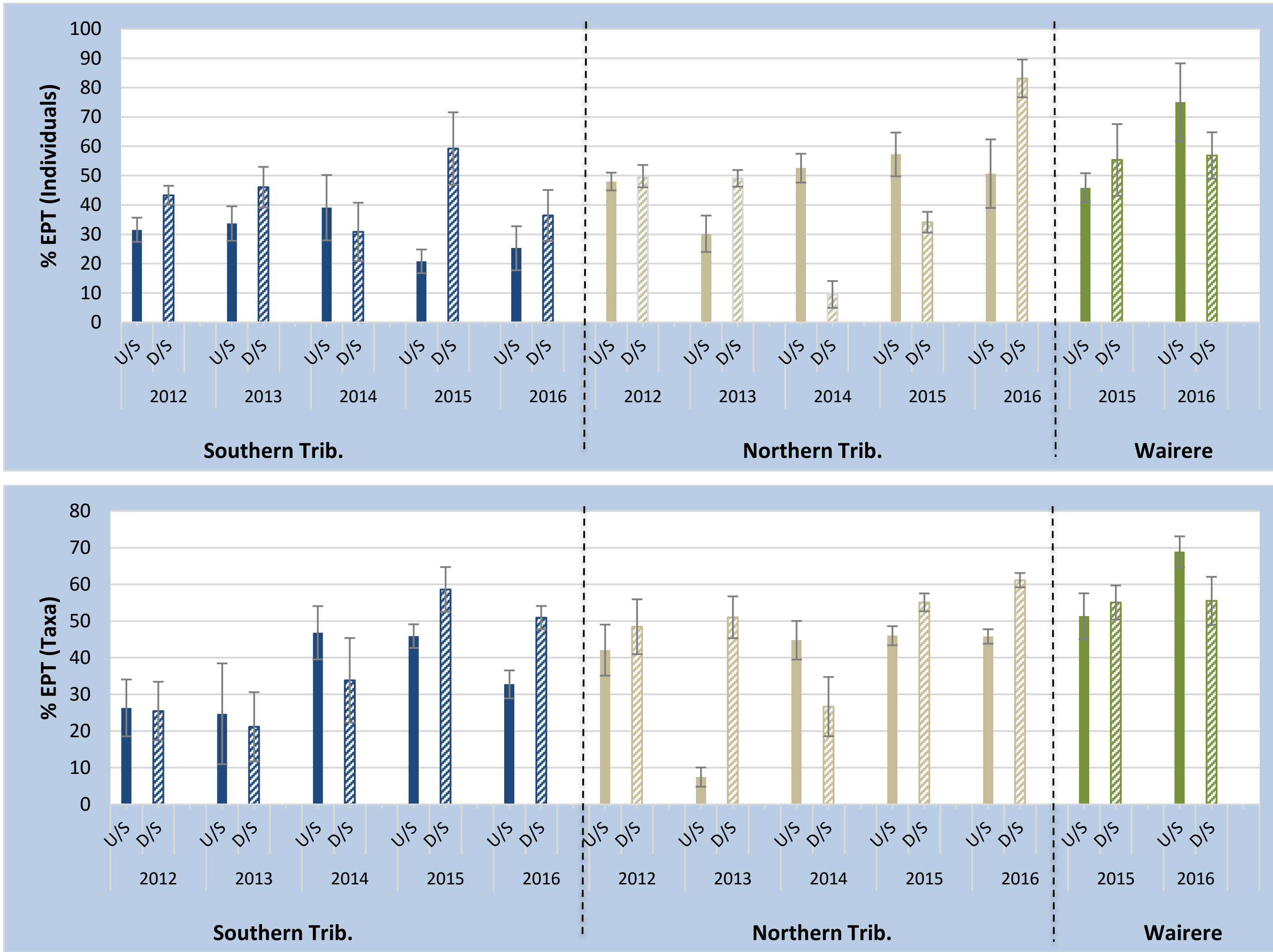


Figure 13: Mean (± 1 SE) %EPT (Individuals) (upper) and %EPT (Taxa) (lower) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012-2016.

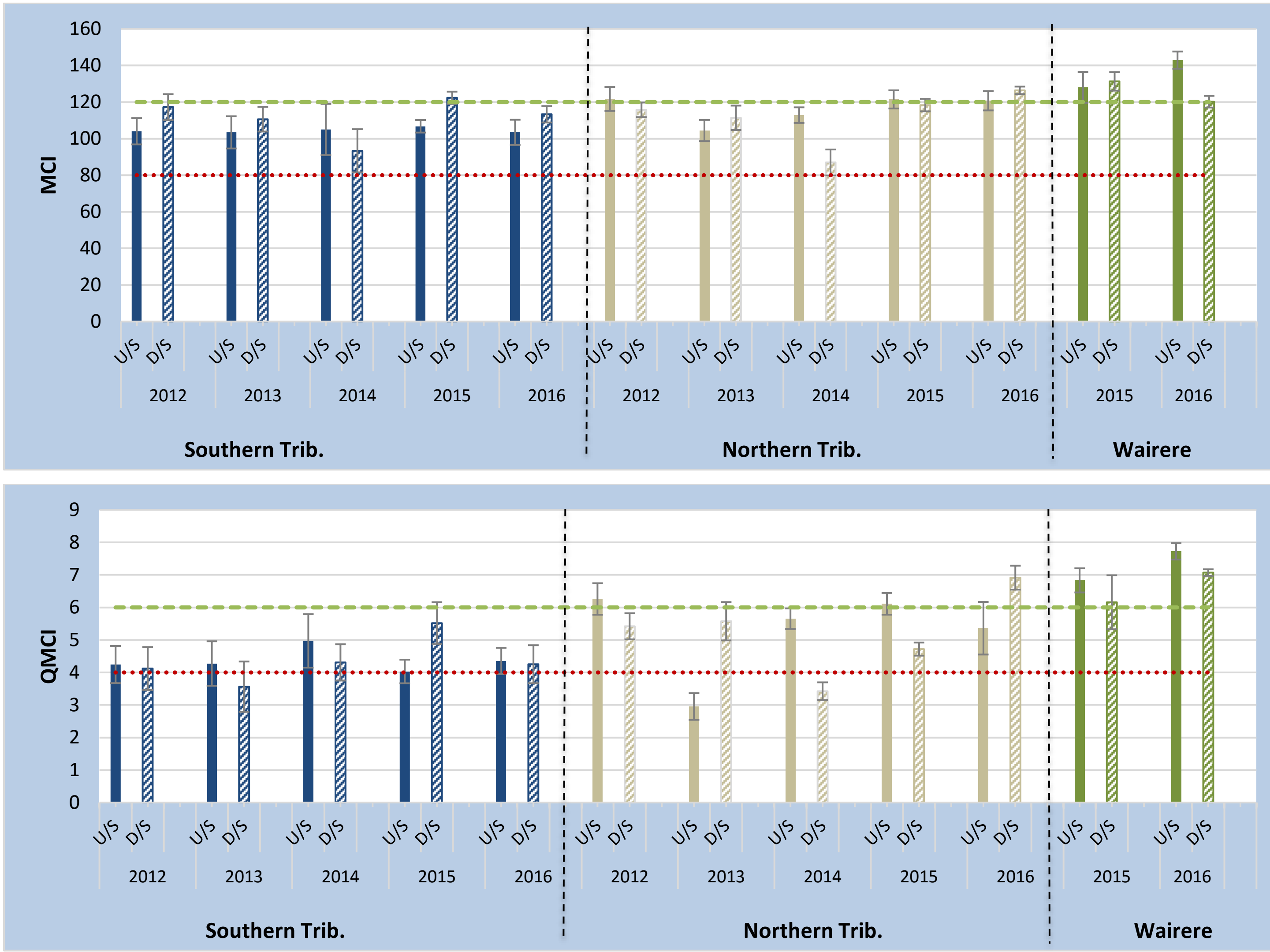


Figure 14: Mean (± 1 SE) MCI (upper) and QMCI (lower) for sites sampled on the Southern and Northern tributaries and the Wairere Stream mainstem upstream and downstream of the Whakapapa WWTP, 2012-2016.

Table 3: Summary of annual biotic indices for upstream and downstream sites on the Southern and Northern Tributaries and the Wairere Stream mainstem, 2012-2016.

	Southern Tributary									
	2012		2013		2014		2015		2016	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Number of Individuals	24	63	96	98	12	17	65	68	69	383
Number of Taxa	8	9	10	9	7	7	10	9	10	16
%EPT Individuals	32	43	34	46	39	31	21	59	25	36
%EPT Taxa	26	25	25	21	47	34	46	59	33	51
MCI	104	117	103	111	105	93	107	122	103	113
QMCI	4.24	4.12	4.27	3.56	4.97	4.31	4.03	5.52	4.35	4.25
% Change in QMCI	*-2.9*		*-16.7*		*-13.3*		*36.8*		*-2.3*	

	Northern Tributary									
	2012		2013		2014		2015		2016	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Number of Individuals	26	89	79	35	33	27	64	201	70	318
Number of Taxa	9	12	7	9	10	4	11	14	9	13
%EPT Individuals	48	50	30	49	53	10	57	34	51	83
%EPT Taxa	42	48	7	51	45	27	46	55	46	61
MCI	122	116	104	111	113	87	121	118	121	126
QMCI	6.26	5.42	2.95	5.58	5.65	3.42	6.11	4.72	5.36	6.92
% Change in QMCI	*-13*		*88.9*		*-39.4*		*-22.8*		*29.0*	

	Wairere Stream									
	2012		2013		2014		2015		2016	
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
Number of Individuals	No data						30	56	125	295
Number of Taxa	No data						7	8	10	11
%EPT Individuals	No data						46	55	75	57
%EPT Taxa	No data						51	55	69	56
MCI	No data						128	131	143	120
QMCI	No data						6.83	6.16	7.73	7.07
% Change in QMCI							*-9.9*		*-8.5*	

APPENDIX 10

GAP ANALYSIS AND RECOMMENDED PROGRAMME OF INVESTIGATIONS

Department of Conservation
Whakapapa Village Wastewater Treatment
Gap analysis and recommended programme of investigations (2015-2016)

March 2016

Report Prepared for the Department of Conservation

Aquanet Consulting Ltd

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441 Church Street
Palmerston North 4410

Department of Conservation

Whakapapa Village Wastewater Treatment

Gap analysis and recommended programme of investigations (2015-2016)

March 2016

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CONTENTS

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1. Introduction

Resource consents associated with the operation and discharges from the Whakapapa Village wastewater treatment plant (WWTP), operated by the Department of Conservation (DoC), expired on 1 December 2014. A resource consent application and Assessment of Environmental Effects (AEE) were lodged with, and accepted by, Horizons Regional Council (Horizons) on 25 August 2014. Horizons later issued a request for further information under S92 of the Resource Management Act (RMA). A response to the S92 request, compiled by Cheal, and including water quality and aquatic ecology information from the Catalyst Group, was lodged on 26 May 2015.

The aim of this document is to summarise the water quality and ecological information and data collected to date in relation to the Whakapapa WWTP and identifies information gaps, as well as a programme of investigations starting in October 2015.

The Whakapapa WWTP receives wastewater from Iwikau Village and Whakapapa Village. Within Iwikau Village, there are 47 ski club lodges, and the Ruapehu Alpine Lifts Ltd (RAL) facilities. Whakapapa Village includes the Chateau Tongariro, Skotel, Whakapapa Holiday Park, DoC facilities (visitor centre, staff accommodation, etc.), RAL staff accommodation and a few club lodges. The numbers of visitors, and therefore the wastewater loads entering the WWTP, are highly seasonal, with a peak during the ski season (July-September).

Since July 2015, the management of the WWTP has been transferred over to Ruapehu District Council. Veolia Water are contracted to carry out the day to day maintenance and management of the WWTP.

A number of operational and maintenance issues have been identified within the reticulation network (infiltration and ingress issue), at the WWTP and at the irrigation fields. These issues mean that the system, currently and for the last few years, has not been operating according to design specifications. It is our understanding that these issues are currently being investigated in detail, and will be addressed over the upcoming months. The sub-optimal functioning of the plant is likely to have had an influence on the contaminant loads exiting the WWTP and discharged, either directly or indirectly, to the receiving streams over the last few years. The programme of investigations and repairs also means that the situation (including the loads and location of loads entering the receiving streams) will be evolving over the 2015-2016 spring and summer period.

The aim of this document is not to discuss the operational issues at the plant, or the programme of investigations and repairs. However, the above are critical aspects to consider when assessing the relevance of current or historical monitoring data and making recommendations regarding a suitable programme of monitoring and investigations for the upcoming months.

A draft of this document was prepared in January 2016 and provided to Horizons's compliance and scientific experts. This final document incorporates these comments.

2. Data and information available to date

2.1. Existing consents

Discharge Permit No. 105684 was granted on 17 January 2012, for a term expiring on 1 December 2014, allowing the discharge of up to a maximum of 700 m^3/day (and a maximum annual average of 170 m^3/day) of treated wastewater into and onto land via subsurface drippers and ground soakage trenches.

It is our understanding that the short term (3 years) consent was granted in recognition that there was limited information available on the treatment plant's performance and the discharge's environmental effects. The Decision on the resource consent application states that short term consent was granted to allow for the necessary monitoring and investigations to be carried out to determine how the plant should be operated and whether any upgrades or additional treatment are required.

2.2. Treatment Plant and discharge

2.2.1. Existing system

The treatment train at the Whakapapa WWTP is currently composed of a coarse/primary screen, Pasveer ditch, sedimentation tanks, sand filters and UV treatment. Treated effluent from the WWTP is then piped to four irrigation fields (A to C). Based on information provided in the consent application, the WWTP is capable of treating up to 720 m^3/day. However, only up to 300 m^3/day can currently be discharged to the irrigation fields, with the balance of flow being discharged to the soakage trenches.

During high wastewater inflow events, flows that cannot be accommodated through the above treatment train are piped to the "emergency overflow pond". Wastewater from the emergency overflow pond is discharged to soakage trenches.

2.2.2. Options considered

The 2015 consent application proposes the decommissioning of the emergency overflow pond and soakage trenches. The pond would be used as a tertiary treatment pond flow equalisation basin (FEB) to attenuate peak flows and allow more uniform flows into the WWTP. Treated wastewater would be discharged to a constructed wetland located immediately below the existing pond.

Water quality and ecological investigations carried out as part of the S92 response (Catalyst Group) have identified that nitrogen loads entering the streams directly or indirectly could be an issue (to be confirmed by in-stream ecological monitoring) and may need to be reduced if monitoring showed a significant adverse effect. It is proposed to implement additional nitrogen removal if the One Plan periphyton and SIN targets are both exceeded after the implementation.

As part of the more recent project planning, the option of developing semi-natural wetland systems to serve as the final polishing and land passage step for the treated effluent is being considered.

2.2.3. Information and data collected to date

The existing consent requires that the following information be collected with regards to wastewater quantity and quality:

- flow meters to be installed to measure the volumes of wastewater "entering and leaving the plant" (conditions 13-16);
- monthly sampling of the treated wastewater "in the wet well after wastewater has been through UV treatment)" (conditions 17, 19 and 20).

2.2.4. Recommendations

First I note that recommendations in this report do not cover information requirements relative to the treatment process itself- these should be covered separately by wastewater engineers from Veolia and/or RDC.

In order to understand and characterise the contaminant loads discharged to the different parts of the receiving environment it is essential that all wastewater streams leaving the WWTP site are (1) clearly identified (i.e. what volume goes where) and (2) monitored for both flow/volume and quality.

The level of monitoring required by the consent is considered adequate to characterise treated effluent quality and quantity in relation to effects on the receiving environment.

Effluent flow is measured via a V-Notch weir located in a wet well located after the Pasveer Ditch, at a location that captures the whole effluent flow going through the plant, which is adequate. I note however, that the accuracy of the flow data has been reported as questionable, and it is recommended that the issue be investigated further and addressed if found to be significant.

Effluent quality is measured from samples taken in a second wet well, located after the clarifiers, sand filters and UV treatment. This only represents one of the effluent streams, with the effluent volumes unable to be accommodated through the sand filters being directed to the EOP, which then discharges to the soakage trenches. To my knowledge, the quality of the effluent leaving the EOP is unknown, and should be monitored in the future, until discharges from the EOP to the soakage trenches cease.

Currently, the consent application is for the discharge of up to 720 m^3/day of treated wastewater to a constructed wetland. However, significantly larger volumes of wastewater currently enter the WWTP/emergency overflow pond during periods of wet weather. A number of wastewater plants in the region are currently experiencing significant compliance issues because of discharge volume or rate limits that do not reflect the actual volumes/rates. Significant processes (e.g. consent variations, new consents) are likely to be required to address these compliance issues. It is strongly recommended that the discharge volume applied for the Whakapapa WWTP be verified and/or re-considered in light of existing discharge flow data. It is suggested that Veolia, RDC and Aquanet work collaboratively on developing an adequate consent condition.

The consent application states that irrigation fields A and B will be de-commissioned, and that only fields C and D will continue being operated, for a discharge for up to 300 m^3/d. It will be important to understand the current and future functioning of the irrigation fields, as this will influence the location at which contaminants ultimately enter the streams, and will thus affect the in-stream monitoring recommendations.

Last point, the option of developing a natural-looking wetland system to provide final polishing, land passage and contact with living plants will need to be developed further. Veolia have indicated that wetland development was somewhat outside their field of expertise. It is recommended that a multi-disciplinary team, composed of specialists with expertise in the fields of wetland treatment, engineering, wetland and aquatic ecology be formed to develop a concept plan. Detailed land topography data (LIDAR if available) may be required.

2.3. Receiving environment

2.3.1. Information available

The resource consent requires that the following data be collected at four sites located on two tributaries (southern and northern tributaries) of the Wairere Stream:

- Monthly water quality sampling and analyses (pH, DO, $ScBOD_5$, TSS, DRP, SIN, TNH_3-N and *E.coli*[1]);
- Annual sampling of macroinvertebrate communities
- Quarterly monitoring of periphyton cover and biomass (in 2012 and 2013 only).

In addition:

- Horizons have requested that a fifth site be added to the monthly water quality monitoring programme
- Investigations by the Catalyst Group have included periphyton cover and biomass monitoring monthly over the November 2014 to April 2015 period.

It is also my understanding that historical water quality data are available at the above sites, but also at additional sites. These data will be very important to understand the how the effects of the WWTP have evolved over time (particularly when the WWTP and the irrigation fields were functioning according to design). Data for sites located further downstream (in particular Wairere Stream downstream of the tributary confluence) will also provide essential information relative to the downstream extent of water quality effects from the WWTP.

Water quality sampling indicates that phosphorus concentrations in the streams are relatively elevated (and well in excess of One Plan water quality targets) upstream of the direct or indirect discharge points from the Whakapapa WWTP. This is not unexpected, as volcanic geology in the area is known to be naturally rich in phosphorus, and naturally elevated phosphorus concentrations have been documented in other rivers in the area. It is unclear whether the discharges from the Whakapapa WWTP cause an increase in DRP concentrations in the streams. By contrast nitrogen concentrations are very low in streams upstream of the WWTP. The discharge from the WWTP appears to cause a significant (both statistically and ecologically) increase in SIN concentrations. The natural imbalance between phosphorus and nitrogen and the naturally very low nitrogen concentrations mean that growth of periphyton in the Wairere Stream and its tributaries is likely to be strongly limited by nitrogen under natural conditions (i.e. upstream of influence/discharges from the WWTP). This means in turn that addition of available nitrogen (ammoniacal nitrite and/or nitrate- nitrogen) to these streams will cause a risk of increasing periphyton growth.

In a river system, nutrients are of environmental concern because they can, under certain conditions, cause excessive growth of periphyton. Periphyton is the green or brown slime growing on hard surfaces on the bottom of streams and rivers. Periphyton is a natural, and essential part of a stream ecosystem, as it provides the primary food source for macroinvertebrates the rest of the food chain. However, periphyton can under certain conditions, reach excessive, or "nuisance", and adversely affect a number of ecological, recreational and cultural values associated with the streams. The One Plan defines targets for both periphyton biomass (primarily in relation to ecological values) and cover (primarily in relation to aesthetic/recreational values).

[1] Water pH, Dissolved Oxygen, Soluble carbonaceous five-day biochemical Oxygen Demand, Total Suspended Solids, Dissolved Reactive Phosphorus, Soluble Inorganic Nitrogen, Total Ammoniacal nitrogen and *Escherichia coli*)

Based on conclusions drawn by the Catalyst Group, effects on other key water quality parameters appear to be either minor or within the One Plan targets.

Ecological (macroinvertebrate and periphyton) data collected by DoC, and then by the Catalyst Group are somewhat contradictory:

- With regards to macroinvertebrate communities, which are used as an overall indicator of the streams' ecological health, or "Life Supporting Capacity", the two surveys undertaken by DoC staff in 2012 and 2013 indicate no significant adverse effects, whilst the survey undertaken in 2015 by the Catalyst Group point to possible significant adverse effects.
- With regards to periphyton, the Catalyst Group report identifies issues with periphyton biomass data provided in previous DoC reports. It is my understanding that these issues have been confirmed by Horizons' scientist. The Catalyst Group report also points to a potential issue associated with excessive periphyton growth in the Wairere Stream itself downstream of the northern tributary confluence, although the conclusions drawn do not seem to be supported by data presented in the same report. Beyond these discrepancies and uncertainties, there appears to be a general increase in periphyton biomass and cover downstream of the discharge points. However, and importantly, there is no clear evidence that these increases cause regular exceedances of the One Plan periphyton biomass or cover targets.

One of the comments received from Horizons (Logan Brown, email dated 29/02/2016) is that the streams in the area of the Whakapapa WWTP have a "Natural State" value under Schedule B, and suggesting that an analysis of this value would be useful. The scope of this document is to address data and information requirements. In this regard, it is considered that the water quality and ecological monitoring programme recommended below is adequate to define the "natural State" of water quality and ecological indicators (using data collected at "upstream" sites). Any analysis of the implications of the "natural State classification in the One Plan are outside the scope of this report and best addressed in the Assessment of Environmental Effects (AEE).

2.3.2. Recommendations

With regards to water quality monitoring, I recommend that the existing monthly monitoring programme at the four sites required by the consent conditions, plus the fifth site requested by Horizons be continued.

I also recommend that the water quality monitoring water quality monitoring programme be extended to include sites located further downstream, to better understand the downstream extent of water quality effects from the WWTP, particularly with regards to nitrogen (SIN). SIN concentrations in the Whakapapa River are very low year round, indicating that dilution and attenuation of SIN are sufficient to ensure that effects are no more than minor at that point, and thus further downstream (including the Whanganui River). However the Whakapapa at Footbridge site is a significant distance downstream of the WWTP, and I recommend that additional monitoring be undertaken at sites between the WWTP and the Whakapapa at Footbridge site in order to understand the downstream extent of effects of the WWTP on nitrogen concentrations – in other words how far downstream are effects from the WWTP detectable and/or significant vs. not detectable and/or minor. Regular (monthly) water quality monitoring is recommended at the following sites (in addition to the sites required as part of the resource consent, as identified above):

- Wairere Stream upstream of northern tributary confluence;
- Wairere Stream downstream of Northern tributary confluence;
- Whakapapanui Stream at Tawhai Falls.

The results obtained during the first 2-3 months of monitoring should be assessed to determine whether an additional further downstream site (e.g. Whakapapanui Stream at SH47) should be added to the programme (specifically if analyses show elevated nitrogen concentrations at the Whakapapanui Stream at Tawhai Falls site).

At this stage, no stream flow information exist for the Wairere Stream or its tributaries. Flow data may become useful in the future to (1) provide background data to help with the interpretation of ecological data and (2) calculate in-stream nutrient loads and recommend discharge. It is noted that the installation of a flow site is strongly supported by Horizons Regional Council Water quality Senior Scientist Logan Brown[2]. Preliminary discussions with Ms Marianne Watson (HydroNet) have indicated that reliable flow relationships with existing flow recorders would be unlikely to be able to be developed, and that a flow recorder would have to be installed and maintained on the Wairere Stream, and flow relationships to this recorder would have to be developed for the smaller tributaries. Costs associated with installing and maintaining a flow recording station (particularly in a National Park) are significant. It is recommended that the benefits, costs and risks associated with the potential installation of a flow recording station be re-evaluated once additional water quality and ecological data are available, in particular once the significance of any periphyton issue (being regular exceedances of the One Plan targets) is confirmed or otherwise.

With regards to <u>ecological monitoring</u>, due to the degree of conflicting information and uncertainties associated with the nature and degree of effects, it is advisable to establish and carry on a robust monitoring programme in order to support the consenting process.

Generally, sampling of macroinvertebrate communities in relation to point-source discharges is undertaken during summer low flow periods, to capture the conditions under which the streams are most sensitive to point source discharges. However, the seasonal nature of visitor numbers and thus wastewater volumes and quality at the Whakapapa WWTP mean that the risk of effects on stream ecology may actually be greater during the winter/spring ski season than during the summer period. It is thus recommended that macroinvertebrate surveys be undertaken twice annually, once in spring (September - October), and once in summer (January-March). Sites should include the four sites required by consent conditions, as well as the Wairere Stream upstream and downstream of the Northern tributary confluence.

Periphyton growth is highly dependent on stream hydrology, light, temperature and, of course, nutrient inputs. Compliance with both the One Plan targets and the NPSFM (2014) Attribute State is best undertaken on the basis of a relatively comprehensive dataset (e.g. the NPSFM recommends three years of monthly monitoring), rather than relying on one-off surveys. Periphyton growth (biomass and cover) should be monitored monthly at the same sites as those recommended for macroinvertebrate sampling.

The duration of above monitoring programme needs to be considered in relation to changes currently occurring at the WWTP. The degree and speed of changes in treatment and/or discharge location mean that data collected now may not be representative of how the plant will operate in the near and more distant future. The monitoring as recommended above started in October 2015. It is recommended that it carries on until key operational improvements have been made and for a period of 6-12 months after that.

[2] Email dated 29/02/2016

TABLE 1 National Park, Ohakune and Raetihi WWTPs and Raetihi Water Supply: List of investigations - Summer 2014-2015				
Task		**Description/comments**	**Who**	**When**
Collection network	Investigations, maintenance and repair	• Ongoing programme of investigations maintenance and repairs of the reticulation collection network (Stormwater ingress)	RDC / Veolia	• Investigation: March 2016 • Delivery: 31 May 2016 (Phase 1)
Treatment plant and discharge	Monitoring	• Identify the different discharge streams (source(s) and point(s) of discharge); • Flow monitoring of the different discharge streams: check what meters are in place, and their calibration + quality/reliability of existing data records; • Monthly water quality sampling of the different discharge streams, with a particular focus on nitrogen (TN, TKN, nitrate-N, nitrite-N and ammoniacal-N), phosphorus (TP and DRP), suspended solids and *E. coli*	RDC / Veolia/ Aquanet	• Investigation: November 2015 • Delivery: February 2016 • Monitoring : ongoing
	Discharge volumes	• Identify current discharge volumes • Identify likely future discharge volumes • Draft realistic consent conditions relative to discharge volumes	RDC / Veolia/ Aquanet	• Investigation: Dec-Jan 2015 • Delivery: Feb 2015
	WWTP / treatment	• Assess the treatment performance, currently and following implementation of maintenance and repairs programme: • Effluent quantity • Effluent quality • Assess seasonal peaks/variability	Veolia	• Investigation: Nov-Dec 2014 • Delivery: End Dec 2014
	Investigate wetland/ tarn option	• Establish technical team (engineer + water quality + ecologist) • Obtain relevant data (LIDAR?) • Develop concept plan and high level costings • Consultation: Iwi, stakeholders, Horizons	Aquanet /RDC	• Investigation: March 2016 • Delivery: July 2016
	Disposal fields	• Assess / confirm state and operability of disposal fields A-D: • Are the fields able to be operated? • How much effluent can each field receive?	Veolia / RDC	• Investigation: February 2016 • August 2016
	Discharge quality monitoring	• Monthly (at least) monitoring of discharge quality • Ideally timing to coincide with in-stream water quality sampling • If several discharge streams (e.g. from the WWTP vs. from the overflow pond), then each discharge stream should be sampled • Samples to be analysed for nitrogen (TN, TKN, nitrate-N, nitrite-N and ammoniacal-N), phosphorus (TP and DRP), suspended solids, *E. coli,* POM, $ScBOD_5$;	Veolia / RDC	• Investigation: October 2015 • Delivery: Ongoing • Monitoring: Ongoing

Receiving Environment	Stream flow monitoring	• Consider installation of flow monitoring site for a period of 18-24 months • Benefits • Costs	Aquanet	• January 2016
	In-stream water quality sampling	• The following sampling regime is recommended • Monthly sampling at sites required by the resource consent; • Monthly sampling at additional downstream sites to assess the downstream extent of effects (see below) • Samples to be analysed for nitrogen (TN, TKN, nitrate-N, nitrite-N and ammoniacal-N), phosphorus (TP and DRP), suspended solids, *E. coli,* POM, $ScBOD_5$ • Monitoring sites, access and protocols should be clearly identified and documented • Sampling should be undertaken by adequately trained personnel • Timing to coincide with in-stream ecological monitoring and discharge quality sampling	Aquanet/ Veolia	• Ongoing from October 2015
	In-stream ecological sampling	• The following ecological monitoring is recommended • Monthly visual observations of periphyton cover using the Aquanet modified version of the Horizons protocol (Kilroy, 2009) • Monthly biomass (Chlorophyll *a*) assessment (1 sample at each site made of 10 individual rock scrapings) • Twice per year macroinvertebrate sampling (winter and summer) • Sites required by consent conditions (4 sites) + 2 sites on the Wairere Stream upstream and downstream of the confluence with the tributary • Monitoring sites, access and protocols should be clearly identified and documented • Sampling should be undertaken by adequately trained personnel • Timing to coincide with in-stream ecological monitoring and discharge quality sampling	Aquanet/ Veolia	• Monitoring: Ongoing (first round undertaken in October 2015)
	Downstream/ Cumulative effects	• Obtain historical Wairere Stream water quality data from DoC (already requested) • Review existing/historical water quality data and information on Wairere Stream and Whakapapa River • Undertake monthly monitoring at downstream sites: Wairere Stream downstream of the confluence with the tributary, and Whakapapanui Stream at Tawhai Falls; • Depending on result, initiate sampling of Whakapapanui at SH47 (Mahuia Rapids)	Aquanet/ Veolia	• Monitoring: ongoing from November 2015

APPENDIX 11

OPERATIONAL MANAGEMENT PLAN

Operation and Maintenance Manual

Whakapapa WWTP

Prepared for:

Ruapehu District Council

Operations & Maintenance Manual

Whakapapa Wastewater Treatment Plant

for:

Department of Conservation

Client:
Department of Conservation
Whakapapa Village

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Revision	Comment	Date	Initials
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2	Version 2.0 Final Draft	19 September	TM

Control Sheet

PROJECT TITLE:	Operations and Maintenance Manual	
CLIENT:	Ruapehu District Council	
DOCUMENT TITLE:	Operations and Maintenance Manual: Whakapapa Wastewater Treatment Plant Version 1.0	
PREPARED BY:	Judith Ellensohn	Date: August 2016
REVIEWED BY:	Nanne de Haan	Date: September 2016
AUTHORISED BY:	Anne-Marie Westcott	Date: September 2016
APPROVED FOR RELASE BY:	Paul Carr	Date: 19 September 2016

The document comprises:

- Title Page
- Quality Control Sheet
- Table of Contents
- List of Figure and List of Tables
- Document

Total: 39 pages + Appendices

Department of Conservation
Te Papa Atawhai

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1 INTRODUCTION

The Whakapapa Wastewater Treatment Plant (WWTP) is owned by the Department of Conservation (DOC) and located within Tongariro National Park. Since the 1940s the Whakapapa Village has been serviced by a reticulated wastewater system and the treated effluent was discharged directly to water. In 2004, primarily due to cultural concerns, Iwikau Village and the Whakapapa Ski Area were connected to the Whakapapa Village wastewater system. Within Iwikau Village, there are 48 ski club lodges, and the Ruapehu Alpine Lifts Ltd (RAL) facilities. Whakapapa Village includes the Chateau Tongariro, Skotel, Whakapapa Holiday Park, DOC facilities (visitor centre, staff accommodation, etc.), RAL staff accommodation and a few club lodges. The numbers of visitors, and therefore the wastewater loads entering the WWTP, are highly seasonal, with a peak during the ski season (July-October). A significant upgrade of the plant was undertaken in time for the 2005 winter season, following which the treated wastewater was discharged to land via subsurface dripper fields.

Since July 2015, the facilities management of the WWTP has been contracted to Ruapehu District Council (RDC). Veolia are contracted to carry out the day to day maintenance and management of the WWTP. Since July 2015 a comprehensive review of the state and performance of the reticulation network and wastewater plant has been undertaken and a program of recommended maintenance and upgrade proposed as per the Whakapapa and Iwikau Village Asset Management Plan.

This Operations & Maintenance Manual for the Whakapapa Wastewater Treatment Plant has been prepared by Veolia to assist both Veolia and Ruapehu District Council with the efficient and effective on-going operation and maintenance of Whakapapa Wastewater Treatment Plant activities. Furthermore, condition 10 of the current Resource Consent [no. 105684] for operating the plant and discharging treated wastewater requires appropriate updating of the Operations and Maintenance Manual. This manual also supports the new Resource Consent for the Whakapapa WWTP. Therefore, this O&M Manual is by nature a living document which will be amended in accordance with any future improvements / upgrades undertaken and in complying with any future resource consent conditions.

2 WHAKAPAPA WASTEWATER SUPPLY – SCHEME PLAN

The Whakapapa wastewater scheme comprises the villages of Whakapapa and Iwikau as well as waste water supplies from ski lodge clubs up the mountain. Figure 1 and 2 on the two following pages outline the wastewater scheme reticulated pipe system.

Figure 1 Whakapapa wastewater scheme, Whakapapa section[1]

[1] GIS information supplied by DOC

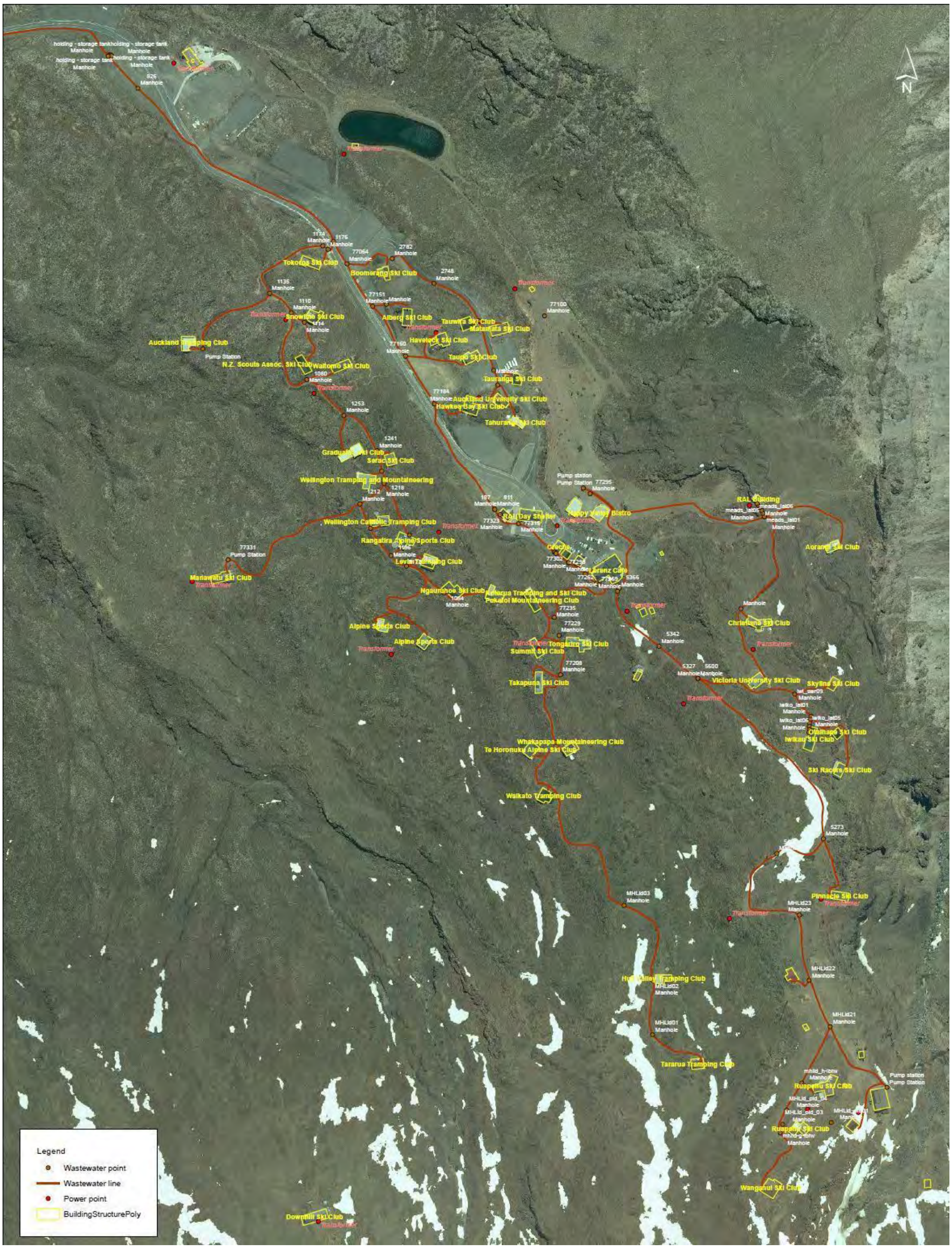


Figure 2 Whakapapa wastewater scheme, Iwikau part

At the bottom of the Iwikau part of the wastewater scheme which is at the top of Figure 2 there is an in-line storage tank that was recently converted to a buffer tank. It has a capacity of 350 m^{3}.

[2] Construction Drawings, ISPS Consulting Engineers, 2016

3 WHAKAPAPA WWTP OVERVIEW

3.1 Summary of WWTP

The current Treatment process at Whakapapa WWTP comprises:

- **Pre-Screening** (basket screen with 15mm openings)
- **Pasveer Channel** with two cage rotors (as variation on the conventional activated sludge process)
- **Flow Splitting Box (**distributes waste water evenly between the Sedimentation Tanks)
- **Dortmond's sedimentation tanks** (to separate activated sludge floc (solids) from the liquid (effluent))
- **Tertiary treatment process** (Filtration through Sand Filter and UV disinfection)
- **Pump station 1**(from where it is pumped through flowmeter to Infiltration fields)
- **Infiltration fields** (consists of four fields with underground dripper lines →note: this will be improved/changed in the near future into wetlands (see Appendix H).
- **Sludge dewatering** (for Waste Activated Sludge)
- **Tertiary Treatment Pond** (serves as treatment back-up and drains to infiltration trenches)

WWTP capacities and volumes:

- Pasveer Channel:238 m^3
- Dortmond's sedimentation tanks ~2x18 m^2
- Sandfilters: 3x6.5 m^3/h
- UV-Disinfection Unit: 22.5m^3/h filtered water
- Hydraulic Peak Inflow: 578 m^3/day (winter weekends)
- Average Daily Inflow: see Table below
- Pond overflow trenches: 100 to 300 m^3/day
- Design Capacity of irrigation fields: 635 m^3/day

Table 1 Estimated Peak Wastewater Volumes[3]

Source	Population	Flow allowance [l/d/p]	Volume [m^3/d]
Iwikau Village			
RAL visitors	6000	25	150
RAL day staff	200	50	10
Ski club lodges	1600	120	192
Whakapapa Village			
Overnight visitors	1280	220	282
DOC day staff & visitors	1450	30	44
Bar & other use	780	30	23
Total Flow			701

[3] According to DOC Whakapapa Village, Tongariro National Park – Application for Resource Consent for Wastewater (21 August 2014)

According to the DOC report[3] the -flows for the years 2005 to 2013 have averaged between 370 and 570 m^3/day. Peak flows have been recorded between 1,400 and 2,200 m^3/day over this period. These figures have recently reduced with a new meter more accurately recording data and recent works to reduce I&I flows. The main plant flow instrument has been identified as faulty in early 2016 and was replaced in June 2016. After this date reported flows are much lower. No reliable conversion of previous flow data is therefore useful.

3.2 Site Location

Physical Address & Specific Location Details

Northeast of the Chateau Tongariro, east of the golf course and east of State Highway 48 as shown in Figure 3.

Map of Location

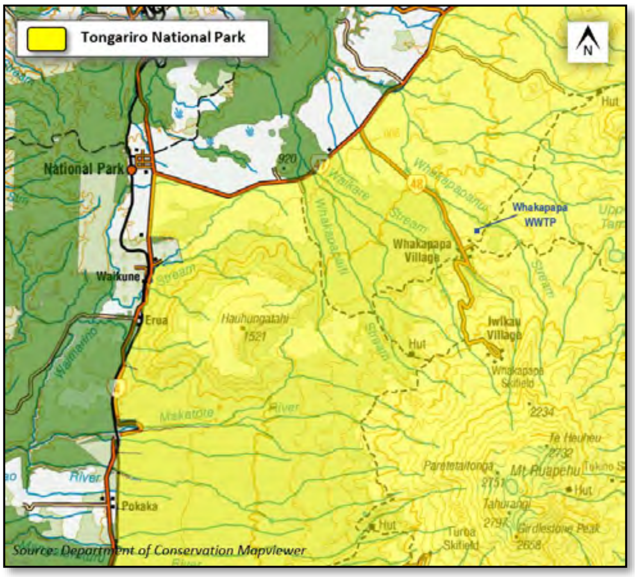


Figure 3 Map of location of Whakapapa WWTP

Aerial Map of Photograph of Location

Figure 4 Arial Map of Whakapapa WWTP

3.3 Site Layout Plan

The Site Layout Plan (Overall Site Plan) for the Whakapapa WWTP is included in Appendix A.

3.4 Schematic (Piping & Instrumentation Diagram)

The Piping and Instrumentation Diagram of the Whakapapa WWTP is included in Appendix A.

3.5 WASTEWATER TREATMENT COMPONENT DESCIPTION

3.5.1 Process Description

The Whakapapa Wastewater Treatment Plant consists of a basket screen to remove gross solids prior to wastewater entering the Pasveer Channel, Settlers, a pumping station to pump the secondary treated effluent through the tertiary treatment filtration and UV disinfection process and a further pumping station to pump the tertiary treated effluent to sub-surface infiltration on nearby land for final effluent disposal.

Surplus activated sludge is currently thickened in a re-aeration tank and disposed of to the Turangi WWTP.

A schematic representation of the current process is given in Figure 5 Block flow diagram of the Whakapapa WWTP.

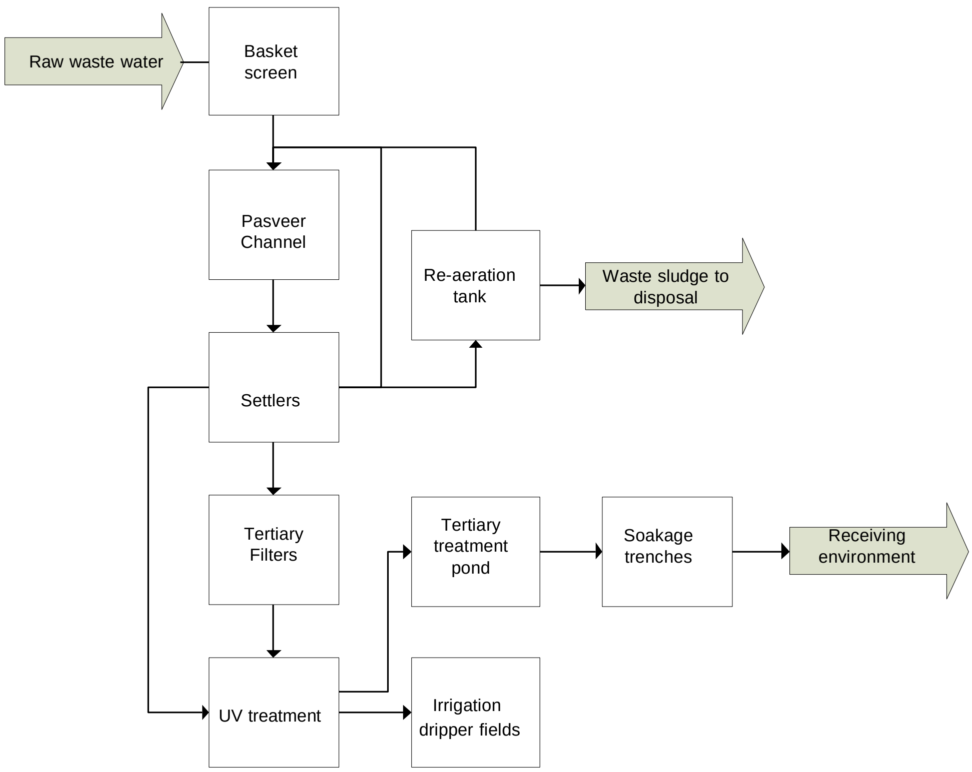


Figure 5 Block flow diagram of Whakapapa WWTP

Figure 6 Basket screen

Figure 7 Cage rotor inside Pasveer Channel

Wastewater is received in a small chamber containing a 15mm aperture screening basket. Return activated sludge (RAS) from the Settlers or Re-aeration tank is also returned to this point. The mixture of raw wastewater from the sewer and return activated sludge (microorganisms that are able to metabolise and break down the pollutants in the wastewater) is received in the Pasveer Channel. The contents of the Pasveer Channel (called mixed liquor) are continuously pumped around by two cage rotors maintaining the necessary velocity to ensure the sludge does not settle out. The two cage rotors also provide for the transfer of atmospheric oxygen, required by the microorganisms carrying out the biological breakdown process of water-borne contaminants. The rotors can be run continuously or on a timer system. During winter maximum nitrification is aimed for and rotors run all the time. Timer sequence operation will depend on variations in load. As the load increases and the measured Dissolved Oxygen (DO) levels drop the timers controlling the rotors are manually adjusted to keep the DO level within the required parameters.

Rag rakes protruding down into the Pasveer Channel in front of the rotors catch gross solids that have made it into the Channel. These rakes are cleaned periodically to remove the solids from the system. Mixed liquor from the Pasveer Channel constantly flows under gravity through the flow splitting box which should distribute flow evenly to the two Settlers. These Settlers can be individually isolated which is done during low flow periods.

Figure 8 Settler

Figure 9 Flow measuring chamber with V-notch weir flow meter

Figure 10 Flow transmitter

The Settlers are used to separate the activated sludge flocs (solids) from the liquid (effluent). The activated sludge is denser than water and settles to the bottom of the tank under gravity while the clarified effluent overflows the weir, through the flow measuring chamber and into a pump well. The clarification tanks are shaped as hoppers and have adjustable weirs. By raising or lowering the weirs through a total vertical movement of about 15 centimetres the level in the Pasveer Channel and the Settlers can be raised or lowered thus increasing or decreasing retention time.

The clarified effluent from the Settlers is collected in Pump Station 1, from where it is pumped through the sand filters. These filters - polish the effluent (remove suspended solids carried over from the Settlers) before it passes through the ultraviolet (UV) disinfection unit. Polishing the effluent maximises the efficacy of the UV disinfection process and the following subsurface infiltration.


Figure 11 Tertiary filters


Figure 12 UV disinfection

The effluent from the tertiary treatment process passes through a coarse safeguarding screen, then runs into Pump Station 2, from where it is pumped through a flow meter and out to the infiltration fields. The infiltration fields consist of 4 fields of sub-surface dripper lines, each able to be supplied independently by operating control valves. All drippers are plugged however and a limited in how much flow they can process.

For the occasions that flow through the plant is in excess of what the infiltration fields can cope with, the secondary or tertiary treated effluent will overflow into the tertiary treatment pond (TTP). The liquid effluent is retained in the pond for a period depending on the effluent flow into the pond and rainfall. It functions as an optional treatment pond. The pond contents eventually drain to infiltration trenches in the land downhill of the pond. From these trenches the water eventually drains to a tributary of the Wairere Stream.

It is proposed that the irrigation fields be replaced by a wetland system. Operating and Maintenance instructions relating to this system will be incorporated in this document once completed. Furthermore, the Tertiary Treatment Pond will allow storage to control flow to the wetlands.

Figure 13 Tertiary Treatment pond

Figure 14 RAS pumps

The activated sludge that has settled to the bottom of the Settlers is normally returned to the head of the plant by means of return activated sludge pumps. Two pumps are present. They are typically operated as one per Settler (normal configuration). The sludge inventory in the plant normally grows due to the contaminant load received. Periodically sludge has to be wasted from the system to keep the correct balance between food (the substrate coming into the system) and mass (the microorganisms breaking down that substrate).

Figure 15 Dewatering pad

Figure 16 Re-aeration tank

The RAS pumps discharge can be diverted to the sludge treatment area to waste it from the system (waste activated sludge, WAS). When sludge is being wasted, it has a polymer dosed into it to help with the dewatering process. WAS is currently being pumped into the re-aeration tank while being dosed with polymer. Here it undergoes gravity thickening. Supernatant is periodically pumped off back to the Pasveer Channel. Originally the thickened sludge from the re-aeration pond was supposed to undergo further dewatering in geotextile bags. However due to health and safety concerns this practice was stopped. Hence the thickened sludge is periodically collected by vacuum truck and sent to the Turangi WWTP

The re-aeration tank is originally designed as an intermediate step between the RAS pumps and the return point in the Pasveer Channel. The microorganisms in the sludge require oxygen to thrive and decay (endogenous respiration) and oxygen to metabolise the contaminants in the wastewater (exogenous respiration). The separate re-aeration tank is included to separate the endogenous respiration from the exogenous respiration and thereby allow a more efficient oxygen transfer for this part.

3.5.2 Table of Significant Assets

A list of all significant Assets of the Whakapapa WWTP can be found in Appendix I.

4 WHAKAPAPA WASTEWATER DISCHARGE RESOURCE CONSENTS

4.1 Resource Consent Application

The current discharge permit for the WWTP (No. 105684) was issued in January 2012. This was granted for a term of three years, expiring on 1st December 2014. An application for new consent(s) was lodged and accepted by Horizons Regional Council on 1 September 2014. Since then the WWTP has continued to operate under s.124 (RMA) while the current consent application is processed. During the course of this process, there have been s.92 (RMA) requests for additional information. In responding to these requests, and to reflect more recent information and a revised approach, DOC has decided that in order to provide answers to the questions and issues that have been raised, it would be more efficient to comprehensively update the application and assessment of effects ('AEE') which was lodged with the Council on 21 June 2016.

The new resource consent application among others includes for a commitment to decommission the existing drip irrigation and trenches and commission a new wetland discharge, with any overland flow directed to the unnamed tributary. In terms of quality the discharge effluent will need to comply with a set of parameters derived of the Horizons One Plan in-stream ecological parameters for the watercourse into which the effluent will eventually run. Historical monitoring has revealed that that Horizons water quality targets are not being compromised except for dissolved organic nitrogen and ammoniacal nitrogen.

4.2 Copy of Resource Consent and Resource Consent Summary

A copy of the Resource Consent (No. 105684) together with a summary is provided within Appendix C.

5 WHAKAPAPA WWTP OPERATIONS & MAINTENANCE

5.1.1 Plant Management Tools and typical Parameters

The values below are generalised only and can be adjusted to suit the situation at the time.

Table 2 Whakapapa WWTP Management Tools for different loadings

Parameter	Low season (Low load)[1]	Ski season (simplified Nitrox)[2]
Dissolved oxygen	0.5 - 1.5 (around 1.0 as a mean value)	0.5 - 1.5(trying to keep it as high as possible)
Aerator	Both aerators on timer	2 aerators continuously (especially necessary at peak in morning when load is at its highest)
Sludge volume index	Try to keep it below 200 at all times	Up to about 200 (the lower the better)
Mixed liquor suspended solids	2,000-4,500 (3,500 on average)	3,500-5,500 (4,500 on average)
pH value	6.0 - 7.8	7.0 – 8.0 (hardly any nitrogen removal and pH approximates that of raw water)
Settlers	1 in use unless stormwater problem	2 in use
Weir settings	Low	High
Reaeration tank	In use as sludge thickener	In use as sludge thickener
Return sludge rates[3]	200-400% daily flow. Value judgment based on effluent quality	About 200-400% of daily flow. But depends on settling characteristics of the activated sludge
Effluent quality	Excellent BOD and SS removal. Nitrification will occur if DO maintained at higher level	Good BOD and SS removal. There may be a slight drop in quality as loading changes. Nitrification partially expected.
Microbiology	Stalked ciliates and rotifers predominant. Low numbers of other organisms may be present	Free-swimming ciliates. Stalked ciliates and odd rotifer may still be present. Suctoria may also be present
Nitrification	Will occur if DO high, in -maximum nitrification‖ – mode DO should be between 1.0 – 2.0mg/L	May partially occur if DO can be maintained above 2.0 during moderate temperatures and flows

1) The WWTP was originally designed to run on extended aeration during the low season. The plant load has become too high to enable this mode. The recommended MLSS is kept reasonably low to avoid upsets in the rather shallow settlers, while trying to combine BOD removal with as much nitrogen removal as the hardware on the plant permits.
2) The WWTP was originally designed to run in high load mode during the ski season which means no nitrogen removal at all. Since it was indicated that nitrogen removal

is a key requirement it was decided to remove as much ammonia as possible within the hardware constraints. This means that a relatively old sludge must be maintained. The elevated plant loads also means that less hydrolysis can take place. As such the MLSS must be kept as high as possible without upsetting the plant. The operator controls this by observing the colour of the sludge and foam in the Pasveer Channel and wasting sludge accordingly. Running the plant in this mode is not recommended in combination with use of the Tertiary Filters.

3) Return sludge rates should as a rule of thumb be around 100% of daily flow, but this is not possible with the current RAS pumps.

Table 3 Whakapapa WWTP typical and design loads

Parameter	Unit of measurement	Typical low season load	Design load
Average dry weather flow rate	m^3/d	211	485
Peak wet weather flow rate	l/s*	18.8	18.8
Temperature	°C	15	≥7.4
Total suspended solids	kg/d	46.2	123.8
Chemical oxygen demand	kg/d as O_2	103.0	259.3
Ammonia nitrogen	kg/d as N	8.1	48.1

* Different unit used to indicate the temporary character of peak wet weather flow

5.2 Frequency of Operating / Maintenance Activities

Prior to executing any operating or maintenance task, be aware of the Health & Safety requirements of the task:

- Correct PPE to be worn;
- Two man working where applicable for the task;
- Job Safety and Hazard Environmental Analysis (JSEA) to be undertaken for non-routine tasks;
- Biological contamination risk.

Fill the sink in the lab with hot water and disinfectant before starting work. This will allow immediate cleaning of sample beakers and labware and as such prevents cross-contamination.

5.2.1 Daily Tasks

Table 4 Daily Operating / Maintenance Activities

Item	Action
Plant Check	Take a walk around the plant and: Look for leaks, spills, overflow pipes running, dirt, signs of rodent activity, anything abnormal. Listen for unusual noises from motors, pumps and pipework. Smell for any strong or unusual smells. Feel for pipework, motors pumps etc. heating up. Record observations on the daily operating sheet (Appendix III, DOCDM-99295). Major operating problems, Health and Safety issues and any non-compliance with the Resource Consent

	conditions should be dealt with immediately to make the situation safe. Immediately thereafter the issue must be brought to the attention of respectively the Supervisor, Operations Engineer and Contract Manager and an incident report has to be lodged in the incident management system (RIVO in the case of Veolia). They may choose to escalate to the RDC Environmental Manager.
Testing and plant settings adjustments	• DO and pH (see section 6.2.3 and 6.2.4) • Sludge settle ability test (see section 6.2.2) • MLSS test (see section 6.2.1) • SVI (see section 6.2.2)
Cleaning and Maintenance	• Removing supernatant from thickened sludge (prior to next item) • Wasting Sludge (see section 6.2.6) • De-ragging of RAS pumps (see section 6.2.5) • Basket screen and channel rake (see section 6.2.9) • Clean Settlers (see 6.2.8) • Disinfect all equipment throughout the day. • Wipe down lab surfaces and floor and end of each day.
Other activities	• Monitor Settlers and determine whether to run to emergency pond or irrigation fields. • Walk around tertiary pond run off field and irrigation field to monitor water flow.

5.2.2 Weekly Tasks

Table 5 Weekly Operating / Maintenance Activities

Item	Action
Manhole inspection	Inspect manholes around the full network (including Iwikau Village) and general observation of network.
Cleaning and Maintenance	• Hose the concrete wave band around Channel removing build up • Grease aerators (automatic process, no procedure), • Return activated sludge to Pasveer channel (see section 6.2.6) • Empty and clean both Settlers (see section 6.2.18) • Empty and hose down Pump station • Clean UV (see Section 6.2.12 or Appendix B4)

5.2.3 Monthly Tasks

Table 6 Monthly Operating / Maintenance Activities

Item	Weekly
Sampling	Wastewater and water quality sampling is to be carried out as per Resource Consent 105684 conditions 17 to 20 (see Appendix C).
V-notch flow measuring weir	Hose out the weir chamber. The chamber edges should be kept clean especially in the warmer months when algae and other filamentous growths are likely to proliferate. Control foaming.
Operate valves	• Operate all valves on the plant to prevent them from becoming stuck in their normal position. • Pay particular attention to the operation of valves which would not otherwise be operated frequently. • Observe and check the function of all automatic valves.
Dose and Flush	Dose fields with chlorine to kill any biological build-up in the pipes (see section 6.2.17)

infiltration fields	
Pumps	All pumps should be checked for leaks at the seals and for overall function.
Waste water pump stations	There are five pump stations at the Whakapapa wastewater network which have to be visited and read off once a month (running hours, number of starts and power [A] usage). Data is recorded and on an Excel Spreadsheet on a shared Google Drive.
Other	Adjust or repair any adversity found in the equipment checks according to the manufacturers recommendations.

5.2.4 Yearly

Table 7 Yearly Operating / Maintenance Activities

Item	Action
Paddle aerators	Bearing replacement (section 6.2.12)
Pasveer Channel	Degrit the channel (section 6.2.13)

5.3 Whakapapa WWTP – Quality Sampling

5.3.1 Data Recording

In order to monitor plant performance and the quality of the effluent, several key process points for recording are listed:

1. Date and Time
2. Prevailing weather;
3. Amount of flow processed and sent to irrigation;
4. UV intensity;
5. DO, temperature and pH levels in Pasveer Channel, Settlers and Tertiary Treatment Pond;
6. MLSS and SVI in the Pasveer Channel;
7. Amount of sludge wasted.

A template for the Data Recording Sheet can be found in Appendix G.

5.4 WWTP Alarms and Operating Response

Only the sand filter plant has a number of alarms implemented on the SCADA system. These alarms are not paged out and can only be noticed by logging into SCADA locally. There are currently no other alarms present at the Whakapapa WWTP. Problems with the plant can only be detected by the daily visit and inspection by the local operator, however SCADA changes are being planned.

5.4.1 Sand Filter Plant Alarms

Incorporated within the sand filter programme are several key alarm settings. Alarm settings are not part of normal viewing of data on screen (apart from Table 8 below). All alarms have to be accepted by pressing Reset on the SCADA screen in order to restart the plant (when the cause of the alarm has been removed).

Table 8 Sand Filter Alarms and Failure

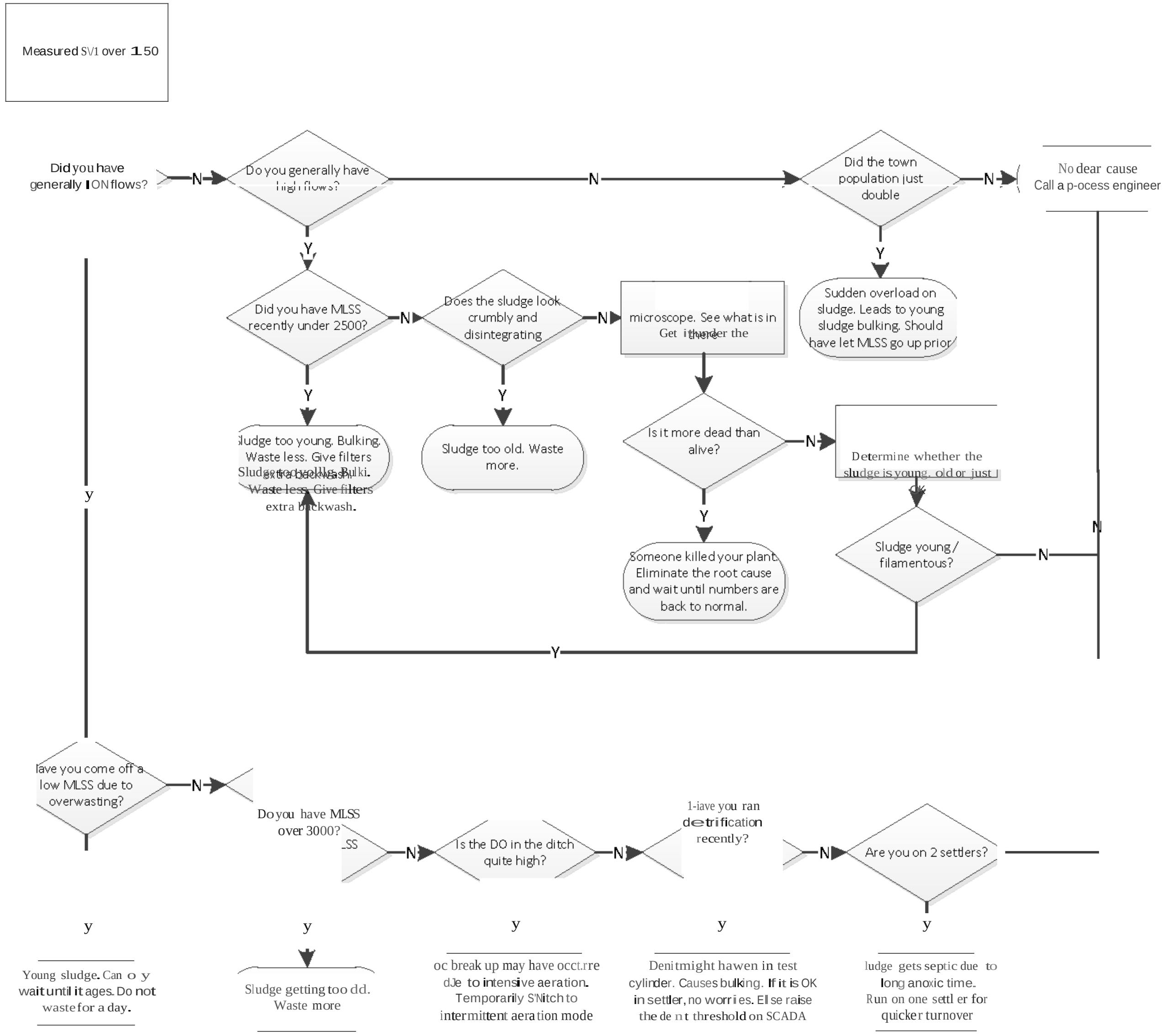
Alarm	Failure
Level Transmitter LT-01 Failed	Loss of signal to PLC programme
Pressure Monitor PT-01 Failed	Loss of signal from Pressure Sensor PT-01
Pump station 1 Pump Overload Trip	Filter Feed pump potentially blocked/jammed
Air Pressure Failed	Pressure Switch indicates loss of air pressure to Keystone Valves, Normal setting 60 PSI, alarm setting 40 PSI
System over Pressure Fail	• Potential Filter Feed pump blockage / backwash valve fault sequence. This alarm is viewed by pressing A on the main SCADA page • The setting is password protected. Current shutdown setting is 3 bar. Press the P button to accept alarm when the cause of the over pressure has been removed.

5.5 SCADA Operation of Plant

The current SCADA system is not very user-friendly as not much process intervention is possible and extracting data is a complicated process. As there is budget to replace the SCADA system in the near future this section is kept blank and a detailed SCADA Operation Procedure will be composed once the new SCADA system is installed.

5.6 Trouble Shooting of the biological process

The following decision tree should give an introduction to fault finding and solving issues with the biological process at the Whakapapa WWTP.



5.6.1 Pasveer Channel

If the channel is operated within the design limits and routine maintenance is carried out on a regular basis it is unlikely that any major problems will be encountered. The operator watches for changes in the physical appearance of the system and relates these to effluent quality. Much can be learned by simple observation of the colour of the activated sludge, the presence and extent of foam or scum on the surface of the channel and presence of rising sludge particles in the sedimentation tank(s).

The mixed liquor should be a good "chocolate brown" colour (see Figure 17 below) and as the sludge is circulating in the Channel a distinct mixing pattern can be observed. There will be areas of sludge intermingled with what appears to be slight clear areas.


Figure 17 Intended sludge colour


Figure 18 Colour of "septic" Sludge

A poor sludge will be indicated by a dark grey or even black colour (see Figure 18. Picture not from Whakapapa). This will be a "septic' sludge due to a lack of dissolved oxygen, caused by overloading or a reduction in aeration efficacy. In this case aeration must be increased.

A modest amount of crisp white foam near the rotors is nothing to worry about and usually indicates that the plant is in good condition (see Figure 19 below).


Figure 19 Foam indicating good condition


Figure 20 Excessive undesirable foam


Figure 21 Thick, dark scummy foam

If foam appears all along the channel it may indicate that too much sludge has been wasted from the system. Such foaming can also be caused by the accidental discharge of excessive amounts of detergents (see Figure 20, Picture not from Whakapapa).

If foam appears that is thick, dark and scummy then not enough sludge is being wasted from the system (see Figure 21, example picture not from Whakapapa). Modest rates of sludge wasting should be carried out until normal operating conditions are restored.

5.6.2 Sedimentation tanks

Careful observation of the surface of the sedimentation tanks gives the operator the best clues to plant performance and if process changes are required. The effluent should be clear. If the effluent is turbid or solids are being carried over then some change or adjustment to plant operation will be necessary. Without any adjustment the situation could well deteriorate and have an adverse effect on succeeding plant and equipment.

5.6.2.1 Clumping and Rising Sludge

The appearance of what appear to be small sludge balls on the surface of the sedimentation tank(s) suggests that sludge is not being cleared off the walls of the tank. More frequent cleaning of the tank walls may be necessary. Refer to 6.2.8

If the problem becomes serious under low flow conditions then flow should be changed over to the other sedimentation tank and the tank pumped down using a submersible pump. Then use high pressure water and or a broom to clear offending sludge from the hopper walls. This sludge can be returned to the Channel without a problem. The tank can then be allowed to fill again.

5.6.2.2 Pin Point Flocs

Pin point flocs are very small flocs that can be observed suspended through the effluent. Another term for this phenomenon is emulsification of the sludge and is due to its too long a residence time in the Pasveer Channel or over aeration. Under such conditions it would be appropriate to cut aeration and/or lower the mixed liquor suspended solids in the Pasveer Channel by wasting sludge.

The laboratory settling test will be the best guide to determine if any action is necessary. Pin point sludge particles will appear as discrete small granules rather than the normal flocs and do not compact readily.

5.6.2.3 Carryover of excessive floc

If settler effluent turbidity looks over 15 NTU then there must be additional monitoring of the filter backwashing. It may be that the filter has to be backwashed by push-button to avoid all 3 filters binding over.

5.6.3 Bypass of the Sand Filters

In case the sand filters cannot be used for any reason there is a possibility to bypass them. Valves V-311 and V-312 have been installed for this purpose. The UV system is designed for filtered water, but on non-filtered water it will still perform some disinfection. Therefore all water shall be send through the UV system.

5.6.4 Manual Flow return on sand filters

There is a flow return possibility on the Sand Filters, which is called a -manual bypass‖ in the Sand Filter manual in Appendix B11. It was installed before the full bypass of the sand filters was installed. The full bypass is recommended over this manufacturer installed -manual bypass‖, because the manual bypass creates a loop from pump station 1 to the Pasveer Channel. This mode can be operated in two situations:

- The filters need to be shut down for any reason for a short period.
- The filters need to be operated on a reduced flow rate of $10m^3/h$

If the -bypass‖ is operated with the filters not running, then there is no exit point for the waste water. This means that water will build up inside the system. This practice can therefore not be sustained for very long.

If the filters are operated on a reduced flow rate, then the flow through the bypass creates a recycle over Pasveer Channel, Settlers and Pump Station 1. This recycle adds to the hydraulic loading of the settlers, which as a result will perform worse than normal. The result will be that the quality of the water onto the filters will deteriorate. The need for running on this bypass quickly becomes a self-fulfilling prophecy as the filters will start to suffer higher than normal solids loading. This practice is therefore not recommended.

For above reasons the use of the manual bypass is not recommended and will become obsolete upon planned control system changes.

<u>To operate the manual return on filter shutdown:</u>

- Switch filters into -off‖ mode. Verify that this has closed all valves on the filters;
- OPEN interconnecting manual bypass valve (V-307);
- Close valves between filters and UV system (V-309 and V-310);
- Manually operate the Filter Feed Pump by pressing the Start button on the controller at Pump Station 1.

<u>To operate the manual return on filter reduced flow:</u>

- Switch filters into -low flow‖ mode;
- OPEN interconnecting manual bypass valve (V-307);
- Close valves between filters and UV system (V-309 and V-310);
- The pump will operate itself based on level in Pump Station 1. Backwashes will be triggered based on a lower pressure setting than normal.

5.6.5 Valves stuck in their seat

If any filter is off for a period of time (2 days or more) it may be necessary to exercise the valves in manual mode to ensure that none of them are stuck in their seats. If they are, then they have to be exercised until they open. Any ongoing issues with the valves must be escalated to the supervisor and operations engineer.

6 OPERATIONS & MAINTENANCE PROCEDURES

6.1 Set-points

In the following locations in the plant set-points apply to the process:

6.1.1 Pasveer Channel paddle aerators

The paddle aerators in the Pasveer Channel have 3 operating modes.

1. Based on DO level (used in summer / low season),
2. Run permanently (used in winter / peak season); or
3. Based on a timer (currently not used).

When operated based on a DO level, the set point can be set on SCADA. The aerators in that case will run until the set point is reached and then stop for 5 minutes. The philosophy is the alternation of nitrification and denitrification: Once the water is high on oxygen, nitrification will have occurred after which denitrification should be allowed. In practice this philosophy does not really work. This may have to do with the difficulty of retaining sufficient nitrification bacteria in the system. For that reason the aerators are allowed to run permanently over the peak season.

The timer based mode is not often used as it is inferior to the DO based mode. The timers can be changed if needed according to the procedure in 6.2.11. They can for instance be set as per the table below.

Table 9 Timers settings for paddle aerators

Level	Set point
Aerator on	10 minutes
Aerator off	5 minutes

There is an interlock with DO level in the Pasveer Channel. In case the DO level does not manage to climb above 1.0mg/l, then the aerator will not switch off. The rationale behind this is: If the DO does not manage to get above 1.0 then no significant nitrification will have occurred. In such case there is no reason to try and denitrify (which is what is supposed to occur with the aerator switched off.

6.1.2 Pump station 1

The Filter Feed pump (P-05) pumps direct from Pump station 1 to the inlet to sand filter plant. Current set point levels for operation are listed in the table below:

Table 10 Set points for pump station 1

Level	Set point
Top Level	2800 mm
Low Level	500 mm
Minimum Level for Backwash Sequence	1500 mm

Note: Overflow of pump station 1 runs directly to Tertiary Treatment pond.

6.1.3 Sand Filters

The Sand Filters operate on a logic that is programmed into the Swampfox RTU housed inside the left hand control cabinet in the plant room. RTU's are not particularly suitable for programming elaborate sequences and that plays a role in the limited operational possibilities that the filters offer. The filters have 2 flow set points:

- A high flow set point of $30m^3/h$
- A low flow set point of 10 m^3/h (not recommended, otherwise refer to 5.6.3)

Those flows are not actually measured, so it has to be relied upon that during commissioning these figures were realised. The low flow set point is realised by returning part of the feed flow back to the Pasveer Channel. This is called -Bypass modell in The Sand Filter Manual in appendix B11, but it is not a true bypass since the water is returned. This has as a side effect that the load on the Settlers increases. This will lead to a Settler overload sooner or later so this low flow mode is advised against.

The filters will backwash on either a timer on or a pressure increase upstream of the filters measured by PT-01. The timer is set at 12 hours running (for all filters, since they are backwashed in the same sequence). The high flow trigger for a backwash is 0.8 bar. The low flow trigger for a backwash is 1.2 bar. All settings are programmed into the RTU, so cannot be changed.

The filters are backwashed in the same sequence. This sequence is as per the table on the next page:

Table 11 Backwash Sequence

	max														
In Service	43200	o	●	●	o	●	●	o	●	●	o	●	o	●	o
Stop for Backwash	30	o	●	●	o	●	●	o	●	●	o	●	o	●	●
Close valves		●	●	●	●	●	●	●	●	●	●	●	●	●	●
Drain Down Filter A	120	●	o	o	●	●	●	●	●	●	●	●	●	●	●
Air Scour Filter A	180	●	●	o	●	●	●	●	●	●	●	o	●	o	●
Media settle	60	●	●	o	●	●	●	●	●	●	●	●	●	●	●
Backwash Filter A	600	●	●	o	o	●	●	o	●	●	●	●	o	●	o
Drain Down Filter B	120	●	●	●	●	o	o	●	●	●	●	●	●	●	●
Air Scour Filter B	180	●	●	●	●	●	o	●	●	●	●	o	●	o	●
Media settle	60	●	●	●	●	●	o	●	●	●	●	●	●	●	●
Backwash Filter B	600	o	●	●	●	●	o	o	●	●	●	●	o	●	o
Drain Down Filter C	120	●	●	●	●	●	●	●	o	o	●	●	●	●	●
Air Scour Filter C	180	●	●	●	●	●	●	●	●	o	●	o	●	o	●
Media settle	60	●	●	●	●	●	●	●	●	o	●	●	●	●	●
Backwash Filter C	600	o	●	●	o	●	●	●	●	o	●	●	o	●	o
Finish Backwash	30	o	●	●	o	●	●	o	●	●	o	●	o	●	●
Return to Service		o	●	●	o	●	●	o	●	●	o	●	o	●	o

● means closed or stopped
o means open or running

6.2 Procedures

6.2.1 MLSS test

MLSS stands for Mixed Liquor Suspended solids. MLSS is tested by filtering 100ml of mixed liquor (the liquid in the Pasveer channel) over a Whatman filter paper and determining the amount of suspended solids in this volume:

1. Clean 2 new Whatman filter paper bags by allowing distilled water to pass through (Only one is needed, second is for back-up).
2. Put Whatman filter papers into tin foil and place in oven to dry for up to 24 hours @ approx. 30° C.
3. Take a full 1 litre cylinder sample of mixed liquor from the middle of the oxidation channel. Always at the same spot and at the same depth.
   - Use exactly 1 litre for the SVI test (below) and exactly 100ml for the MLSS test.
   - Pour excess MLSS into jar for pH test. Record pH result incl. temperature at measurement on spread sheet on clip board.
4. Clean the Buchner funnel with distilled water and put it on the conical flask.
5. Take a dried filter paper from the oven and weigh it on the scale using tweezers. Note the weight on the daily recording sheet.
6. Put the filter paper in the Buchner funnel using tweezers and wet it with distilled water so that it fully covers the holes.
7. Start the vacuum pump. Make sure the funnel seals onto the flask and the paper onto the funnel.
8. Pour the MLSS sample on trying to get the solids not spilling too much over the edge of the paper.
9. Wash the 100ml cylinder out with distilled water onto the paper.
10. Squirt the edges of the Buchner funnel so all solids end up on the paper.
11. Once sure that the solids will not run off the paper anymore, stop the vacuum pump.
    - Peel an edge of the paper off the funnel, take a point with no solids. If the paper is damaged like this, the test does not need to be redone. However if solids are lost off the paper, the test must be redone though.
    - Let the vacuum clear before peeling all paper off.
    - Put the paper in the oven (put into tin foil so it doesn‘t stick to the oven tray) for at least 2 hours before weighing it again. Overnight is even better.
    - MLSS in (g/m^3) is calculated as follows: (weight after (g)-weight before(g))x10

6.2.2 Sludge Settle-ability and SVI test

SVI stands for Sludge Volume Index. It is the volume that 1 gram of sludge takes up in milli-litres and is a measurement of how good the settlers will perform. The MLSS and the Sludge Settle-ability test results are needed in order to calculate the SVI value:

- Take a full 1 litre cylinder sample of mixed liquor from the middle of the oxidation channel. Always at the same spot and at the same depth.
- Pour off the sample to exactly 1 litre on the scale. Make sure no settlement has occurred before pouring off.
- Put the sample on the bench top and let it sit still for 30 minutes exactly.

- Read the height of the sludge blanket on an accuracy of 10ml and record rate of settlement (= Sludge Settle-ability test)
  - o Sludge in good condition should settle fairly rapidly to a volume of about 200 ml at the end of 30 minutes. Poor quality sludge will settle only slowly at room temperature, if at all.
- The SVI is calculated as follows: SVI=(height of sludge blanket (ml))/(MLSS (g/m^3)) x1000 (this means a figure of 50-250 is obtained)
- If the sludge blanket has split and sits partially at the top the both volumes can be taken together BUT note MUST be made of this in the recording, because this is not good.
- The SVI result will always predict a worse performance than what your settlers actually do. This is because the amount of wall area for a certain volume is vastly different between the settlers or the test cylinder. This means that if the settling looks bad in the test there is still time to act.
- The higher the SVI the fluffier the sludge. Fluffy sludge usually means young sludge, but not always. It also has to do with the wasting regime and the nitrification regime over the past period.

6.2.3 DO test

DO testing should be carried out at least daily using the portable DO meter.
The probe of the meter needs to be kept moist at all times. It is left in a beaker of water while in the laboratory. If taken into the field it should be placed in a plastic bag with moist tissue in.
Take a 200ml jar outside to the middle of the Channel where the fixed DO probe is positioned and fill jar with 200ml sample.

As the DO is constantly being used up by microorganisms, the testing should be carried out as soon as the sample is collected.

- Turn on the meter using the Power On button.
- Place the probe into the beaker of mixed liquor and push start button

The meter will flash -stabilising and show an instantaneous temperature and DO reading while it is testing. Once it has finished testing it will beep, a lock symbol will appear and it will show the final temperature and DO reading.

Clean and sterilise the DO probe and meter and put the probe back into the beaker of water to keep it moist. It is important to keep it clean so it does not absorb any contaminated water. Replace beaker distilled water each time.

When the plant is operated in the low load mode (based on DO level) aiming at both nitrification and denitrification, the DO level should be between 0.5 -1.5 mg/L to maintain the activated sludge in the endogenous respiration stage of treatment.

When the plant is operated in ‖high load‖ mode (run permanently) the DO level should ideally be over 1.5mg/L if it is possible at all to keep it there.

Record results on spread sheet on clip board.

6.2.4 pH test

The sample used from the DO test can be reused for the pH test:

- Turn on the pH meter.
- Take the cap off and place the meter into the beaker of mixed liquor.
- Allow the meter to stabilise before taking the reading.
- Clean and sterilise the pH meter and cap and put the cap back onto it.

The pH should be within the range of 6.0 – 8.0. If nitrification occurs without denitrification the pH tends toward the lower end of the range. Sudden changes on pH value can have an adverse effect on micro-biological populations, but no major variations are likely.

6.2.5 Rag removal of RAS pumps

This procedure has to be carried out before wasting sludge (see next section 6.2.6). It is important that the correct PPE is worn which comprised of at least the following:

- Gumboots,
- Disposable Overall,
- Disposable cloves,
- Safety Glasses and
- Face mask

After putting on all PPE listed above follow the procedure below:

- Wet the floor to prevent sludge sticking to it
- Put container in place under pump
- Stop pump manually (P-01 / P-02)
- Close isolation valves (V-203, V-204, V-205 and V-206)
- Undo wingnuts
- Take off the end of the housing
- Pull rag out of housing and impeller by using a screw driver
- Put unit back together
- Open isolation valves (V-203 and V-206)
- Re-start pump
- When everything is leak free, clean up

6.2.6 Wasting and returning sludge

Activated Sludge from the bottom of the Settlers is returned to the Pasveer Channel on a continuous basis. However as described in section 3.5.1 sludge has to be wasted to keep the balance of the system. Wasting a little sludge every day is preferable to wasting a lot of sludge infrequently. The procedure is described below:

- Check that the fluid level in the polymer mixing tank in the plant room is adequate, then turn on the Polymer mixing motor, open valve (V-601) at the bottom of the tank and turn on polymer dosing pump (P-04) at the wall switches.
- The dosing pump is set at 80% during the summer and low load periods and 100% during the winter peak period.
- Open up tap on WAS pit (V-701) so the WAS can flow into Re-aeration tank
- Shut off valve (V-208) to the screening chamber.
- Continue to run WAS for desired amount stated by permanent operator or based on experience.

- Once WAS has reached desired amount, turn off mixer (MX-1), pump (P-04) and valve (V-601) at poly tank.
- Open RAS (V-208) valve and close WAS (V-701) valve.

Note: Prior to wasting sludge, the sludge pumps should always be cleaned out (see Section 6.2.5 above).

In order to return sludge to the Pasveer channel V-208 (NO) stays open and V-701 (NC) stays closed. The general operation procedure for the two RAS pumps can be found in the section below.

6.2.6.1 General Operation of RAS pumps

The two RAS pumps are operated separately. Pump 1 pumps RAS from Settler 1 back to the inlet whereas pump 2 pumps RAS from Settler 2 back to the inlet.

- The picture below illustrates the operation of RAS pump 1 operating out of Settler 1.

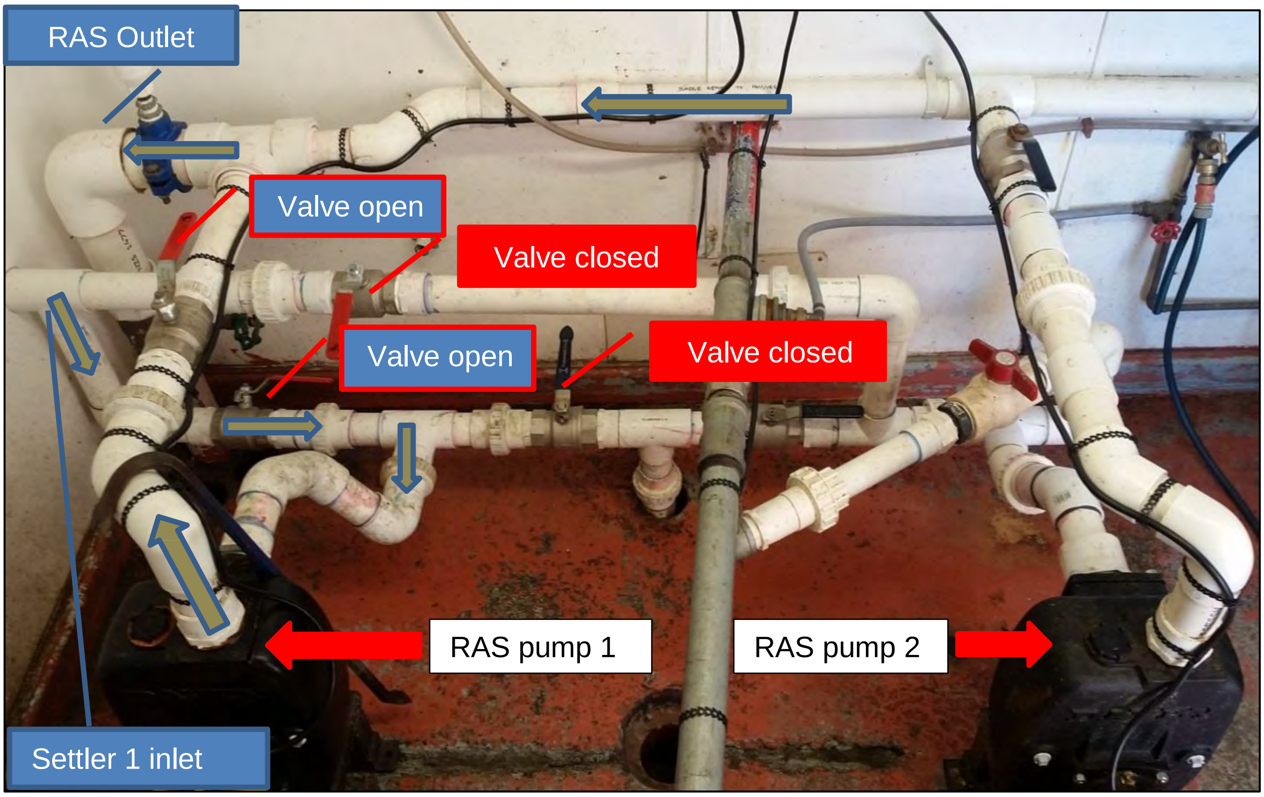


Figure 22 Operation of RAS pump 1(P-01)

- The second picture illustrates the operation of RAS pump 2 out of Settler 2

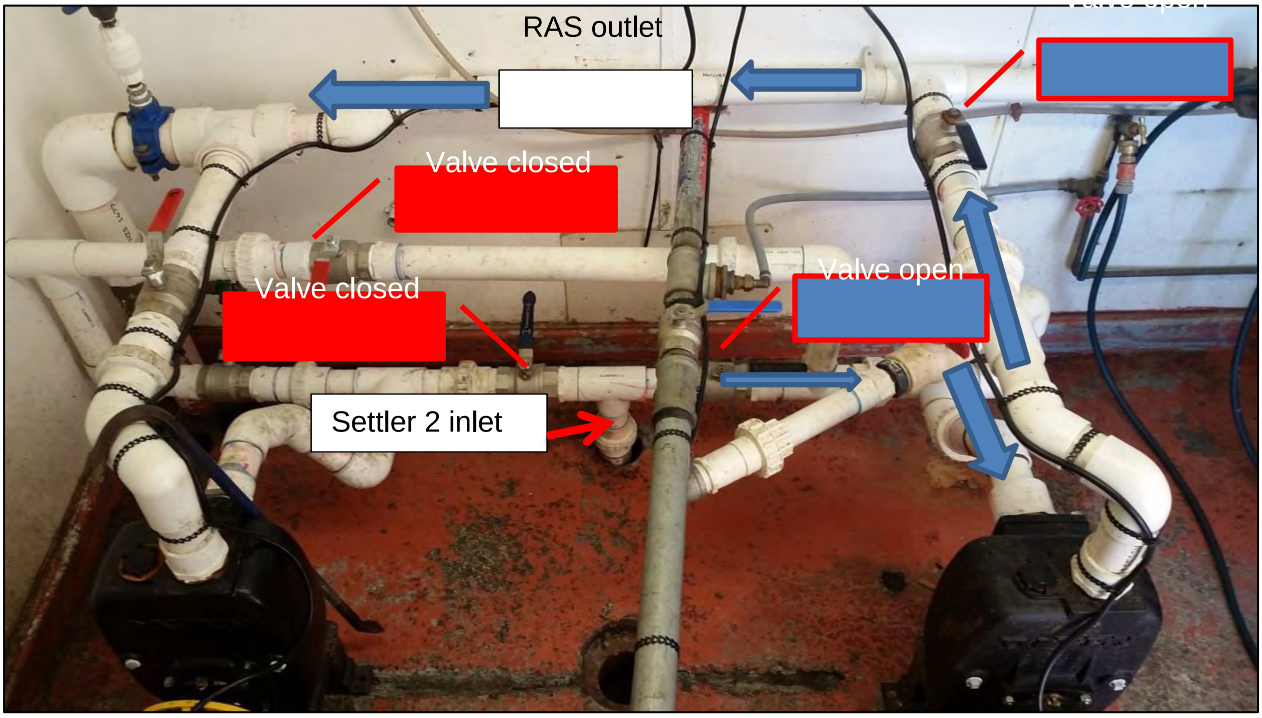


Figure 23 Operation of RAS pump P-02

6.2.7 Removing supernatant from thickened sludge

The wasted sludge/polymer mix in the Re-aeration tank will thicken and settle down to the bottom of the tank. The supernatant on top of the sludge layer periodically has to be pumped down by following the steps listed below:

- Turn on pump (P-09) in WAS pit.
- Observe water runoff into the Channel, will be brown to start with but then should run clear after 1 min. If water is still brown after 1 min Lift the pump 2 inches which should pull pump out of waste settlement at bottom of WAS pit.
- Allow water run off continue until water runs from clear to mud colour.
- Turn off pump, water run off complete.

6.2.8 Settler maintenance

The settlers have to be monitored and cleaned on a daily basis. Once a week (during low season, twice a week during high season) they have to be emptied and hosed down (see Section 6.2.18 below).

- Use pool scoop to skim off surface fat from both settlers, work slowly to avoid carry-over. Dispose of fat into the WAS tank.
- Use the squeegee to clean the inside walls of Settler, run down the inside walls to remove sludge build up.

6.2.9 De-ragging Screening Chamber and Pasveer Channel

De-ragging the Screening Chamber and Pasveer Channel is one of the daily tasks. As the screening chamber with the basket screen does not have a lot of capacity it has to be cleaned out daily to prevent blockages.

For the de-ragging tasks the same PPE as in section 6.2.5 above has to be worn:

- Gumboots,
- Disposable Overall,
- Disposable cloves,
- Safety Glasses and
- Face mask

Screening Chamber:

- Lift the screen basket up using the manual winch on the hoist.
- Let the basket drain for a minute before emptying it into a wheely bin or drying basket
- Hose out pit before lowering the screen basket back.

Pasveer Channel:

In the absence of an influent screening facility there are rag rakes in the Pasveer Channel in front of the rotors to catch gross solids that have made it into the Channel (see Figure 24 below). These rakes are cleaned daily to remove the solids from the system after the following procedure:

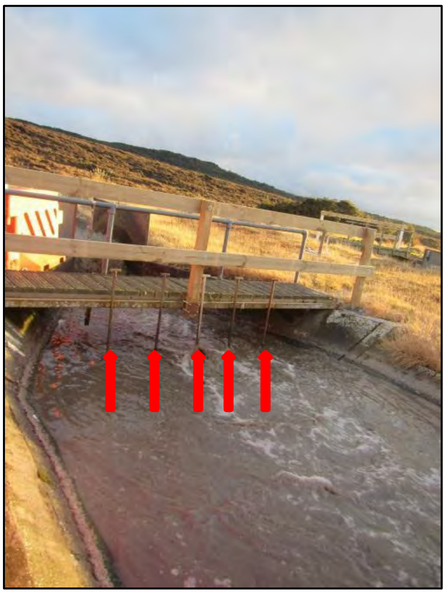


Figure 24 Pasveer Channel with Rag rakes

- Turn off the aerators

- On platform there are 5 poles with spikes on them: remove one pole at a time and remove all rags etc. with a spade.
- Once the pole is clean put it back and repeat process for all poles
- Scoop up rags etc. and put in basket to dry.

6.2.10 Daily Housekeeping Activities at Whakapapa WWTP

- The lab benches and all utensils used should be cleaned down after each use. Use plenty of hot water and disinfectant.
- Apart from the Settlers, the rest of the daily cleaning is up to the operators‘ discretion. The more often it is cleaned, the less likely issues are to arise.
- All rags/rubbish is left out to dry, then placed in the skip bin.

6.2.11 Adjusting Rotor Time Clocks

The small rotor timeclock is on the wall below the meter board in the laboratory. The large rotor timeclock is in the control panel inside the pump shed housing the sludge return pumps. A small switch on the face of the timeclocks has 3 settings:

0	=	Off
1	=	On continuously
Clock	=	turns on and off at times pre-set by the location of the pins around the face of the dial. (Pins in = off, pins out = on for that period)

6.2.12 Rotor bearings

The aeration rotors have two bearings each. These bearings have a lifespan of approximately two years and have to be replaced one each year.

6.2.13 Degritting channel

In the absence of a grit trap, grit will settle in the Pasveer Channel. This causes shoaling, i.e. a reduction in treatment volume and potential of carry-over of heavy solids into the Settlers and RAS pumps (causing wear). A three-monthly removal of grit is recommended. A fine mesh rigid sieve on a long pole will allow the operator to reach into the centre of the Channnel where the grit will settle. Going around the Channel with this device and a lined wheelie bin will allow keeping the Channel at its optimum condition.

6.2.14 Trojan UV3000

The UV unit is located downstream of the sand filters. The system is ON continually, except for maintenance or service requirements. The controller on the wall measures UV intensity and elapsed time in hours. UV intensity is measured in milliwatts per square centimetre (mW/cm^2). The display will flash when the intensity falls below Low UV Intensity Alarm Set Point. Elapsed time measures time lamps have been running. Following 12,000 hours the display will flash (and continue to count) indicating the lamps to be changed in the near future. To replace a lamp please follow the instructions below. For any further issues look at Appendix B4.

Warning: Care should always be exercised as direct exposure to UV can result in skin burn and damage to eyes. Transition boxes at inlet and outlet should not be opened to view inside chamber when UV is ON!

<u>Cleaning the sleeves</u>

1. Take affected V\UV module out of service by unplugging corresponding module from the power distribution receptacle
2. Support the UV module on the wall rack as per below picture.

Figure 25 UV system ready for maintenance

3. Spray citric or phosphoric acid onto the sleeves and wipe it off with a clean non- abrasive cloth. If there is a deposit that does not want to come off easily let the acid soak for a few minutes before wiping the surface.

At this point the unit can be placed back and taken back into service, unless a lamp replacement must be done. It is recommended that quartz sleeves be cleaned on any occasion of lamp replacement.

Lamp replacement

4. Unthread the sleeve nut (see Figure 26, #2) by hand until it loosens from the sleeve cup (#1)

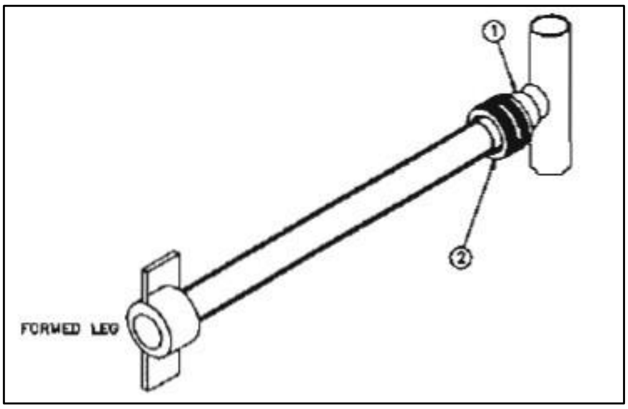


Figure 26 Replacement of UV lamp (Step 1 to 4)

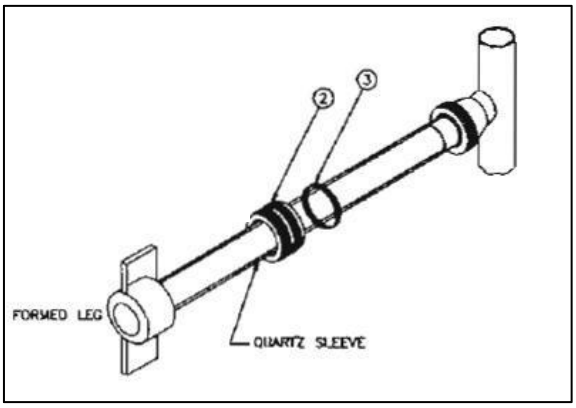


Figure 27 Replacement of UV lamp (Step 5)

5. Carefully slide the sleeve nut (see Figure 27, #2) and O-ring (#3) along the quartz sleeve for 15-20cm
6. Carefully remove the quartz sleeve from the sleeve cup (see Figure 28, #1). Do this by pulling and rotating the quartz sleeve at the same time. The quartz sleeve should be extended 7 to 8 inches (15cm) beyond the formed leg of the module.

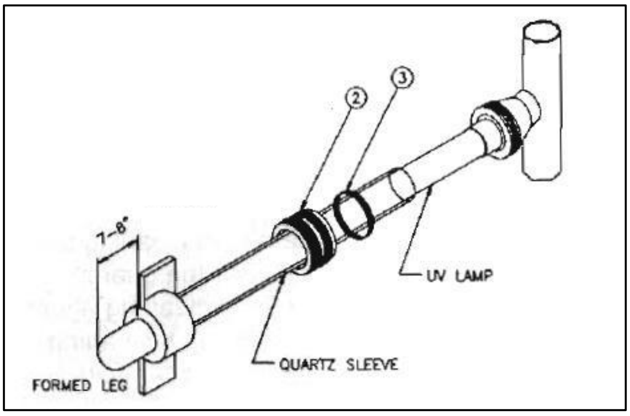


Figure 28 UV lamp replacement (Step 6)

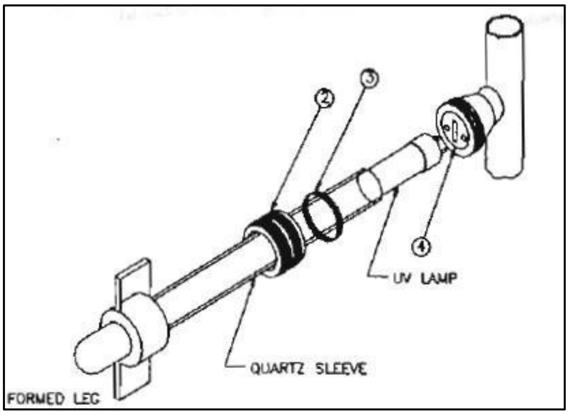


Figure 29 Replacement of UV lamp (Step 7)

7. Remove the lamp from the lamp holder (see Figure 29, #4). Do this by gently pulling the lamp away from the lamp holder (#4).
8. Support the quartz sleeve (when lamp is free from lamp holder (#4) and remove the lamp (see Figure 31, #4).
9. Replace the O-Ring (#3) at this time if any deterioration is evident.
10. Replace the lamp by repeating the above steps in reverse order.

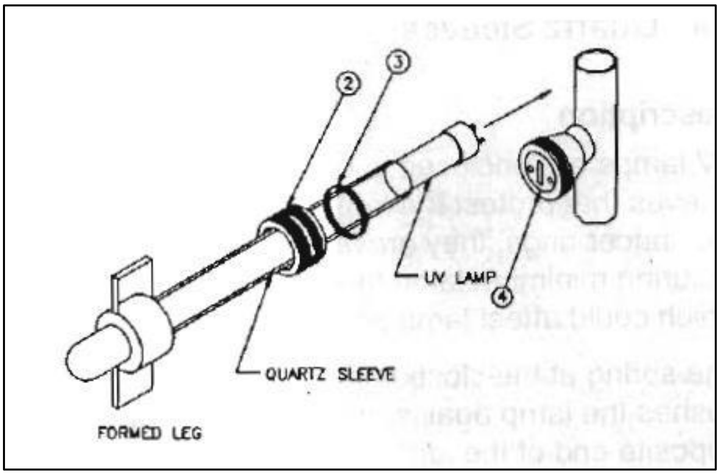


Figure 30 UV lamp replacement (Step 8 and 9)

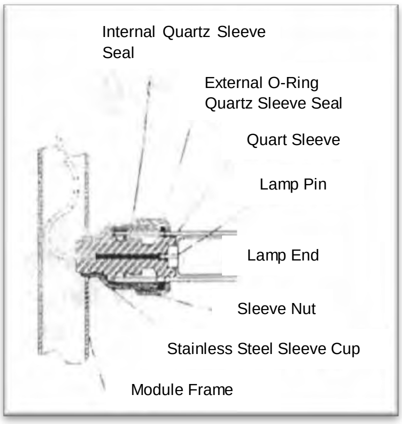


Figure 31 UV lamp details

When reassembling the UV module ensure the quartz sleeve is in full contact with the rubber sleeve stop and not just in contact with the internal quartz sleeve seal. Push the sleeve until it is past the internal sleeve seal and against the rubber stop.

Any additional instructions can be found in Appendix B4.

6.2.15 Mixing new batches of Polymer

Polymer is mixed as required. The polymer mixing tank in the tertiary treatment plant room should be almost empty before a new batch of polymer is mixed.
The polymer is used to thicken the waste activated sludge prior to it going into the thickening tank (the re-aeration tank is currently used for this).

- 1.5kg of Crystalfloc B430H polymer granules is weighed using the wall scales and sprinkled slowly into the mixing tank while the mixing motor and the water sprinkler are running. (2 x 750g amounts will mix in well)

Pouring in too much polymer at once will result in a rubbery mass congealing in the tank rather than the granules distributing evenly throughout the water!

- The tank is filled to $1m^3$ with water and the mixing motor is left on overnight for thorough mixing and maturation to occur.
- The following day all granules should have dissolved, maturation completed and the polymer can then be used.

6.2.16 Operating wash-down hoses

The wash-down hoses are fed from the black polyethylene service water tank outside the pump shed.

- Check that the tank is full of water before starting the pump.
- Turn off the small red handled gate valve (V-503) in the pump shed if it is on.

V-503 linking the domestic water supply to the wash-down hose pipework must be turned off to stop the back-feed of wash-down water into the domestic water line when the backwash pump is on!

- Open the blue handled ball valve (V-505) on the wash-down pump outlet and open the nozzle on one of the wash-down hoses slightly to keep water flowing though the pump for cooling purposes.

Never shut off all nozzles completely when the wash-down pump is running. The pump will overheat and the thermal cut-out will operate. Pump will then have to cool down before it will restart!

- Turn on the wash-down pump at the switch inside the panel in the pump shed. Over

winter, V-503 in the pumps shed is left open when the plant is unattended. This provides water to the wash down system. The end of all wash-down hose is left open a little bit so water drips steadily and prevents them from freezing up.

6.2.17 Dosing and Flushing Infiltration Fields

Note this section will be replaced and become obsolete when the irrigation fields are being replaced by wetlands.

Biological slimes build up on the inside pipe walls and block the dripper holes. The fields are dosed with a chlorine solution to kill these slimes.

- Take a 20L container of Sodium hypochlorite and mix it into pump station 2.

- Open the flushing valve at the bottom of the field and then run the chlorine solution through the field until chlorine can be smelt coming out of the flushing valve.
- Shut the flushing valve and leave the chlorine solution to sit in the lines overnight.

Always wear the correct PPE when handling concentrated Sodium Hypochlorite (see Appendix F3).

- Next day the flushing valve can be reopened and the irrigation field pump turned on to flush out any remaining chlorine solution and the built up solids out of the lines.
- Once the effluent coming out of the valve is running clear, shut the flushing valve and turn off the pump.

6.2.18 Procedure of emptying and cleaning the Settlers

This procedure should be completed for both Settlers twice a week during peak season and once a week during low season.

1. To empty the Settler shut the corresponding penstock valve (V-102-1 or V-102-1). In Figure 32 Settler 1 is closed and Settler 2 is open;
2. The Settler can be pumped down by it RAS pump, but one must be careful not to run the pump dry;
3. Once almost empty, shut off the RAS pump (P-01 or P-02);
4. Isolate the Settler further by closing the RAS pump suction valves;
5. Clean the Settler with a water jet. Apply detergent and scrub (scrubber on pole) where deposits do not release by themselves;
6. Refill the Settler by opening the penstock and RAS isolation valve and put back into operation.

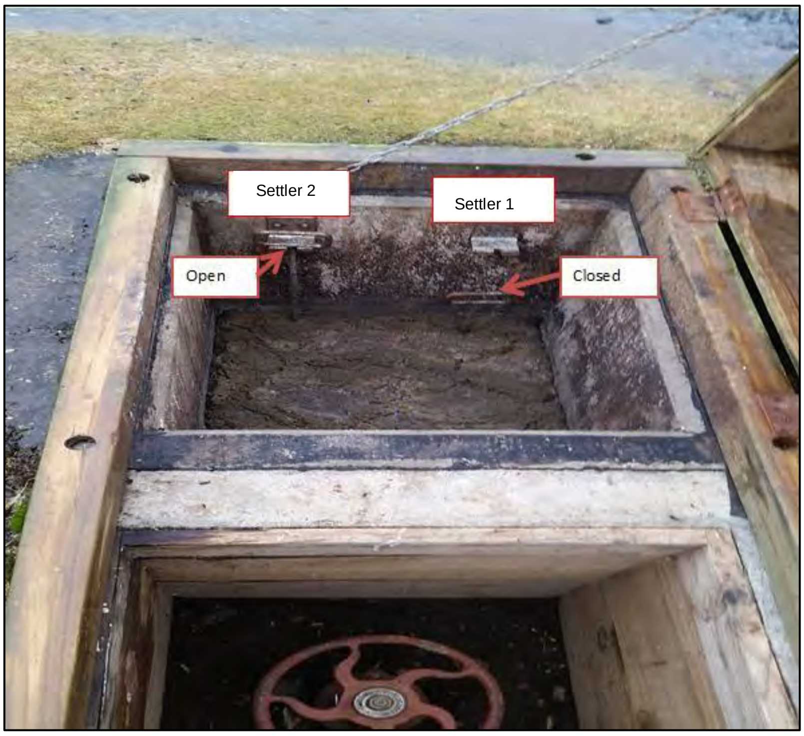


Figure 32 Flow splitter with Valves to control inflow to Settlers

6.2.19 Floc Carryover into Filters

In the event of floc carry over from the Settlers to the filters, the water can be diverted to the UV unit. Refer 5.6.3. This protects the filters from clogging.

Floc will be obvious as it is a lot ‗fluffier' and brown, compared to the fat which sometimes floats on top of the Settlers and needs scooping off.

Figure 33 Example of Floc on top of a settler (photo not from Whakapapa)

6.2.20 Sand Filter Plant operation

The Sand Filter plant has limited operational functionality. It can be operated in 2 automated modes which are described in section 6.1.3. There is no good way of manually operating the filters. In order to manually operate a valve it has been suggested to swap the inlet and outlet air tubes, but this practice is advised against. Apart from the risk of working with high pressure air the air tubes and fittings will wear out due to this practice and eventually not a good fit will be possible anymore. A filter plant upgrade is planned for the near future in which this issue will be addressed.

Automated backwash follows the sequence as described in section 6.1.3. It is initiated either by a timer or pressure switch located at main inlet pipe just before sand filters. Pressure Sensor PT-01 measures the pressure (bar), before sand filters. Increase of inlet pressure due to solid load build up on sand filters. A push button backwash start is available on control panel. The sequence steps are the same as auto backwash. On completion of any backwash sequence the sand filter plant reverts to online.

Backwash start-up will only be initiated when level of pump station 1 is 1500 mm or over (indicated on main page of PLC screen). In the event the level of the pump station 1 has not reached 1500 mm, filter plant will go offline and wait until the level is obtained.

The RTU programme controls the Pneumatic valves in auto and push-button backwash mode. The Sand filter is drained down, followed by air scouring to effectively loosen up sand media: a settling time to vent residual air, followed by a backwash with filtered water from other two filters. Backwash water piped to Pasveer Channel. Refer to section 6.1.3 for the backwash settings.

6.2.20.1 Control Panel Overview

Figure 34 Control Panel for Sand Filters

<u>Control Switch:</u>

- LOW POSITION - System run on -bypass‖. Filter flow limited to 10 m^3/h
- HIGH POSITION — System run on 30 m^3/h. Bypass closed.
- OFF POSITION — Pump station 1Chamber Pump OFF. Sand Filter Plant filtered outlet valve (V-308) closed: Inlet valves to filters open.
- Emergency Stop; Sand Filter Plant defaults to OFF Position. Pump station 1Chamber pump STOPS.
- Mains power switch ON/OFF to panel.
- Disposal Valves: ON/OFF

Note: LOW and HIGH settings relate to inlet pressure values for backwash

6.2.21 Manual Filter feed pump Control

Manual START button located at top of pump station 1. In the event operator wishes to run the filter feed pump manually, plant switch at PLC panel has to be turned OFF. Plant automatically defaults to online mode (inlet valves open and main outlet valve open).

Filter Feed pump (P-05) will only start on manual press of START button. Releasing START button will stop the pump.

Note: For sand filter plant to revert back to PLC control, system has to be switched back to low or high flow setting (see section 6.2.20.1).

6.2.22 Manual filter wash

The filters will collect material that cannot be removed by the regular backwash. From time to time an extended air scour or a caustic wash would be beneficial. However given the absence of a possibility to control the filter valves manually, there is no safe way of performing such activity. It is therefore advised against. A filter plant upgrade is planned for the near future in which this issue will be addressed.

7 HEALTH & SAFETY

7.1 Hazard Register

The Hazard Register for the Whakapapa WWTP is included within Appendix E.

7.2 General Hazards around the WWTP

7.2.1 Biological Hazards

As well as being present in the treatment system, harmful bacteria, contaminants, viruses and other pathogens will be on the ground around the WWTP and also in the air. Avoid splashing, spraying, blowing etc. when working to reduce the spread of/and exposure to these organisms.

Use appropriate PPE at all times when there is the potential of contact with biological hazards

7.2.2 Chemical Hazards

A number of harmful chemicals are used and stored around WWTPs, including fuel, oils, greases, cleaning chemicals and water treatment chemicals.

Material Safety Data Sheets of all chemicals used and stored on the WWTP are kept in a folder in the Laboratory. The MSDSs for the Polymer and Caustic used and stored at the Whakapapa WWTP are provided in Appendices F1 and F2.

PPE appropriate to the chemical must be worn at all times when handling and should include but not be limited to:

- Eye Protection
- Chemical gloves

7.2.3 Slips/trips/falls

Wipe away spills as they occur. Aqueous polymer is especially slippery and presents a significant slip hazard when spilt.

Keep the work area tidy and have a regular clean-up programme to reduce the chances of a slip/trip/fall type accident.

7.2.4 Environmental Hazards

The location of the Whakapapa WWTP means that there is occasionally snow and ice on the ground during the winters months. Be extra careful at these times, especially around the Pasveer Channel and the sedimentation tanks,

Also be aware of the cold temperatures and dress accordingly when working outside.

7.2.5 Water

Be aware that a fall into a tank or pond could result in the individual hitting their head and becoming unconscious or otherwise unable to get out.

The Pasveer Channel and sedimentation tanks have steep sides which makes them difficult to exit. Working near the Pasveer channel that is not protected by railing requires:

- Safety harnesses to prevent operators falling in;
- A second worker to provide assistance

7.2.6 Machinery

Always be vigilant around machinery.

Ensure guards are in place when working on, or near operating equipment. Electrocution or mechanical hazards due to energizing circuits on equipment being repaired or serviced is also a concern. Use the "Lock Out/Tag Out" procedure when working on equipment to prevent accidental starting of equipment. Physically locking out the breaker and motor starter prevents these types of accidents.

7.2.7 Notifiable work

The Department of Labour must be notified 24 hours prior to the commencement of the following work, which must also be carried out under the supervision of a certified safety supervisor.

- The work is of a more extensive nature than can be performed from a ladder and where the worker risks a fall of more than 4.5m
- An excavation is more than 1.5m deep and in which the depth is greater than the width.

7.2.8 Confined Space

The pump station and re-aeration tank are identified as confined spaced and Entry permits (FM-NZ-3- 3627-6) must be completed and authorised before any confined space entry is commenced and read in conjunction with the Risk Assessment. Only people who successfully completed training for confined spaces can enter/work in the pump station and re-aeration tank.

7.2.9 Work at height

If an employee or contractor undertakes -Working at Height‖ (>1.2m) work the employee/contractor must complete a Working at Heights Permit (FM-VIC-3-4398-5). Training shall be provided to operators and other staff as required on.

7.2.10 Personal Protective Equipment

All PPE required for the works listed in Section 6 above is stored in the main building/office next to the Pasveer Channel.

Department of Conservation
Te Papa Atawhai

7.3 REPORTING AND REVIEWS

7.4 Routine Reporting

Condition 30 of Resource Consent 105684 - requires one annual report for Compliance Reporting.

1.1.1 Annual Report

Annual data records and a report summarising the results for each year ending 1 April shall be forwarded to the Manawatu-Wanganui Regional Council's Environmental Protection Manager by **31 May** of each year of this consent, commencing 31 May 2012 and shall include but not be limited to the following:

a) The results and analysis of wastewater and water quality sampling required by Conditions 17-19;
b) A copy of the Operations and Management Plan and any subsequent updates required by Conditions 10 and 11;
c) A copy of the inflow and outflow records required by Conditions 13 and 14;
d) The results and analysis of macro-invertebrate and periphyton sampling required by conditions 21-26;
e) The results and analysis of soil sampling required by Conditions 27-29;
f) An overall assessment of effects on land and water quality in the receiving environment from the discharges authorised by this resource consent;
g) Details of any upgrades or maintenance already implemented or planned for the following 12 months;
h) Details of investigations into plant performance including inflows, outflows, effluent disposal system and treatment system;
i) Details of any changes to the operation of the plant and/or proposed upgrades resulting from investigations into plant performance and monitoring results; and
j) The records of any complaints received and details of measures undertaken in response to the complaint.[4]

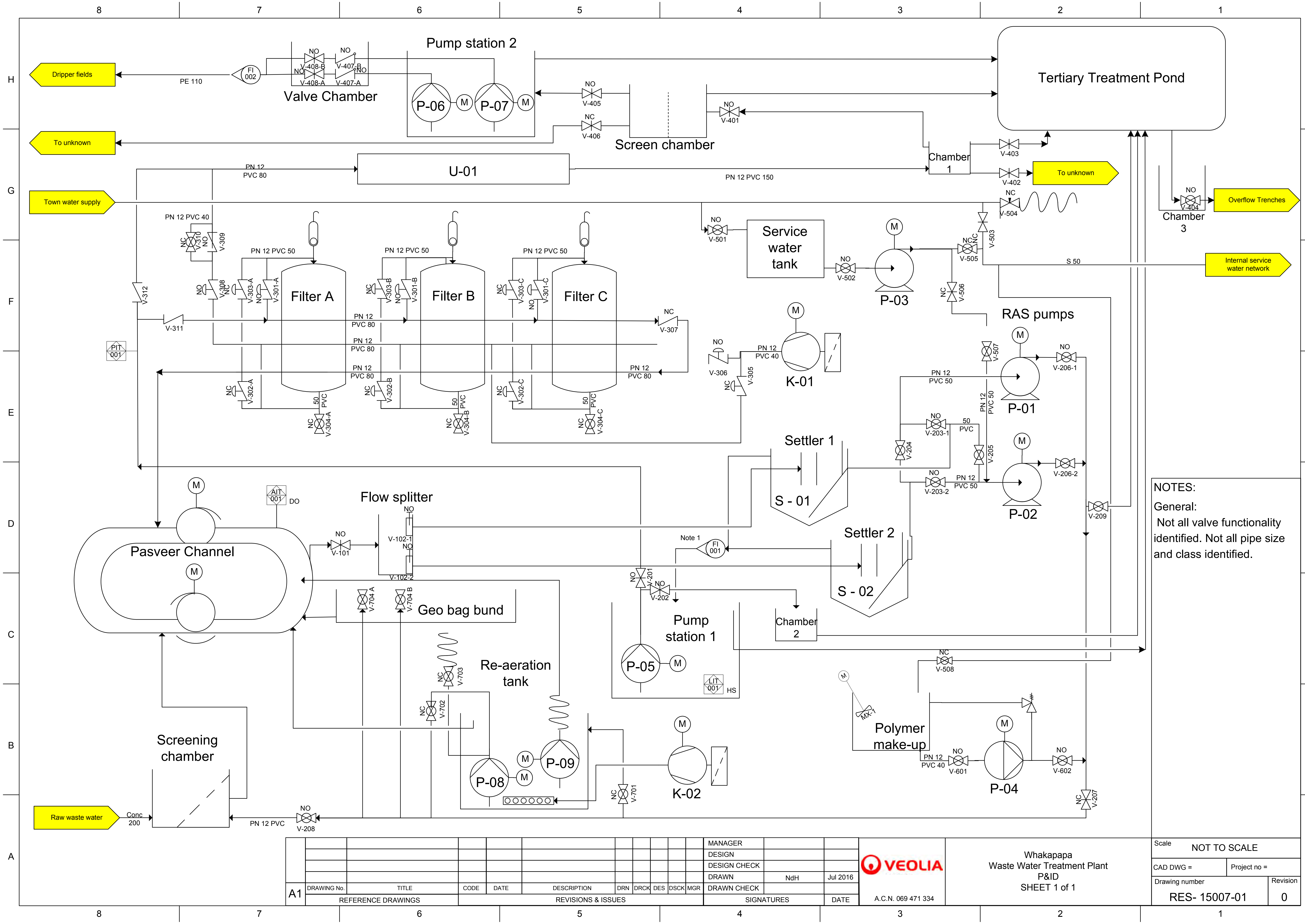
7.4.1 Review of the O&M Manual

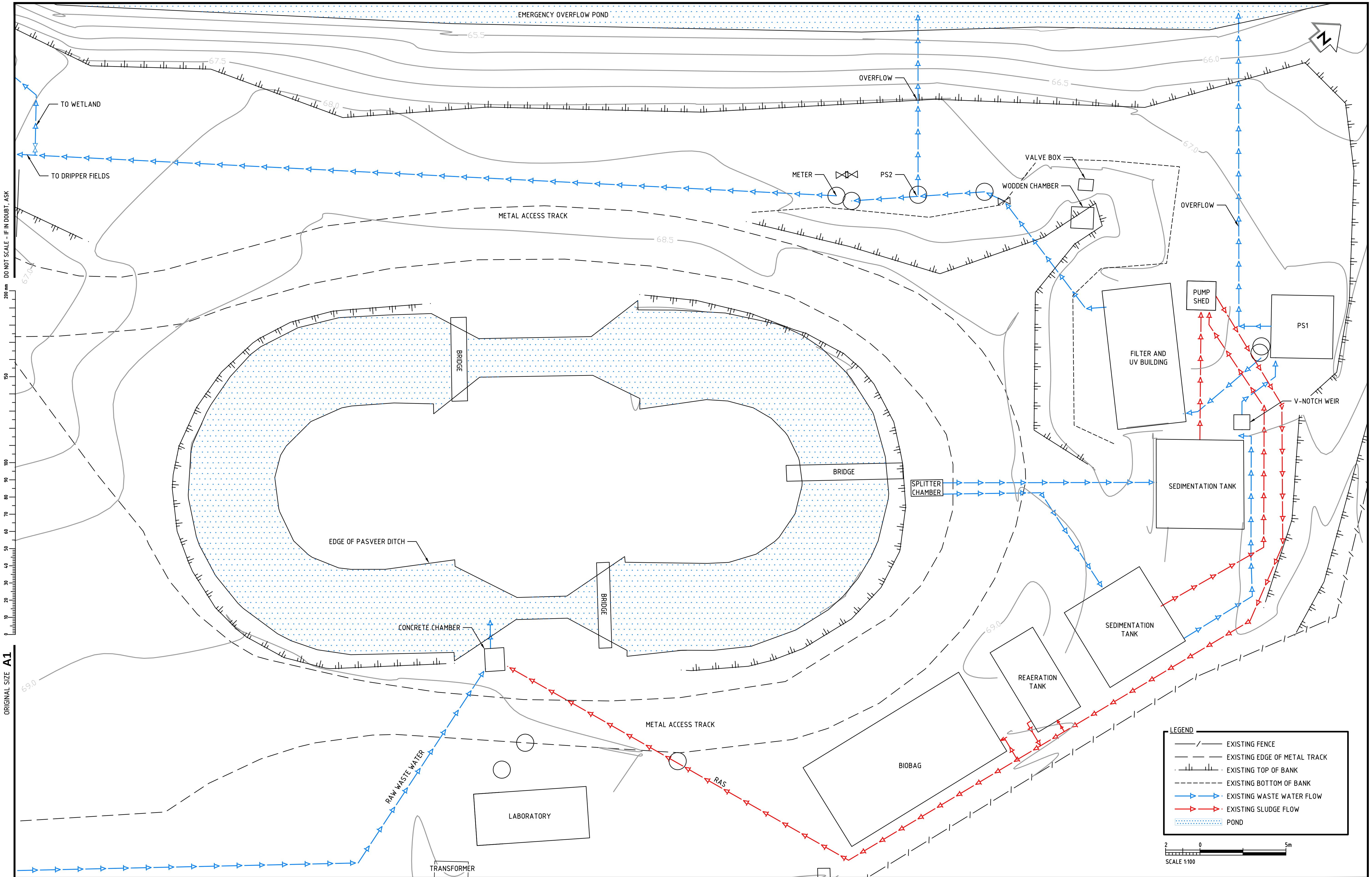
This O&M Manual shall be revised if -alterations to the Maintenance and Operations Plan [are] made as a result of changes to the treatment plant, land application area and/or wastewater scheme […]. The consent holder shall submit a revised copy of the Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager by **1 June** of each year.[5]

[4] Resource Consent No. 105684 – Condition 30
[5] Resource Consent No. 105684 – Condition 11

APPENDIX A

As Built Drawings


Pump station 2
Tertiary Treatment Pond
Dripper fields
PE 110
FI 002
V-408-B
V-408-A
V-407-B
V-407-A
Valve Chamber
P-06
P-07
V-405
V-406
V-401
Screen chamber
To unknown
U-01
PN 12 PVC 80
PN 12 PVC 150
Chamber 1
V-403
V-402
To unknown
Town water supply
V-504
Chamber 3
V-404
Overflow Trenches
PN 12 PVC 40
V-310
V-309
PN 12 PVC 50
Filter A
Filter B
Filter C
V-501
Service water tank
V-502
P-03
V-505
V-503
S 50
Internal service water network
V-506
V-312
V-308
V-303-A
V-301-A
V-303-B
V-301-B
V-303-C
V-301-C
V-311
PN 12 PVC 80
V-307
RAS pumps
PIT 001
V-306
V-305
K-01
V-507
V-206-1
PN 12 PVC 50
P-01
V-302-A
V-302-B
V-302-C
V-304-A
V-304-B
V-304-C
V-203-1
V-204
V-205
Settler 1
S - 01
V-203-2
V-206-2
P-02
AIT 001
DO
Flow splitter
V-102-1
V-102-2
V-101
Pasveer Channel
Note 1
FI 001
Settler 2
S - 02
V-209
V-201
V-202
Chamber 2
V-704 A
V-704 B
Geo bag bund
Pump station 1
P-05
LIT 001
HS
V-508
V-703
Re-aeration tank
V-702
MX-1
Polymer make-up
Screening chamber
P-08
P-09
K-02
V-701
PN 12 PVC 40
V-601
P-04
V-602
V-207
Raw waste water
Conc 200
PN 12 PVC
V-208
NOTES:
General:
Not all valve functionality identified. Not all pipe size and class identified.
Scale NOT TO SCALE
CAD DWG =
Project no =
Drawing number RES- 15007-01
Revision 0
MANAGER
DESIGN
DESIGN CHECK
DRAWN NdH Jul 2016
DRAWN CHECK
SIGNATURES
DATE
A1
DRAWING No.
TITLE
REFERENCE DRAWINGS
CODE DATE DESCRIPTION DRN DRCK DES DSCK MGR
REVISIONS & ISSUES
VEOLIA
A.C.N. 069 471 334
Whakapapa
Waste Water Treatment Plant
P&ID
SHEET 1 of 1



REV	REVISIONS	DRN	CHK	APP	DATE
A	PRELIMINARY	GMT	-	-	1/8/2014

SURVEYED	D. Sherrit (Cheal)	18/07/2014
DESIGNED	John Cocks	01/08/2014
DRAWN	Garfield Toro	01/08/2014
DRAWING CHECK	-	-
DESIGN CHECK	-	-
DESIGN REVIEW	-	-
APPROVED	-	-
PROF REGISTRATION:		

MWH

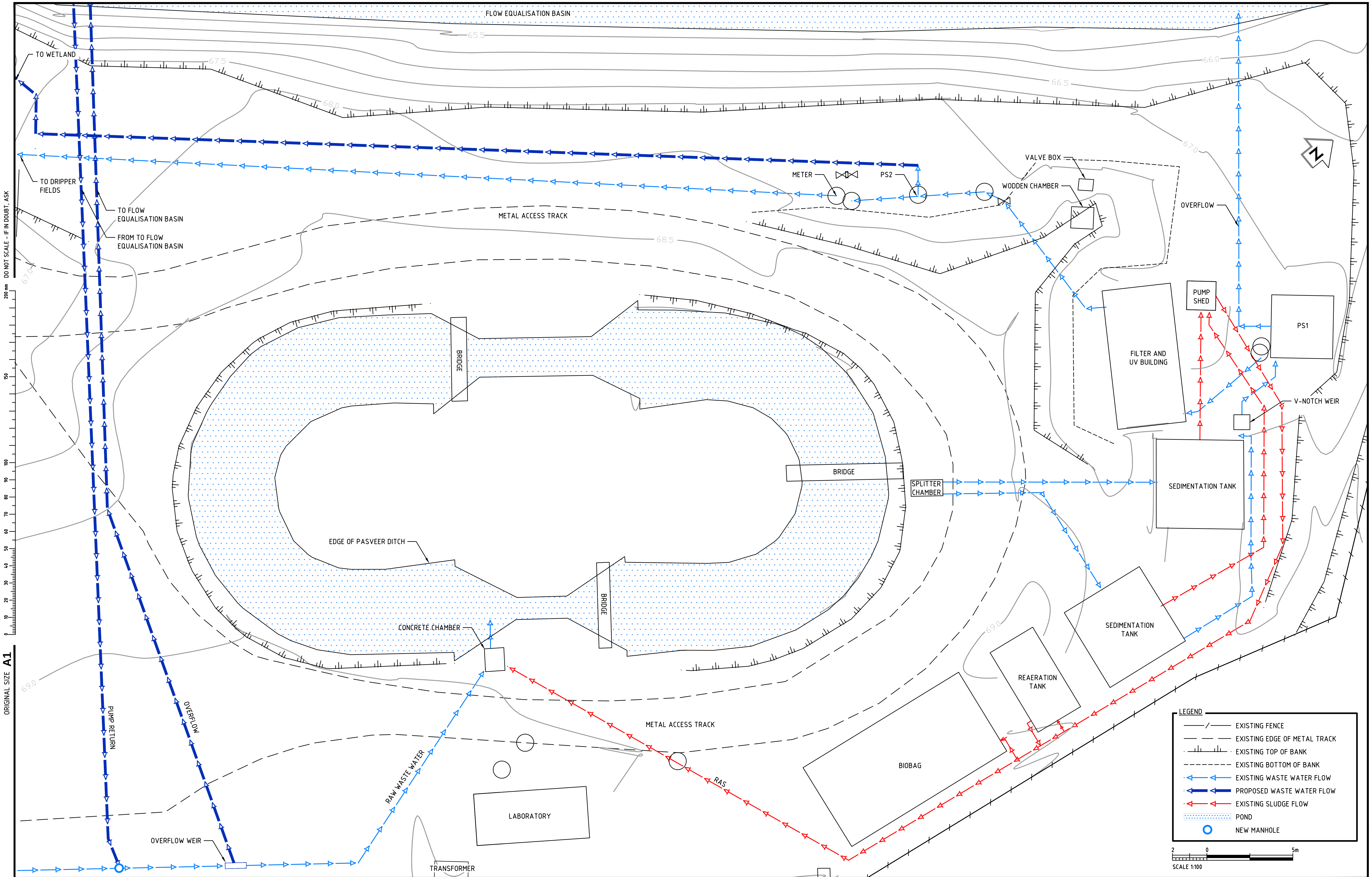
Client: Department of Conservation Te Papa Atawhai

DEPARTMENT OF CONSERVATION
WHAKAPAPA WASTE WATER TREATMENT PLANT

EXISTING LAYOUT
SHEET 1 OF 1

Status Stamp: PRELIMINARY
Date Stamp: 01/08/2014
Coordinate System:
Scales (A1) 1:100 (A3) 1:200
Datum:
Drawing No. 80505998-01-0106-C100
Rev. A

P:__2012 Onwards\Dept of Conservation\80505998 Whakapapa WWTP\DESIGN\2014-07-31 CAD



A	PRELIMINARY	GMT	-	-	1/8/2014
REV	REVISIONS	DRN	CHK	APP	DATE

SURVEYED	D. Sherrit (Cheal)	18/07/2014
DESIGNED	John Cocks	01/08/2014
DRAWN	Garfield Toro	01/08/2014
DRAWING CHECK	-	-
DESIGN CHECK	-	-
DESIGN REVIEW	-	-
APPROVED	-	-
PROF REGISTRATION:		

MWH®

Client: Department of Conservation Te Papa Atawbai

DEPARTMENT OF CONSERVATION
WHAKAPAPA WASTE WATER TREATMENT PLANT

PROPOSED LAYOUT
SHEET 1 OF 1

Status Stamp	PRELIMINARY
Date Stamp	01/08/2014
Coordinate System:	
Scales (A1) 1:100 (A3) 1:200	Datum:
Drawing No. 80505998-01-0106-C200	Rev. A

P:_2012 Onwards\Dept of Conservation\80505998 Whakapapa WWTP\DESIGN\2014-07-31 CAD

APPENDIX B

Manufacturer Manuals

Department of Conservation
Te Papa Atawhai

PENTAIR

KEYSTONE

Operating and Maintenance Instructions for: Figure 79 Pneumatic Actuators (U/E options)

Double Acting Actuator

Single Acting Actuator

Introduction

The Keystone Figure 79 Pneumatic Actuator range is available in three mounting options, as follows:-

79U - Keystone Mounting Standard
79E - ISO 5211

General Pneumatic Systems Recommendations

All Keystone Pneumatic Actuators are factory lubricated with Molyrace LT grease and, unless the operating environment is extremely poor, do not require re-lubrication. To maintain maximum efficiency with this, or other pneumatic actuators or pressure vessels, we advise that the following basic system recommendations are followed:

1. Where air pipelines are subjected to extremes of temperature, the system should be fitted with air drying equipment.
2. Air control lines should be run to a 'Recommended Piping Practice' and should not have "exaggerated" loops which may trap condensate.
3. All pipe ends should be thoroughly cleaned and deburred after cutting to ensure that the pipeline is clear of cuttings.
4. If pipelines are hydraulically tested, then the lines should be "blown down" with high pressure air to clear all water, prior to connecting lines to the actuator.
5. Where pipe fitting sealants are used, they should be applied to the male threads only. When applied to female threads, excess compound can be transmitted into the actuator control lines.
6. Where a system is dependent on Air Filter Equipment, the air filters should be situated in positions that allow easy access to maintain and/or drain.
7. Where pneumatic valve positioners, or pneumatic controllers are fitted to valve actuator assemblies, oil mist lubricated air should not be used unless the manufacturer states specifically that the controllers are compatible with lubricated air.

   Note: Figure 79 Actuators are rated for air pressure in the range 40psig (2.75barg) to 120psig (8.3barg) and can withstand a maximum of 150psig (10barg).

Construction

Figure 79 actuators are available in a range of sizes producing up to 27624 lb in/ 3121 Nm output torque and are designed to be mounted to quarter turn valves either directly or using the correct mounting brackets/adaptors and sizing procedures.

All models are of the opposed piston type. Each piston incorporates a wide toothed rack which engages a one piece drive shaft. The drive shaft is sealbond (TM) treated for maximum protection. The actuator body is of extruded aluminium and is fitted with "Engineered polymer" bearings at the drive shaft locations. Bearing and piston seals are dynamic 'O'-ring type. The actuator drive is by means of a double keyed female shaft (79U/E). A comprehensive range of double "D" adaptors is available for fitting to both the top and bottom of the output shaft for accessories (top) and valve stems (bottom).

Standard Installation - Double & Single Acting Units

These instructions assume that the actuators are installed with the cylinder axis parallel to the axis of the valve bore (In Line).

Single acting actuators are supplied as FAIL-CLOSE units as standard.
Reverse acting FAIL-OPEN must be specified at the time of order.

The actuator is mounted as follows:

1. Ensure that the valve and actuator are both in the following positions:
   Double Acting units - fully closed
   Single Acting units - air fail mode (normally closed)
2. Check that the actuator mounting studs are tightly secured in the actuator housing.
3. Install the correct adaptor, if required, into the actuator (fig. 1 - direct mounting) or install the correct coupling and bracketry, if required, to the valve (fig. 2 - bracket mounted option).
   See Notes 1 & 2
4. Mount the actuator onto the valve flange or the bracket and secure using a lockwasher and nut on each mounting stud.
5. Before installing the valve/actuator assembly in a piping system, the disc travel should be verified.
6. When installing the valve/actuator assembly into pipeline, ensure that the specific instructions relating to the valve installation are followed. For valves which need to be fitted with the valve in a position other than fully closed, it may be necessary to fit the valve into the pipeline prior to mounting the actuator to the valve. Rubber lined butterfly valves are an example of this.
7. For valves which need to be installed in the pipeline prior to fitting the actuator, ensure that the valve is operated into its failsafe position before mounting the actuator onto the valve.

Non Standard Installation - Double & Single Acting Units

In circumstances where the actuator is required to be installed in the transverse position i.e. at right angles to the valve bore (Across Line), the actuator must be rotated through 90°.
This is achieved in the following manner:

1. Remove the actuator from the valve or the bracket by unscrewing the 4 fixing nuts and withdraw it vertically from the valve.
2. **79U/E Models** - remove the double 'D' adaptor located in the bore at the bottom of the actuator and re-fit, locating in previously unused keyway of shaft.
3. Refit actuator to the top of the valve. (note:- on models 036/065/090 adaptors may not be required to be fitted ie directly mounted, in this case simply use the previously unused keyway.)

Notes

1. The adaptor should be **lightly tapped or pressed into the actuator.**
2. **The coupling should be lightly tapped** or **pressed onto the valve stem.**
   Excessive force should not be used
   (the use of a lubricant such as Coppaslip is recommended).

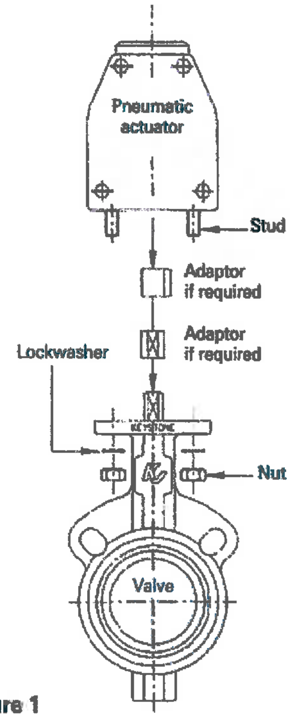


Figure 1

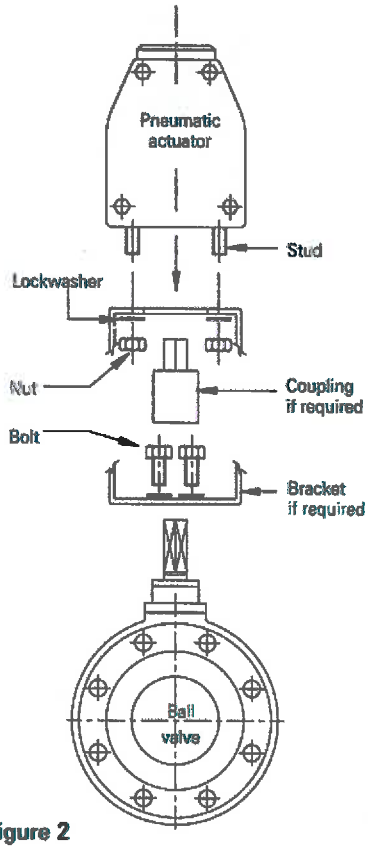


Figure 2

Disassembly - Double Acting Units

Note: Please refer to the relevant exploded views further on.

CAUTION! Remove all air pressure and observe normal safety precautions including the use of eye protection.

1. Pull off the indicator cap (item 17) from the top of the actuator. If this cap is too tight, light pressure may be applied to the underside via a short length of round bar or a similar blunt ended tool, inserted from the bottom end of the actuator shaft. (Note: levering with a screwdriver is considered to be a potentially dangerous practice and should be avoided.)
   The position relative to the shaft should be noted to ensure correct position for assembly.
2. Remove both travel stop bolts, if fitted (items 19 to 22, see page 10 for all items)
3. Loosen endcap fixing screws evenly (item 15)
4. Remove endcaps (item 3)
5. Rotate output shaft (item 5) in a anti-clockwise direction to drive pistons apart, and remove pistons (item 2) complete with backing pads/rings - if fitted.
6. Remove circlip (item 12) from bottom bore of actuator.
7. Tap shaft downward and remove. Take care to protect the actuator bore from possible damage from the pinion gear teeth.
8. Remove top bearing (item 9) from the actuator body (the bottom bearing (item 6) will have been removed along with the pinion shaft).

Disassembly - Single Acting Units

Note: Please refer to the relevant exploded views further on.

CAUTION! Remove all air pressure and observe normal safety precautions including the use of eye protection. Always ensure that spring return actuators are in fail safe position before attempting any maintenance. Pay particular attention to this requirement when manual operators are fitted.
For safety reasons DONOT 'Air Assist' Single Acting Pneumatic actuators.

1. Pull off the indicator cap (item 17) from the top of the actuator. If this cap is too tight, light pressure may be applied to the underside via a short length of round bar or a similar blunt ended tool, inserted from the bottom end of the actuator shaft. (Note: levering with a screwdriver is considered to be a potentially dangerous practice and should be avoided.)
   The position relative to the shaft should be noted to ensure correct position for assembly.
2. Remove both travel stop bolts, if fitted (items 19 to 22, see page 11 for all items).
3. Loosen endcap/spring return housing fixing screws (item 15) evenly until the spring load is relaxed (3 - 5mm).
   Warning: If, after loosening the screws by 5mm there is still compression on the spring pack, re-tighten the endcap screws and return the unit to the factory for service.
4. Remove endcap/spring housing assemblies.
   Warning: Under no circumstances should the spring retaining bolt be loosened or adjusted without first consulting the factory.
5. Rotate output shaft (item 5) in an anti-clockwise direction to drive pistons apart and remove pistons (item 2) complete with backing pads/rings - if fitted.
6. Remove circlip (item 12) from bottom bore of actuator.
7. Tap shaft downward and remove. Take care to protect actuator bore from possible damage from the pinion gear teeth.
8. Remove top bearing (item 9) from the actuator body (the bottom bearing (item 6) will have been removed along with the pinion shaft).

Assembly - Double Acting Units

Note: Please refer to the relevant exploded views further on.

Liberally grease actuator bore, pistons and pinion assembly with Molyrace LT lubricant.

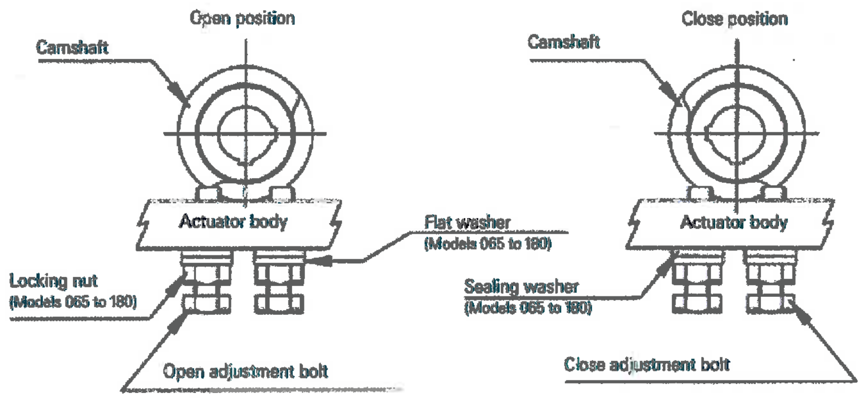
1. Coat all 'O'-ring seals with Molyrace LT lubricant.
2. Output shaft assembly:-
   a) Fit the top bearing assembly (item 9) into the top bore of the actuator body (item 1) with the outer o-ring uppermost.
   b) Fit the bottom bearing assembly (item 6) on to the bottom of the pinion shaft (item 5) with internal o-ring uppermost.
3. Insert pinion shaft assembly from underside of the actuator as shown in fig. 4.
4. Fit internal circlip (item 12) to bottom recess of body to locate the shaft assembly.
5. Fit 'O'-ring seals (item 13) on pistons (item 2).
6. Orientate output shaft at 45° ± 2°.
7. Insert pistons (item 2) complete with backing pads(1) (item 18) and backing rings (5), with piston legs on left side of bore (when viewed from the o-ring end of the piston), until racks engages with pinion and then push fully inward, the actuator is now in the fully closed position.
   ** If no travel stops are fitted proceed to instruction 12.*
8. Turn the pinion shaft anti-clockwise approximately 5° until it is orientated in line with the major axis of the actuator body. The shaft is now in the closed position.
9. Insert CLOSE travel stop bolt (item 19/20) together with sealing nut or lock nut (2)(3), flat washer (2)(3) and sealing washer (2)(3) until the bolt hits the travel stop cam. Tighten the lock nut.
10. Turn the pinion shaft anti-clockwise through 90° to bring it in line with the centre line of the actuator bore, the actuator is now in the open position.
11. Insert Open travel stop bolt (item 19/20) (together with sealing nut or lock nut (2)(3), flat washer (2)(3) and sealing washer (2)(3)) until the bolt hits the travel stop cam. Tighten the lock nut.
12. Fit 'O'-ring seals (item 14) to endcaps (item 3) using a light smear of grease.
13. Fit endcaps to body and alternately tighten the endcap screws (item 15) until secure (see recommended torque table).
14. Fit position indicator to top of actuator.
15. Operate the actuator to OPEN & CLOSE positions using compressed air and note the actual positions. If the required travel is not achieved refer to page 12.

Notes

1 Backing pads are not required on 002/003 models which have nylon pistons.
2 Lock nuts, flat washers and sealing washers are only fitted to models 065-180.
3 On models 003/036 the lock nut & sealing nut are one item.
4 Gear shim is required on models 006 and 012 only.
5 Backing rings and pads are only fitted to models 065/090/180.

Note:- Backing pads and rings need only a smear of grease on the undersides before fitting to pistons.

Figure 3

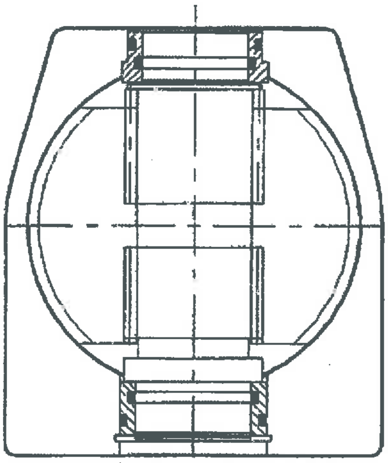


Viewed from top of actuator

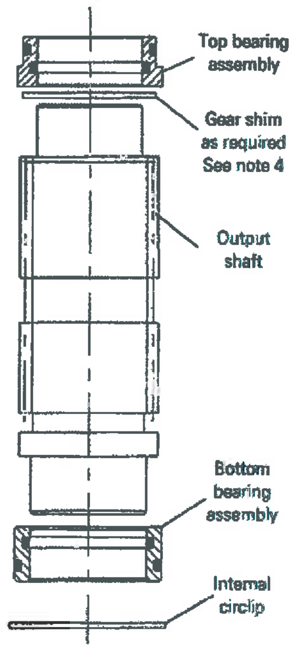
Notes

Refer to notes on page 4 as indicated.

Figure 4



Sectioned assembly of actuator body and output shaft



Assembly - Single Acting Units

Note: Please refer to the exploded views further on.

Liberally grease actuator bore, pistons and pinion assembly with Molyrace LT lubricant.

Note: The endcap spring assembly is a complete module with the appropriate spring preset to suit the selected duty parameters. Spring retaining bolt threads are bonded to end caps with threadlock sealant to ensure double security.

Caution! No attempt should be made to remove or adjust spring retaining bolts.

1. Coat all 'O'-ring seals with Molyrace LT lubricant.
2. Output shaft assembly:-
   a) Fit the top bearing assembly (item 9) into the top bore of the actuator body (item 1) with the outer o-ring uppermost.
   b) Fit the bottom bearing assembly (item 6) on to the bottom of the pinion shaft (item 5) with internal o-ring uppermost.
3. Insert pinion shaft assembly from underside of the actuator as shown in the diagram opposite.
4. Fit internal circlip (item 12) to bottom recess of body to locate the shaft assembly.
5. Fit 'O'-ring seals (item 13) on pistons (item 2).
6. Orientate output shaft at 45° ± 2°.

Fail Close Units

7. Insert pistons (item 2) complete with backing pads(1)(item 18) and backing rings(4) as follows:-
   - with piston legs on **left side** of bore (when viewed from the o-ring end of the piston), until racks engages with pinion and then push fully inward, the actuator is now in the fully closed position.
   Note: If no travel stops are fitted proceed to instruction 12.
8. Turn the pinion shaft anti-clockwise approximately 5° until it is orientated in line with the major axis of the actuator body. The shaft is now in the closed position.
9. Insert CLOSE travel stop bolt (item 19/20) together with sealing nut or lock nut (2)(3), flat washer (2)(3) and sealing washer (2)(3) until the bolt hits the travel stop cam. Tighten the lock nut.
10. Turn the pinion shaft anti-clockwise through 90° to bring it back in line with the centre line of the actuator bore, the actuator is now in the open position.
11. Insert Open travel stop bolt (item 19/20) together with sealing nut or lock nut (2)(3), flat washer (2)(3) and sealing washer (2)(3) until the bolt hits the travel stop cam. Tighten the lock nut.

Fail Open Units

7. Insert pistons (item 2) complete with backing pads (1) (item 18) and backing rings (4) as follows:-
   - with piston legs on **right side** of bore (when viewed from the o-ring end of the piston), until racks engages with pinion and then push fully inward, the actuator is now in the fully open position.
   Note: If no travel stops are fitted proceed to instruction 12.
8. Turn the pinion shaft clockwise approximately 5° until it is orientated in line with the major axis of the actuator body. The shaft is now in the open position.
9. Insert Open travel stop bolt (item 19/20) together with sealing nut or lock nut (2)(3), flat washer (2)(3) and sealing washer (2)(3) until the bolt hits the travel stop cam. Tighten the lock nut.
10. Turn the pinion shaft clockwise through 90° to bring it in line with the centre line of the actuator bore, the actuator is now in the close position.
11. Insert CLOSE travel stop bolt (item 19/20) together with sealing nut or lock nut (2)(3), flat washer (2)(3) and sealing washer (2)(3) until the bolt hits the travel stop cam. Tighten the lock nut.

12. Fit 'O'-ring seals (item 14) to endcaps (item 3) using a light smear of grease.
13. Fit endcap spring assemblies to body and alternately tighten the endcap screws (item 15) until secure (see recommended torque table).
14. Fit position indicator to top of actuator.
15. Operate the actuator to OPEN & CLOSE positions using compressed air and note the actual positions. If the required travel is not achieved refer to page 10.

Standard Double Acting Actuator Assembly - 79U/E Models 002 - 036

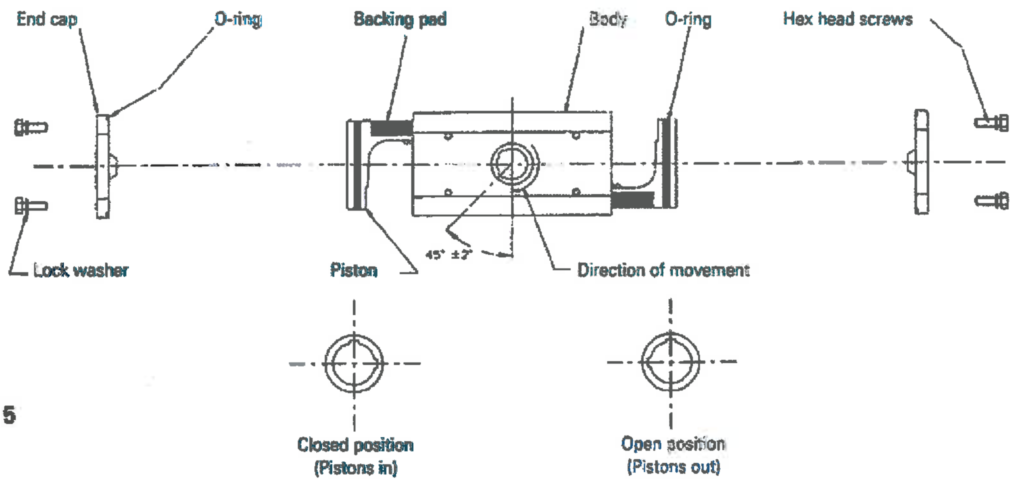


Figure 5

Top view of Actuator

Standard Single Acting Actuator Assembly - 79U/E Models 002S-036S

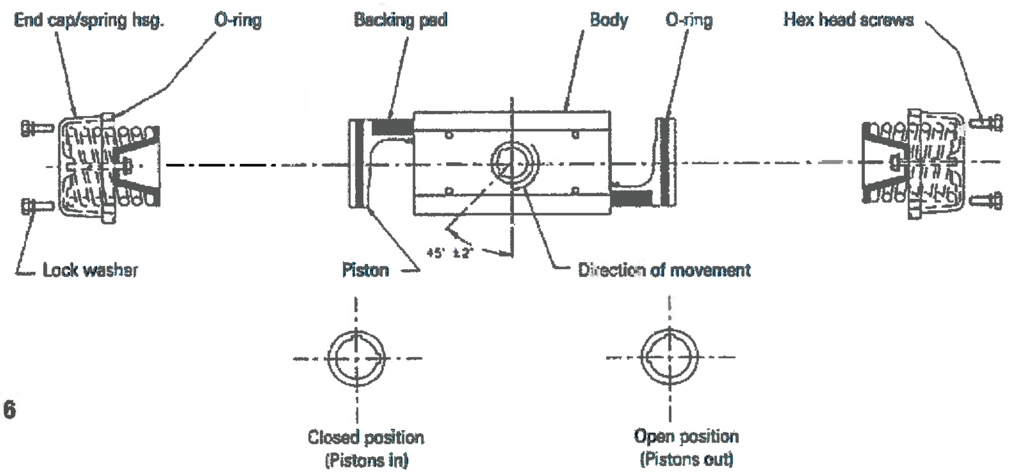


Figure 6

Top view of Actuator

Non-Standard (Fail Open) Single Acting Actuator Assembly - 79U/E Models 002S-036S

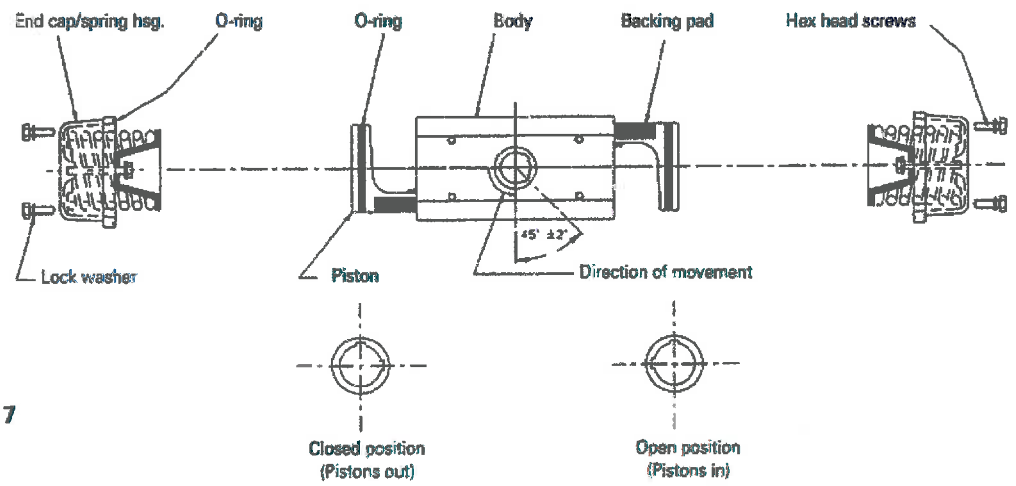


Figure 7

Top view of Actuator

Standard Double Acting Actuator Assembly - 79U/E Models 065-180

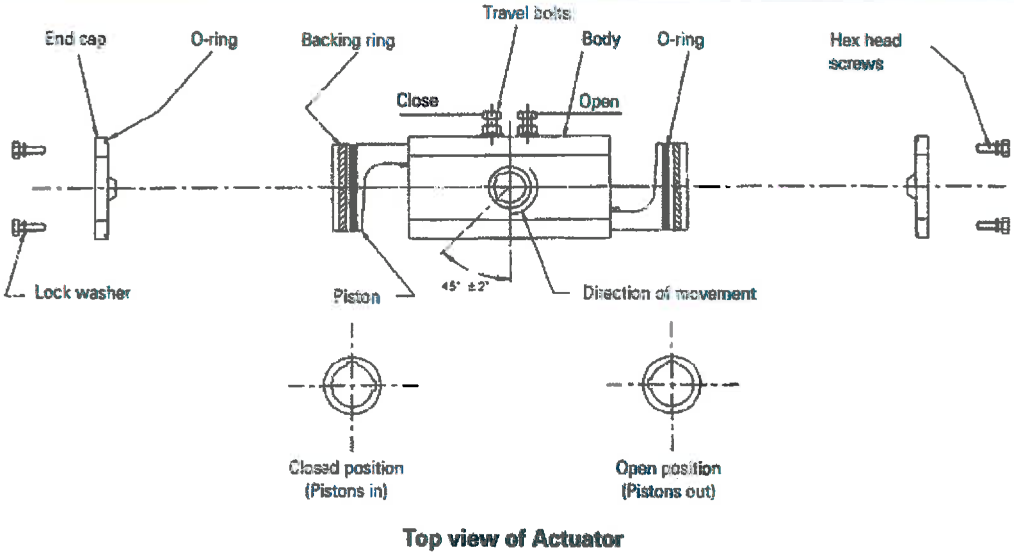


Figure 8

Standard (Fail Close) Single Acting Actuator Assembly - 79U/E Models 065S-180S

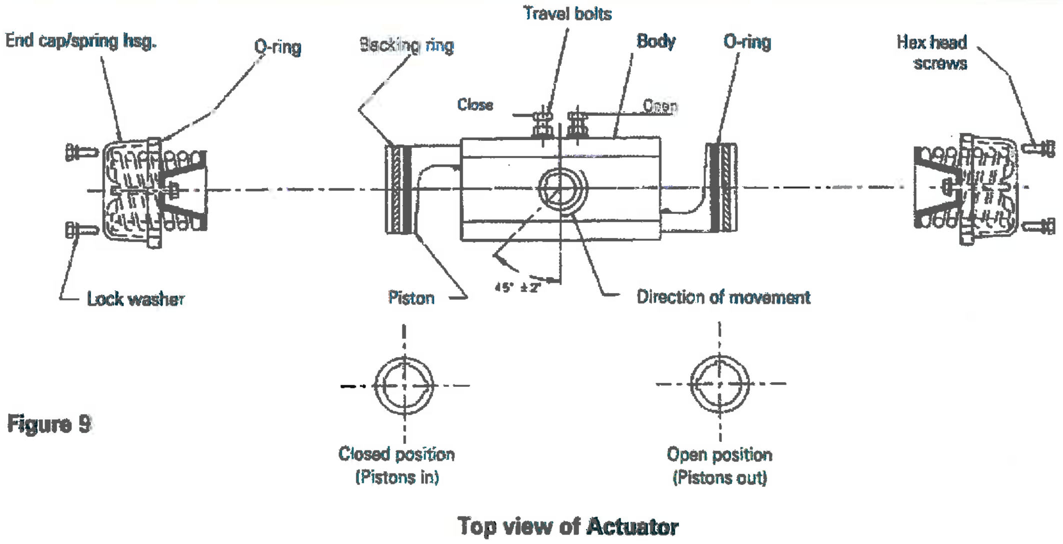


Figure 9

Non-Standard (Fail Open) Single Acting Actuator Assembly - 79U/E Models 065S-180S

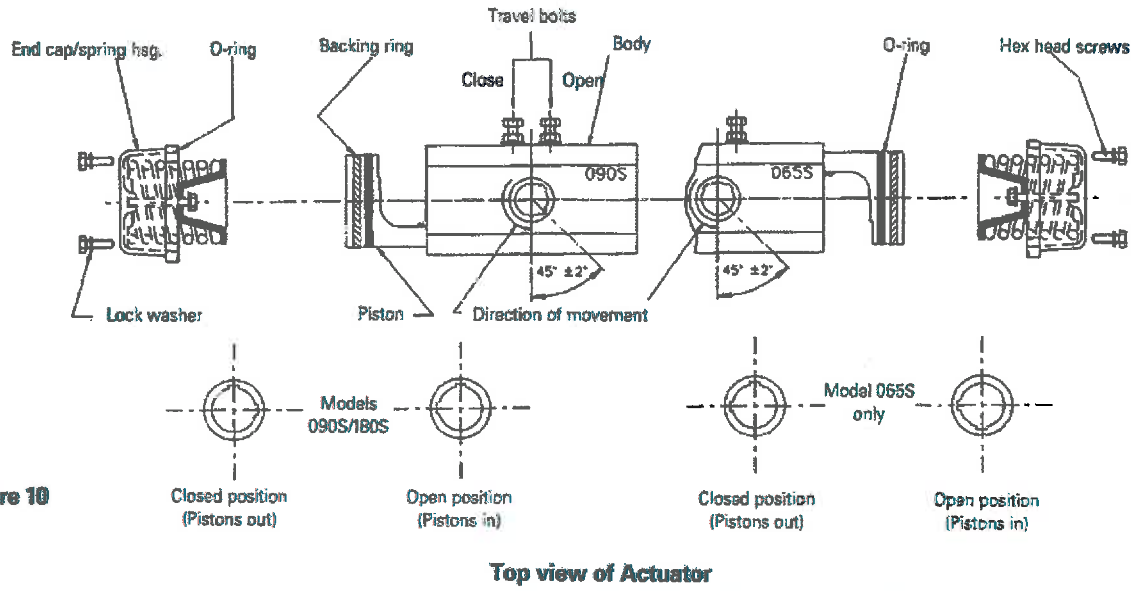
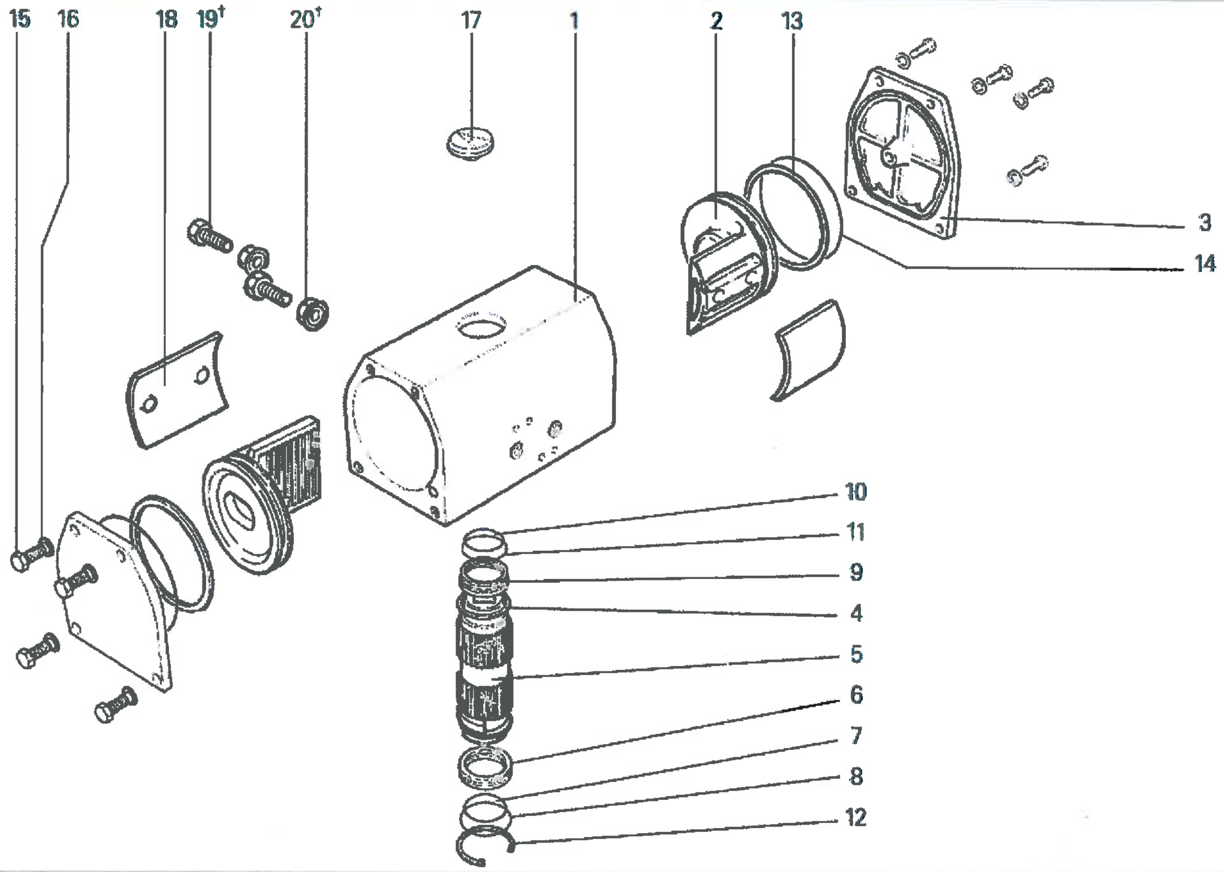


Figure 10

Exploded view of Double Acting Actuator Assembly - Model 002 - 036



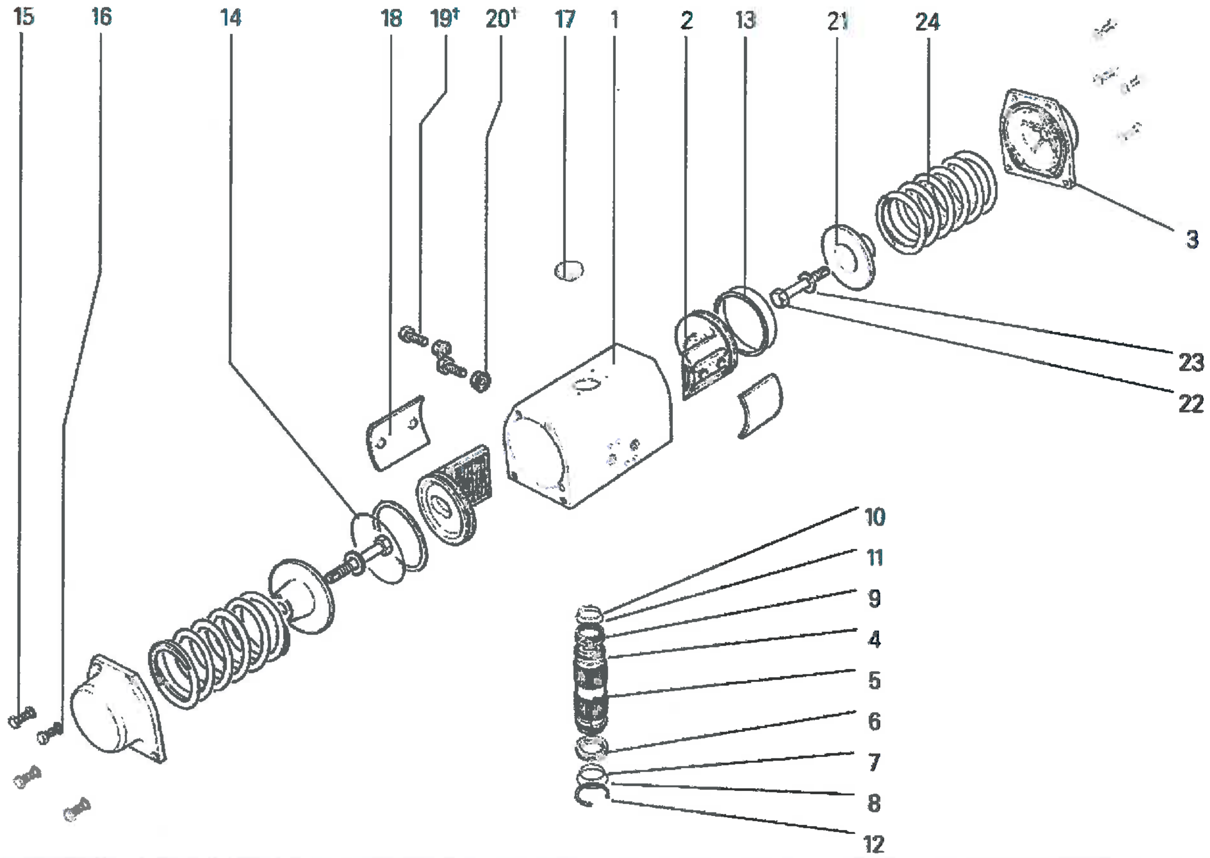
Materials of construction - Models 002 - 036

Item	Description		Qty	Material
1	Body		1	Aluminium
2	Piston		2	Aluminium (006-036) Nylon (002-003)
3	End Cap		1	Aluminium
4	Gear shim (models 006 & 012 only)		1	Polymer
5	Pinion Shaft		1	Steel (003-036) Nylon (002)
6*	Bottom Bearing		1	Polymer
7*	Bottom Bearing - Internal O-Ring		1	Nitrile
8*	Bottom Bearing - External O-Ring		1	Nitrile
9*	Top Bearing		1	Polymer
10*	Top Bearing - Internal O-Ring		1	Nitrile
11*	Top Bearing - External O-Ring		1	Nitrile
12*	Internal Circlip		1	Spring steel
13*	Piston O-ring		2	Nitrile
14*	End Cap O-ring		2	Nitrile
15	Hex Screw	(M5 x 16 -002/003, M5 x 20 -006 M8 x 25 -012, M10 x 30 -024/036)	8	Stainless steel
16	Lock Washer (M5 -002/006, M8 -012, M10 -024/036)		8	Steel
17	Position Indicator		1	ABS
18	Backing pad		2	Polymer (006-036)
19†	Travel Stop Bolt	(M6 x 25 -003, M8 x 45 -006 M10 x 50 -012, M12 x 65 -024/036)	2	Stainless Steel
20†	Travel Stop Nut	(M6 -003, M8 -006, M10 - 012, M12 - 024/036)	2	Steel/Polyamid 11

Components shown on the above view may differ slightly in the design shape owing to the range of models being covered.

* *Repair Kit contains these items*

Exploded view of Single Acting Actuator Assembly - Model 002S - 036S

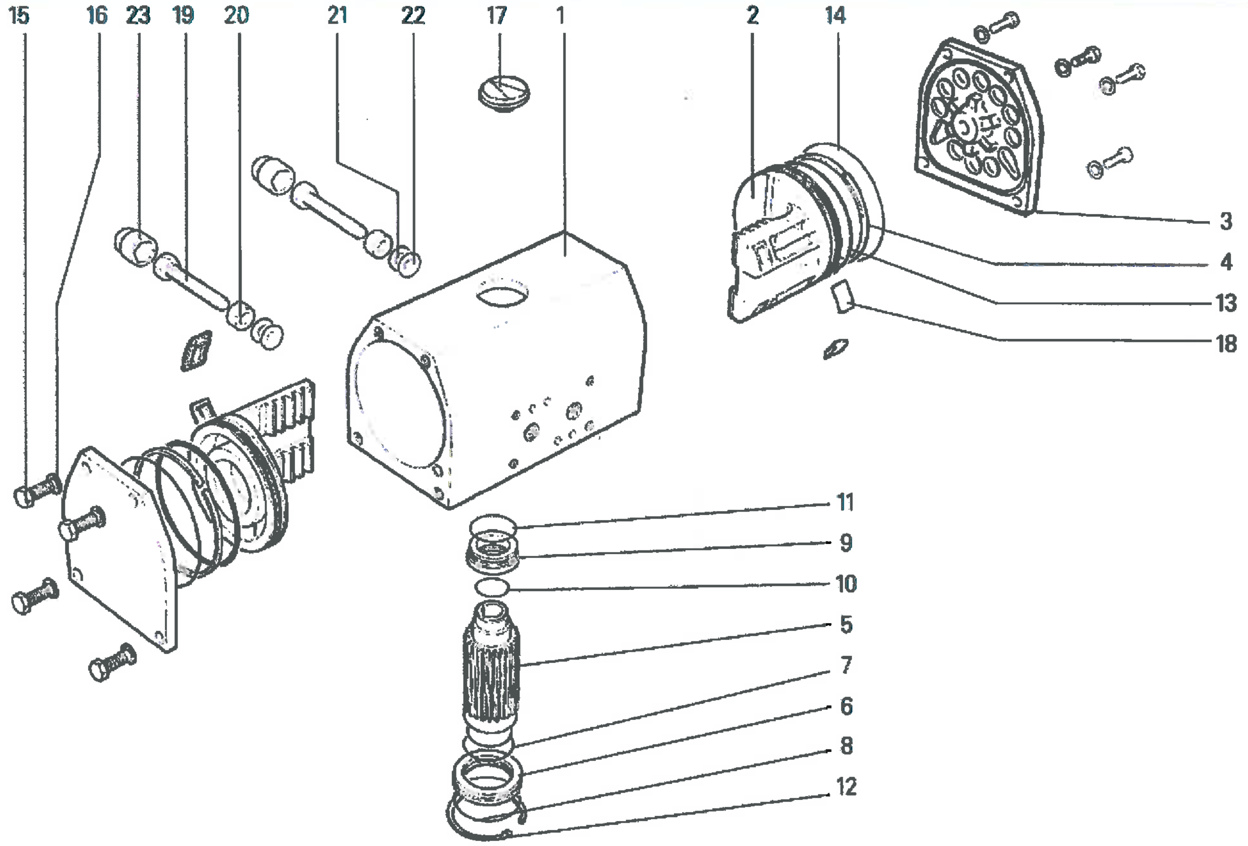


Materials of construction - Models 002S - 036S

Item	Description	Qty	Material
1	Body	1	Aluminium
2	Piston	2	Aluminium (006-036) Nylon (002-003)
3	End Cap	1	Aluminium
4	Gear shim (models 006 & 012 only)	1	Polymer
5	Pinion Shaft	1	Steel (003-036) Nylon (002)
6*	Bottom Bearing	1	Polymer
7*	Bottom Bearing - Internal O-Ring	1	Nitrile
8*	Bottom Bearing - External O-Ring	1	Nitrile
9*	Top Bearing	1	Polymer
10*	Top Bearing - Internal O-Ring	1	Nitrile
11*	Top Bearing - External O-Ring	1	Nitrile
12*	Internal Circlip	1	Spring steel
13*	Piston O-ring	2	Nitrile
14*	End Cap O-ring	2	Nitrile
15	Hex Screw (M5 x 16 -002/003, M5 x 20 -006 M8 x 25 -012, M10 x 30 -024/036)	8	Stainless steel
16	Lock Washer (M5 -002/006, M8 -012, M10 -240/036)	8	Steel
17	Position Indicator	1	ABS
18	Backing pad	2	Polymer (006/036)
19†	Travel Stop Bolt (M6 x 25 -003, M8 x 45 -006 M10 x 50 -012, M12 x 65 -024/036)	2	Stainless Steel
20†	Travel Stop Nut (M6 -003, M8 -006, M10 - 012, M12 - 024/036)	2	Steel/Polyamid 11
21	Spring Retaining Cone	2	Aluminium
22	Spring Retaining Bolt (M8 x 55 -006, M8 x 60 -012 M10 x 80 -024, M10 x 90 -036)		
23	Plain washer (M8 -006/012, M10 -024/036)	2	Steel
24	Spring (40/60/80 or 100 psi) #	2 or 4	Spring Steel

Components shown on the above view may differ slightly in the design shape owing to the range of models being covered.
Items 3,19 to 22 are supplied as a preset spring assembly and must not be dissassembled.
\# *See standard spring colour codes for spring combinations.*
* *Repair Kit contains these items*

Exploded view of Double Acting Actuator Assembly - Models 065 - 180

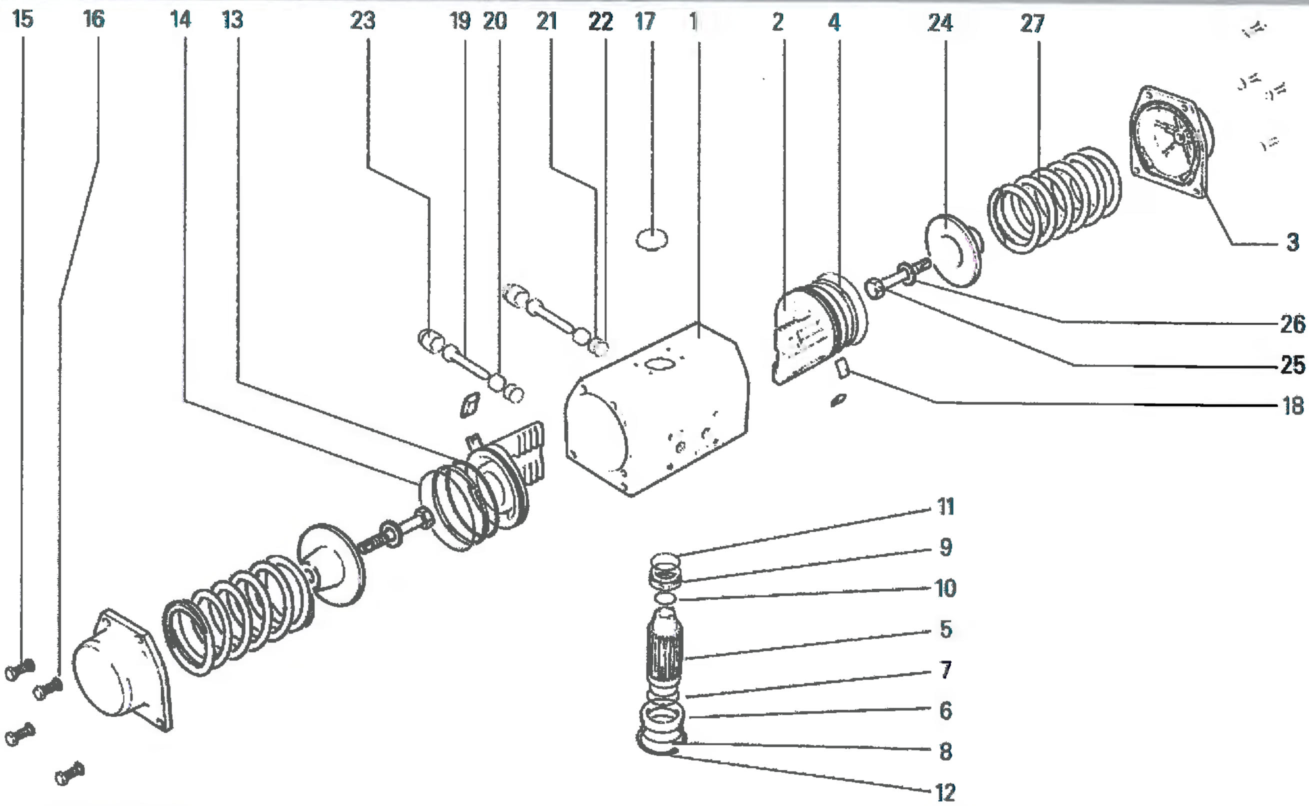


Materials of construction - Models 065 - 180

Item	Description	Qty	Material
1	Body	1	Aluminium
2	Piston	2	Aluminium
3	End Cap	2	Aluminium
4	Backing ring	2	Polymer (065/180)
5	Pinion Shaft	1	Steel
6*	Bottom Bearing	1	Polymer
7*	Bottom Bearing - Internal O-Ring	1	Nitrile
8*	Bottom Bearing - External O-Ring	1	Nitrile
9*	Top Bearing	1	Polymer
10*	Top Bearing - Internal O-Ring	1	Nitrile
11*	Top Bearing - External O-Ring	1	Nitrile
12*	Internal Circlip	1	Spring steel
13*	Piston O-ring	2	Nitrile
14*	End Cap O-ring	2	Nitrile
15	Hex Screw (M12 x 40 -065/090, M16 x 55 -180)	8	Stainless steel
16	Lock Washer (M12 -065/090, M16 -180)	8	Steel
17	Position Indicator	1	ABS
18	Backing pad	4	Polymer
19	Travel Stop Bolt (M16 x 65 -065, M16 x 90 -090, M20 x 130 -180)	2	Stainless steel
20	Travel Stop Nut (M16 -065/090, M20 -180)	2	Stainless steel
21	Washer Flat (M16/M20)	2	Stainless steel
22	Washer Thread Seal (5/8" -065/090, 3/4" -180)	2	Steel/Nitrile
23	Protective Cap M16 Bolt	2	Plastic

* *Repair Kit contains these items*

Exploded view of Single Acting Actuator Assembly - Models 065S - 180S



Materials of construction - Models 065S - 180S

Item	Description	Qty	Material
1	Body	1	Aluminium
2	Piston	2	Aluminium
3	End Cap	2	Aluminium
4	Backing ring	2	Polymer (065/180)
5	Pinion Shaft	1	Steel
6*	Bottom Bearing	1	Polymer
7*	Bottom Bearing - Internal O-Ring	1	Nitrile
8*	Bottom Bearing - External O-Ring	1	Nitrile
9*	Top Bearing	1	Polymer
10*	Top Bearing - Internal O-Ring	1	Nitrile
11*	Top Bearing - External O-Ring	1	Nitrile
12*	Internal Circlip	1	Spring steel
13*	Piston O-ring	2	Nitrile
14*	End Cap O-ring	2	Nitrile
15	Hex Screw (M12 x 40 -065/090, M16 x 55 -180)	8	Stainless steel
16	Lock Washer (M12 -065/090, M16 -180)	8	Steel
17	Position Indicator	1	ABS
18	Backing pad	4	Polymer
19	Travel Stop Bolt (M16 x 65 -065, M16 x 90 -090, M20 x 130 -180)	2	Stainless steel
20	Travel Stop Nut (M16 -065/090, M20 -180)	2	Stainless steel
21	Washer Flat (M16/M20)	2	Stainless steel
22	Washer Thread Seal (5/8" -065/090, 3/4" -180)	2	Steel/Nitrile
23	Protective Cap (M16/M20 Bolt)	2	Plastic
24	Spring retaining cone	2	Aluminium
25	Spring retaining bolt (M16 x 115 -065, M16 x 125 -090 M20 x 125 -180)	2	Stainless Steel
26	Plain washer (M16 -065/090, M20 -180)	2	Steel
27	Spring (40/60/70/80/90 or 100 psi)#	2 or 4	Spring Steel

Items 3, 24 to 27 are supplied as a preset spring assembly and must not be dissassembled.
 # See standard spring colour codes for spring combinations.
** Repair Kit contains these items*

Setting of Internal Travel Stops

Figure 79U & 79E - 065/090/180 are fitted with integral end of travel stops to enable setting of exact travel for the valve being operated.
These stops give adjustment of 5° overtravel to 7° undertravel at each end of stroke. The range of the actuator travel is, therefore :-

at closed (0°) position - 5° to +7°

at open (90°) position 83° to 95°

To Set the Stops (Double acting units)

1. Operate valve/actuator assembly to the closed position.
2. Remove air supply.
3. Slacken locknut on the close travel stop.
4. Turn the stop clockwise to reduce travel or anticlockwise to increase travel.
5. Re-Tighten locknut.
6. Reconnect air supply and check that the position is correct. If not repeat from instruction 2.
7. Apply air to operate to the open position.
8. Remove air supply.
9. Adjust open travel stop screw as per instructions 3 to 6.

To Set the Stops (Single acting units) Air Fail Close

1. Remove air supply so that actuator drives to closed position. Note actual position.
2. Apply air to open the actuator. Note actual position.
3. Whilst the air supply is maintained slacken the locknut on the close stop and adjust the stop screw by an amount estimated to give correct position. (clockwise adjustment decreases travel).
4. Re-tighten lock nut.
5. Remove air so that actuator closes. If correct closed position is not achieved repeat from instruction 2.
6. Slacken locknut on the open stop and adjust the travel by an amount estimated to give correct position. (clockwise adjustment decreases travel).
7. Re-tighten locknut.
8. Apply air and check open position. If correct open position is not achieved.
   Repeat from instruction 5.

To Set the Stops (Single acting units) Air Fail Open

1. Remove air supply so that actuator drives to open position. Note actual position.
2. Apply air to close the actuator. Note actual position.
3. Whilst the air supply is maintained slacken the locknut on the open stop and adjust the stop screw by an amount estimated to give correct position. (clockwise adjustment decreases travel).
4. Re-tighten lock nut.
5. Remove air so that actuator opens. If correct open position is not achieved repeat from instruction 2.
6. Slacken locknut on the close stop and adjust the travel by an amount estimated to give correct position. (clockwise adjustment decreases travel).
7. Re-tighten locknut.
8. Apply air and check close position. If correct close position is not achieved.
   Repeat from instruction 5.

Warnings !

Under no circumstances must the travel stop bolts be totally withdrawn from the actuator whilst compressed air is being applied.

Internal travel stops must not be used for manual override

Accessories mounted to the top of Actuators must be re-adjusted accordingly after setting the travel stops.

Maintenance

If basic pneumatic system procedures are maintained, the Figure 79 actuators will require minimum maintenance for many thousands of cycles.

Troubleshooting

If loss or reduction of power (in output torque) occurs, take the following steps:-

1) Check air supply.

2) Check for o'ring leakage at the following

'A' Top and Bottom Bearing Seals
Apply pressure to PORT A and check with soap/water solution for leaks at the top and bottom bearing seals.
'B' Endcap Seals
Apply air pressure to PORT B and check endcap joints for leakage.
'C' Piston Seals
Apply air pressure to PORT B and check PORT A for leakage.
For access to 'O'-ring seals in order to replace, refer to Disassembly procedures for appropriate models i.e. single or double acting.

Note: Reduced stroke i.e. valve to which actuator is fitted not travelling the required stroke or "backlash" may be caused by an incorrect fit between output bore and valve stem.

General Information

As standard, clockwise to close rotation, air to PORT A will rotate the actuator to the OPEN position. Air to PORT B will rotate the actuator to the close position.

Warning - for safety reasons <u>DO NOT</u> 'Air Assist' single acting pneumatic actuators.

Standard spring colour codes

Spring Rating	Models 003S to 180S	
	End 1	End 2
40 psi - 2.8 bar	Light Blue	Light Blue
50 psi - 3.5 bar	Light Blue	White
60 psi - 4.2 bar	White	White
70 psi - 4.8 bar	Light Blue/Dark Blue*	White
80 psi - 5.5 bar	Light Blue/Dark Blue*	Light Blue/Dark Blue*
90 psi - 6.2 bar	Light Blue/White*	Light Blue/Dark Blue*
100 psi - 6.9 bar	Light Blue/White*	Light Blue/White*

* Nested (double) springs

Recommended Tightening Torques for End Caps

Models	Bolt Diameter	Torque (Nm)	Torque (lbs-ft)
002	M5	3.2	4.3
003	M5	3.2	4.3
006	M5	3.2	4.3
012	M8	13.1	17.7
024	M10	26.2	35.5
036	M10	26.2	35.5
065	M12	45.2	61.3
090	M12	45.2	61.3
180	M16	108.5	147.1

GF Piping Systems

Betriebsanleitung

Kugelhahn Typ 546, handbetätigt

Betriebsanleitung beachten
Die Betriebsanleitung ist Teil des Produkts und ein wichtiger Baustein im Sicherheitskonzept.
- Betriebsanleitung lesen und befolgen.
- Betriebsanleitung stets für Produkt verfügbar halten.
- Betriebsanleitung an alle nachfolgenden Verwender des Produkts weitergeben.

EG-Konformitätserklärung
Der Hersteller Georg Fischer Rohrleitungssysteme AG, 8201 Schaffhausen (Schweiz) erklärt, dass die Kugelhähne des Typs 546 gemäss der harmonisierten Bauart-Norm ISO 16135:2001
1. druckhaltende Ausrüstungsteile im Sinne der EG-Druckgeräterichtlinie 97/23 EG sind und solchen Anforderungen dieser Richtlinie entsprechen, die für Armaturen zutreffen,
2. den für Armaturen zutreffenden Anforderungen der Bauprodukte-Richtlinie 89/106/EG entsprechen.

Das E-Zeichen an der Armatur zeigt diese Übereinstimmung an (nach der Druckgeräterichtlinie dürfen nur Armaturen grösser DN 25 mit E gekennzeichnet werden) Die Inbetriebnahme dieser Kugelhähne ist so lange untersagt, bis die Konformität der Gesamtanlage, in die die Kugelhähne eingebaut sind, mit einer der genannten EG-Richtlinien erklärt ist. Änderungen am Kugelhahn, die Auswirkungen auf die angegebenen technischen Daten und den bestimmungsgemässen Gebrauch haben, machen diese Herstellererklärung ungültig. Zusätzliche Informationen können den «Georg Fischer Planungsgrundlagen» entnommen werden.

Schaffhausen, 01.01.2013

Dirk Petry
R&D Manager

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161.484.582 / GFDO 5684/1b, 2b, 4b, 6b (10.13)

GF Piping Systems

Instruction Manual

Ball Valve Type 546, manual

Observe instruction manual
The instruction manual is part of the product and an important module of the safety concept.
- Read and observe instruction manual.
- Always keep instruction manual available at the product.
- Pass instruction manual to following users of the product.

EC declaration of conformity
The manufacturer, Georg Fischer Piping Systems Ltd, 8201 Schaffhausen (Switzerland), declares, in accordance with the harmonized ISO 16135:2001 standard, that the ball valves type 546
1. are pressure-bearing components in the sense of the EC Directive 97/23 EC concerning pressure equipment and that they meet the requirements pertaining to valves as stated in this directive,
2. correspond to the respective requirements for valves pursuant to Directive 89/106/EC concerning building products.

The E emblem on the valve refers to this accordance (as per the directive on pressure equipment, only valves larger than DN 25 may be marked with E. Operation of these ball valves is prohibited until conformity of the entire system into which the ball valves have been installed is established according to one of the above mentioned EC directives. Modifications on the ball valve which have an effect on the given technical specifications and the intended use render this manufacturer's declaration null and void. Additional information is contained in the «Georg Fischer Planning Fundamentals

Schaffhausen, 01.01.2013

Dirk Petry
R&D Manager

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1. Bestimmungsgemässe Verwendung
Der Kugelhahn Typ 546 ist ausschliesslich dazu bestimmt, nach Einbau in ein Rohrleitungssystem zugelassene Medien innerhalb der zugelassenen Druck- und Temperaturgrenzen abzusperren, durchzuleiten oder den Durchfluss zu regeln. Die maximale Betriebsdauer beträgt 25 Jahre.

2. Zu diesem Dokument
2.1 Mitgeltende Dokumente
- Georg Fischer Planungsgrundlagen Industrie

Diese Dokumente sind über die Vertretung von GF Piping Systems oder unter www.piping.systems.com erhältlich.

2.2 Abkürzungen

PN	Nenndruck
DN	Dimension

2.3 Sicherheits- und Warhinweise

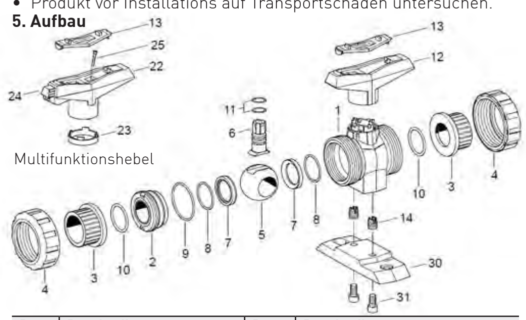
GEFAHR	• Unmittelbar drohende Gefahr! Bei Nichtbeachtung drohen Ihnen Tod oder schwerste Verletzungen
WARNUNG	• Möglicherweise drohende Gefahr! Bei Nichtbeachtung drohen Ihnen schwere Verletzungen
VORSICHT	• Gefährliche Situation! Bei Nichtbeachtung drohen leichte Verletzungen
ACHTUNG	• Gefährliche Situation! Bei Nichtbeachtung drohen Sachschäden

3. Sicherheit und Verantwortung
- Produkt nur bestimmungsgemäss verwenden, siehe bestimmungsgemässe Verwendung.
- Kein beschädigtes oder defektes Produkt verwenden. Beschädigtes Produkt sofort austauschen.
- Sicherstellen, dass Rohrleitungssystem fachgerecht verlegt ist und regelmässig überprüft wird.
- Produkt und Zubehör nur von Personen montieren lassen, die die erforderliche Ausbildung, Kenntnis oder Erfahrung haben.
- Personal regelmässig in allen zutreffenden Fragen der örtlich geltenden Vorschriften für Arbeitssicherheit, Umweltschutz vor allem für druckführende Rohrleitungen unterweisen.

Für Kugelhähne gelten dieselben Sicherheitsvorschriften wie für das Rohrleitungssystem, in das sie eingebaut werden.

4. Transport und Lagerung
- Produkt in ungeöffneter Originalverpackung transportieren und lagern.
- Produkt vor schädlichen physikalischen Einflüssen wie Licht, Staub, Wärme, Feuchtigkeit und UV-Strahlung schützen.
- Produkt und seine Komponenten dürfen weder durch mechanische noch durch thermische Einflüsse beschädigt werden.
- Produkt in geöffneter Hebelstellung (Anlieferungszustand) lagern.
- Produkt vor Installations auf Transportschäden untersuchen.

5. Aufbau



Pos.	Beschreibung	Pos.	Beschreibung
1	Gehäuse	11	Zapfendichtung
2	Einschraubteil	12	Standardhebel
3	Anschlussteil	13	Hebelklipp
4	Überwurfmutter	14	Gewindebuchsen
5	Kugel	22	Multifunktionshebel
6	Zapfen	23	Distanzring
7	Kugeldichtung	24	Entriegelungstaster
8	Hinterlagedichtung	25	Befestigungsschraube (Torx)
9	Gehäusedichtung	30	Befestigungsplatte
10	Anschlussteildichtung	31	Befestigungsschrauben

6. Installation

WARNUNG
Sachschaden bei Verwendung des Kugelhahns als Endarmatur
Wird der Kugelhahn ohne Überwurfmutter und Einlegeteil an der geschlossenen und der offenen Seite betrieben, kann es zum Defekt des Kugelhahns kommen.
- Sicherstellen, dass der Kugelhahn ausschiesslich mit beiden Einlegeteilen und Überwurfmuttern betrieben wird.

- Funktionsprobe durchführen: Kugelhahn von Hand schliessen und wieder öffnen. Kugelhähne mit erkennbarer Funktionsstörung dürfen nicht eingebaut werden
- Kugelhahn stets in geöffneter Kugelstellung in System bauen.
- Sicherstellen, dass Druckklasse, Anschlussart und Anschlussabmessungen den Einsatzbedingungen entsprechen.

WARNUNG
Der Kugelhahn Typ 546 hat produktspezifische Einbaumasse, Anschlüsse und Überwurfmuttern.
Schäden des Rohrleitungssystems durch Verwendung anderer Bauteile und Einbaumasse (als für Typ 546 vorgesehen).
- Einbaumasse und -bezeichnungen in den technischen Dokumentationen mit den vorliegenden Bauteilen abgleichen.

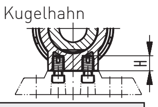
- Kugelhahn erst unmittelbar vor Einbau aus Originalverpackung nehmen.
- Sicherstellen, dass Kugelhahn und Rohrleitung fluchten, um mechanische Beanspruchungen zu vermeiden.
- Kugelhahn einbauen, siehe Abbildungen **a – d**
- Spezifischen Verbindungsvorschriften für Klebe-, Schweiss- oder Schraubverbindungen einhalten, siehe Betriebs-/Klebeanleitungen der Schweissmaschinen bzw. Klebstoffhersteller.
- Anschlussteile gemäss ihrem Material und ihrer Ausführung mit den Rohrenden (Schweissen, Kleben, Schrauben, Flanschen) verbinden.
- Anzugsmomente der Flanschschrauben und weitere Informationen beachten, siehe Planungsgrundlagen.

WARNUNG
Materialbeschädigung der Überwurfmutter oder Gewindebeschädigung durch Einsatz von Zangen oder vergleichbaren Hilfsmitteln durch zu starke Anzugskräfte.
- Überwurfmuttern handfest, ohne Einsatz von Hilfwerkzeug, anziehen.

WARNUNG
Beschädigung des Materialgehäuses durch Nichtbeachtung der max. Einschraubtiefe
Die Druckbelastung eines beschädigten Gehäuses kann zum Bruch führen.
- Bei Verwendung der integrierten Befestigung im Fuss des Typs 546, Angaben der max. Einschraubtiefe der Schrauben beachten.

Maximale Einschraubtiefe der Schrauben in den Kugelhahn

DN	10/15	20/25	32/40	50
Schraube	M6	M6	M8	M8
Einschraubtiefe H (mm)	12	12	15	15



ACHTUNG
Wird bei Temperaturwechseln die Wärmeausdehnung verhindert, treten Längs- bzw. Biegekräfte auf.
Um die Funktionsweise der Armatur nicht zu beeinträchtigen:
- Sicherstellen, dass Kräfte durch geeignete Festpunkte vor bzw. hinter Armatur aufgenommen werden.
  Befestigungsplatte (30) für Befestigung der Armatur von vorn verwenden. Dadurch werden Kräfte aufgenommen, die bei der Betätigung der Armatur entstehen können (z. B. Losbrechmoment). Übertragung der Bedienungskräfte auf Rohrleitungssystem werden vermieden.

VORSICHT
Der Prüfdruck einer Armatur darf den Wert 1.5 x PN (höchstens aber PN + 5 bar) nicht überschreiten).
Die Komponente im Rohrleitungssystem mit dem niedrigsten PN bestimmt den maximal zulässigen Prüfdruck im Leitungsabschnitt.
- Armaturen und Anschlüsse während Druckprobe auf Dichtheit prüfen. Ergebnisse protokollieren.

Für die Druckprobe von Kugelhähnen gelten dieselben Anweisungen wie für die Rohrleitung. Detaillierte Informationen, siehe Kapitel Verarbeitung und Verlegung in den Planungsgrundlagen.
- Sicherstellen, dass alle Armaturen in der erforderlichen Offen- oder Geschlossenstellung sind
- Leitungssystem füllen und sorgfältig entlüften.
- Nach erfolgreicher Dichtheitsprüfen: Prüfmedium entfernen.

7. Demontage

WARNUNG
Verletzungsgefahr durch unkontrolliertes Ausweichen des Mediums
Wurde der Druck nicht vollständig abgebaut, kann das Medium unkontrolliert entweichen.
Je nach Art des Mediums besteht Verletzungsgefahr.
- Druck in der Rohrleitung vor dem Ausbau vollständig abbauen.
- Bei gesundheitsschädlichen, brennbaren oder explosiven Medien Rohrleitung vor dem Ausbau vollständig entleeren und spülen. Dabei mögliche Rückstände beachten.
- Ein sicheres Auffangen des Mediums durch entsprechende Massnahmen gewährleisten (z.B. Anschluss eines Auffangbehälters). Der Kugelhahn soll nach dem Ausbau gelagert oder zerlegt werden.
- Den ausgebauten Kugelhahn halb öffnen (45° Stellung) und in senkrechter Lage leerlaufen lassen. Medium dabei auffangen.

- Wurde der Kugelhahn durch Lösen der Überwurfmuttern (4) aus der Leitung entfernt und kann eine Restentleerung sichergestellt werden, so sind zur Demontage Schritte **e – i** auszuführen
- Berücksichtigen, dass Einschraubteil (2) ein Linksgewinde hat.

8. Wartung
Kugelhähne benötigen im Normalbetrieb keine Wartung. Dennoch müssen die folgenden Massnahmen beachtet werden:
- Periodische Prüfung, dass nach aussen kein Medium austritt.
- Kugelhähne, die dauernd in der gleichen Stellung sind, 1-2 x pro Jahr zu betätigen, um ihre Funktionstätigkeit zu prüfen.

Bei häufigen Stellbewegungen – z.B. durch Automatisierung der Armatur oder infolge chemischen Angriffs auf das Dichtungsmaterial – kann es notwendig sein, Teile im Innern der Armatur auszutauschen. Zu diesem Zweck muss die Armatur aus dem Rohrleitungssystem ausgebaut werden. Die Dichtungselemente sowie Kugel, Zapfen und Einschraubteil können ausgetauscht werden, siehe Ersatzteile von GF Piping Systems.

VORSICHT
Materialschaden und/oder Verletzungsgefahr.
Bei einem Austausch dürfen ausschliesslich die für die Armatur vorgesehenen Original-Ersatzteile von GF Piping Systems verwendet werden.
- Ersatzteile mit den Angaben auf dem Typenschild bestellen.
- Keine Schmiermittel auf Mineralölbasis oder Vaseline (Petrolatum) verwenden.
- Für lackstörungsfreie Kugelhähne spezielle Herstellerhinweise beachten.
- Dichtungen mit Fett auf Silikon- oder Polykolbasis schmieren.
- Alle Dichtungen (Material z.B. EPDM, FPM) sind organische Werkstoffe. Sie reagieren auf Umwelteinflüsse und müssen daher in ihrer Originalverpackung möglichst kühl, trocken und dunkel gelagert werden. Dichtungen vor dem Einbau auf mögliche Alterungsschäden wie Anrisse und Verhärtungen prüfen. Keine defekten Ersatzteile verwenden.

- Zur Montage der Einzelteile und Austausch der Dichtungen, Schritte **k – s** ausführen.
- Anschraubteil (2) so anziehen, dass Kugel noch satt drehbar ist.

9. Montage und Betätigung des MF-Hebels
Alternativ zum Standardhebel kann ein verriegel- und abschliessbarer Multifunktionshebel (MF-Hebel) montiert werden, siehe Explosionszeichnung MF-Hebel in Kapitel 5. Dazu Schritte **t – w** ausführen:
- Am unteren Teil des Hebelschafts befindet sich ein Distanzring (23). Korrekten Sitz im Schaft (Arretierung) kontrollieren.

Um den MF-Hebel zu bedienen, Schritte **x – y** ausführen:
x: Taster (24) zur Entriegelung in den Hebel drücken. Taster in dieser Position halten: Der Hebel kann nun um 90° bewegt werden.
y: Der Hebel wird in der entsprechenden Position verriegelt und kann in dieser Position durch ein Schloss vor unbefugtem Zugriff gesichert werden.

1. Intended Use
The ball valve type 546 is intended exclusively for shutting off and conducting allowed media within the allowable pressure and temperature range or for controlling flow in the piping systems into which it has been installed. The maximum service life is 25 years.

2. Regarding this document
2.1 Related documents
- Georg Fischer planning fundamentals industry

These documents can be obtained from the GF Piping Systems representation or under www.piping.georgfischer.com.

2.2 Abbreviations

PN	Pressure Nominate
DN	Dimension

2.3 Safety Instructions and Warnings

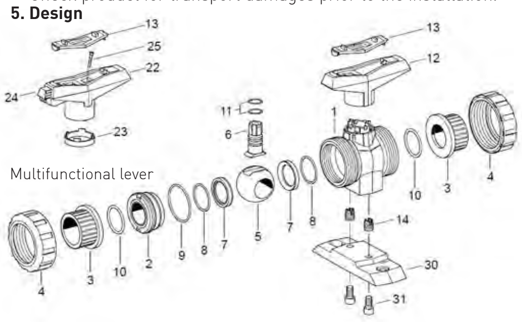
DANGER	• Imminent danger! Non-observance may result in major injuries or death
WARNING	• Possible danger! Non-observance may result in major injuries
CAUTION	• Dangerous situation! Non-observance may result in minor injuries
NOTICE	• Dangerous situation! Non-observance may result in material losses

3. Safety and responsibility
- Products may only be used for its intended purpose, see intended purpose.
- Never use a damaged or defective product. Immediately sort out damaged product.
- Make sure that the piping system has been installed professionally and serviced regularly..
- Products and equipment shall only be installed by persons who have the required training, knowledge or experience.
- Regularly train personnel in all relevant questions regarding locally applicable regulations regarding safety at work, environmental protection especially for pressurised pipes.

The safety instructions for the ball valve are the same as for the piping system they are installed in.

4. Transport and storage
- Transport and/or store product in unopened original packaging.
- Protect product from dust, dirt, dampness as well as thermal and UV radiation.
- Make sure that the product has not been damaged neither by mechanical nor thermal influences.
- Check product for transport damages prior to the installation.

5. Design



Pos.	Description	Pos.	Description
1	Body	11	Stem seal
2	Union bush	12	Standard lever
3	Connecting part	13	Lever clip
4	Union nut	14	Threaded insert
5	Ball	22	Multi-functional lever
6	Stem	23	Spacer
7	Ball seal	24	Unlocking latch
8	Backing seal	25	Fastening screw (Torx)
9	Body seal	30	Mounting plate
10	Union seal	31	Fastening screws

6. Installation

WARNING
Damage to property when using the ball valve as end of line. If the ball valve is operated without union nut and insert at the closed and the opened side, there can be malfunction of the valve.
- Make sure the valve is operated with both union nuts and inserts.

- Make a function test: close the ball valve by hand and open it again. Ball valves which do not function properly must not be installed.
- Built the ball valve always into the system in the opened position.
- Make sure that pressure rating, type of connection and dimensions correspond to the operating conditions.

WARNING
The installation dimensions, connections and union nuts of the ball valve type 546 are product specific.
Use of components and installation dimensions other than those prescribed for type 546 can cause damage to the piping system.
- Compare the installation dimensions and specifications in the technical documentation with those of the components at hand.

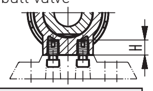
- Remove the ball valve from its original packaging immediately before installation.
- Make sure that the ball valve is aligned with the pipe so that the valve is kept free of mechanical stress.
- Install ball valve, see figures **a – d**
- Adhere specific jointing instructions for solvent cementing, fusion and screw connection methods, see operating manuals of the fusion machines or the cementing instructions of the adhesive manufacturer.
- Join the connecting parts with the pipe ends according to their materials and types (fusion, cementing, screwing, flanges).
- The tightening torque of the flange screws and other useful information, see Georg Fischer Planning Fundamentals.

WARNING
Material damage of the union nut or the thread due to tools, such as pliers or if they are tightened too strong.
- Thighten the union nuts only handtight without the use of additional tools.

WARNING
Material damage due to nonobservance of the insertion depth
The pressure load of a damaged housing can cause breakage.
- When using the integrated fastening in the foot of the ball valve, always observe the requirements regarding the maximum insertion depth of the screws.

Maximum insertion depth of the screws into the ball valve

DN	10/15	20/25	32/40	50
Schraube	M6	M6	M8	M8
Einschraubtiefe H (mm)	12	12	15	15



NOTICE
In piping systems with temperature fluctuations, bending and longitudinal forces can occur if heat expansion is hindered.
o as not to impair the functioning of the valve:
- Forces must be absorbed by implementing suitable fixed points in front of or behind the valve.
  Use mounting plate (30) for front fastening. Forces which can occur during valve operation are absorbed (e.g. initial break-away torque). The operating forces are thus prevented from being transferred over to the piping system.

CAUTION
Overstraining due to exceeded maximum pressure
The test pressure of an assembly may not exceed 1.5 x PN (maximum of PN + 5 bar). The component with the lowest PN determines the maximum allowed test pressure in the performance section.
- Prior to and during the pressure test, the assemblies and connectors must be checked for leak-tightness. Record result..

For the pressure test of ball valves, the same instructions apply as for the piping system. For detailed information, please refer to the GF Planning Fundamentals, chapter Processing and Installation.
- Check that all valves are in the required open or closed position.
- Fill the piping system and deaerate carefully.
- After the leak test: remove the test medium.

7. Disassembly

WARNING
Risk of injury due to uncontrolled evasion of the medium. If the pressure was not relieved completely, the medium can evade uncontrolled. Depending on the type of medium, risk of injury may exist.
- Completely relieve pressure in the pipes prior to dismounting.
- Completely empty and rinse pipe prior to dismounting in connection with harmful, flammable, or explosive media. Pay attention to potential residues.
- Provide for safe collection of the medium by implementing appropriate actions (e.g. connection of a collection container). After dismounting, the ball valve should be stored or disassembled.
- Partially open the dismounted ball valve (45° position) and let drain in vertical position.

- When the ball valve has been removed from the pipe by loosening the union nut (4) and preparations have been made for drainage, disassemble the valve by following steps **e – i**
- Note that the union bush (2) has left-handed thread.

8. Maintenance
Ball valves require no maintenance under normal operating conditions. However, following measures should be noted:
- Periodic inspection to make sure that no medium is leaking is sufficient.
- Make a function test for ball valves which are kept permanently in the same position 1–2 x a year to check serviceability.

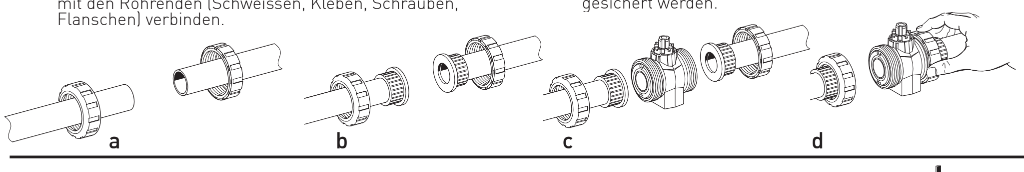
For frequent control operations – valve automation, or due to chemical attack on the sealing material – it may become necessary to replace parts inside the valve. For this purpose, the valve must be removed from the piping system. The sealing elements, as well as the ball, stem and union bush can be replaced, see spare parts list of GF Piping Systems.

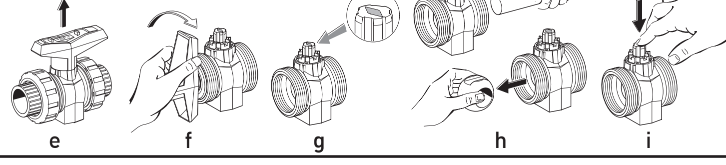
CAUTION
Material damage and/or risk of injury.
Only original Georg Fischer spare parts designed specifically for this valve may be used for replacement purposes.
- Note all the details given on the type plate when ordering spare parts.
- Never use petroleum-based greases or Vaseline (Petrolatum).
- For silicon-free ball valves, please consult the special manufacturer's instructions.
- All the seals must be lubricated with a silicon or polyglycol based grease.
- All the seals (made of e.g. EPDM, FPM) are organic materials which react to environmental influences. They must therefore be kept in their original packaging, and stored cool, dry and dark. The seals should be checked for damages from aging, such as fissures and hardening, before mounting.
- Do not use defective spare parts.

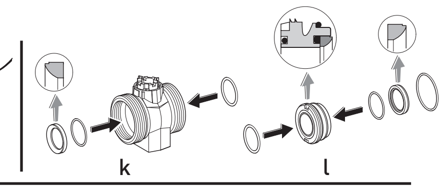
- To assemble the components and replace seals, follow the steps **k – s**.
- Tighten the union bush (2) so that the ball moves snugly.

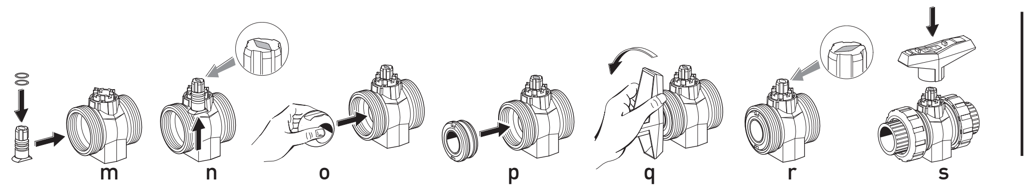
9. Mounting and using the MF lever
As an alternative to the standard lever, you can install a lockable multi-functional (MF) lever, see exploded drawing for MF lever in chapter 5. Follow steps **t – w**:
- There is a spacer (23) at the bottom of the lever shaft. Make sure it is positioned correctly in the shaft (catch).

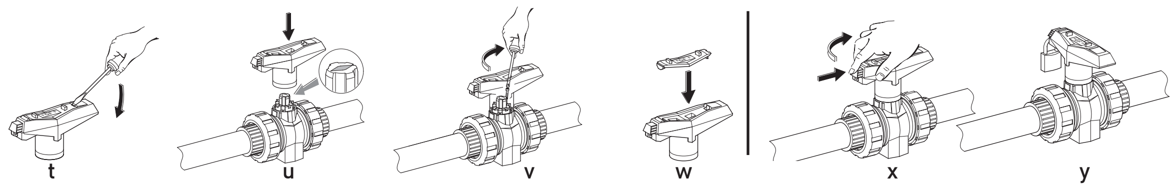
To work the MF lever, follow the steps **x – y**:
x: Press the unlocking latch (24) into the lever. Hold the latch in this position and the lever can be moved 90°.
y: The lever will lock in the respective position and can be secured in this position with a lock, protecting it from unauthorized access.











GF Piping Systems

Mode d'emploi

Robinet à bille Type 546, à actionnement manuel

Les données techniques sont fournies à titre indicatif. Elles ne sont pas des garanties et ne constituent pas non plus un gage de propriété intrinsèque ou de durabilité. Sous réserve de modifications. Nos conditions générales de vente s'appliquent.

Se reporter au mode d'emploi
Le mode d'emploi fait partie intégrante du produit et constitue un élément essentiel du concept de sécurité.
- Lire et respecter le mode d'emploi.
- Le mode d'emploi doit toujours être à proximité du produit.
- Transmettre le mode d'emploi à tous les utilisateurs successifs du produit.

Déclaration de conformité CE
Le fabricant Georg Fischer Rohrleitungssysteme AG, 8201 Schaffhausen (Suisse) déclare que les robinets à bille de type 546, conformément à la norme harmonisée relative aux types de construction EN ISO 16135:2001
1. sont des accessoires sous pression au sens de la directive CE sur les appareils sous pression 97/23 CE et répondent aux exigences de cette même directive en ce qui concerne les vannes.
2. sont conformes aux exigences relatives aux vannes définies par la directive sur les produits de construction 89/106/CE.
Le sigle E apposé sur la vanne témoigne de cette conformité (selon la directive sur les appareils sous pression, seules les vannes d'un diamètre nominal supérieur à DN 25 doivent être identifiées avec le sigle E) La mise en service de ces robinets à bille est interdite tant que la conformité de l'installation complète dans laquelle les robinets à bille sont intégrés n'a pas été attestée par l'une des directives CE citées. Toute modification apportée au robinet à bille qui affecte les caractéristiques techniques indiquées et l'usage conforme du produit invalide cette déclaration du fabricant. Vous trouverez des informations supplémentaires dans les « Principes de planification Georg Fischer ».

Schaffhausen, 01.01.2013

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161.484.582 / GFDO 5684/1b, 2b, 4b, 6b (10.13)

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1. Utilisation conforme
Le robinet à bille de type 546 est exclusivement destiné, après son montage dans un système de tuyauterie, à bloquer, à diriger ou à régler le débit des fluides autorisés dans la limite des températures et des pressions admissibles. La durée de fonctionnement maximale est de 25 ans.

2. À propos de ce document
2.1 Documents applicables
- Principes de planification pour l'industrie Georg Fischer

Ces documents sont disponibles auprès d'un représentant de GF Piping Systems ou sur www.piping.systems.com.

2.2 Abréviations

PN	Pression nominale
DN	Dimension

2.3 Instructions de sécurité et avertissements

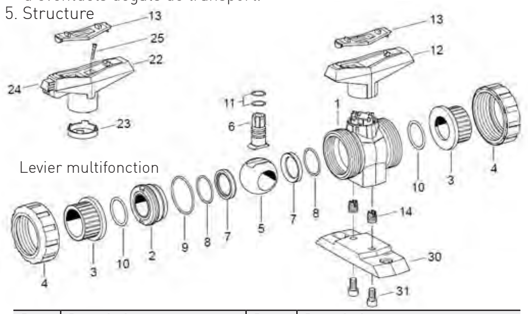
DANGER	• Menace de danger imminente ! En cas de non-respect, vous risquez la mort ou de graves blessures.
AVERTISSEMENT	• Menace de danger potentielle ! En cas de non-respect, vous risquez de graves blessures.
PRUDENCE	• Situation dangereuse ! En cas de non-respect, vous risquez de légères blessures.
ATTENTION	• Situation dangereuse ! En cas de non-respect, il existe un risque de dégâts matériels.

3. Sécurité et responsabilité
- Utiliser le produit conformément aux dispositions uniquement, voir Utilisation conforme
- Ne pas utiliser un produit s'il est endommagé ou défectueux. Remplacer immédiatement tout produit endommagé.
- S'assurer que le système de tuyauterie est posé correctement et qu'il est contrôlé régulièrement.
- Les produits et accessoires doivent uniquement être montés par des personnes qui disposent de la formation, des connaissances ou de l'expérience nécessaires.
- Informer régulièrement le personnel de toutes les questions relatives aux dispositions locales applicables en matière de sécurité du travail et de protection de l'environnement, notamment pour les canalisations sous pression.

Les mêmes dispositions de sécurité s'appliquent aux robinets à bille ainsi qu'au système de tuyauterie dans lequel ils sont intégrés.

4. Transport et stockage
- Transporter et stocker le produit dans son emballage d'origine non ouvert.
- Protéger le produit des agressions physiques telles que la lumière, la poussière, la chaleur, l'humidité et les rayonnements UV.
- Le produit et ses composants ne doivent pas être détériorés par des influences thermiques ou mécaniques.
- Stocker le produit avec le levier en position ouverte (état de livraison).
- Contrôler le produit avant son installation afin de détecter d'éventuels dégâts de transport.

5. Structure



Pos.	Description	Pos.	Description
1	Boîtier	11	Joint de téton
2	Pièce filetée	12	Levier standard
3	Raccord	13	Basculement de levier
4	Écrou d'accouplement	14	Douilles filetées
5	Bille	22	Levier multifonction
6	Téton	23	Bague entretoise
7	Joint de sphère	24	Bouton de déverrouillage
8	Joint arrière	25	Vis de fixation (Torx)
9	Joint du boîtier	30	Plaque de fixation
10	Joint de raccord	31	Vis de fixation

6. Installation

AVERTISSEMENT
Dégâts matériels en cas d'utilisation du robinet à bille en tant que vanne d'extrémité. Le robinet à bille risque d'être endommagé s'il est utilisé sans écrou d'accouplement, ni pièce d'insertion sur les côtés fermé et ouvert.
- S'assurer que le robinet à bille n'est utilisé qu'avec les pièces d'insertion et écrous d'accouplement.

- Procéder à un essai de fonctionnement : fermer manuellement le robinet à bille et le ré-ouvrir. Des robinets à bille présentant des défauts de fonctionnements ne doivent pas être intégrés.
- Lors du montage du robinet à bille dans le système, la bille doit se trouver en position ouverte.
- S'assurer que la classe de pression, le type de raccordement et les dimensions de raccordement correspondent aux conditions d'utilisation.

AVERTISSEMENT
Le robinet à bille de type 546 possède des dimensions de montage, des raccords et des écrous d'accouplement spécifiques. Dégâts sur le système de tuyauterie dus à l'utilisation de pièces et dimensions de montage différentes (autres que celles prévues pour le type 546).
- Comparer impérativement les dimensions et schémas de montage fournis dans la documentation technique avec les pièces livrées.

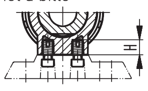
- Ne sortir le robinet à bille de son emballage d'origine que peu de temps avant son montage.
- S'assurer que le robinet à bille et la conduite sont alignés l'un sur l'autre afin d'éviter toute sollicitation mécanique.
- Monter le robinet à bille, voir figures **a – d**
- Se conformer aux instructions d'assemblage afférentes aux raccords par soudage, collage ou vissage : voir Instructions d'utilisation et de collage élaborées par les constructeurs et fabricants de machines de soudage et de colles.
- Assembler les raccords avec les extrémités des tuyaux selon leur matériau et leur modèle de machine.
- Les bases de planification Georg Fischer fournissent des renseignements sur les couples de serrage à respecter ainsi que bien d'autres informations.

AVERTISSEMENT
Le matériau de l'écrou d'accouplement ou le filetage risque d'être endommagé en raison des forces de serrage excessives exercées lors de l'utilisation de pinces ou d'outils d'aide similaires.
- Serrer l'écrou d'accouplement à la main, sans utiliser d'outil d'aide.

AVERTISSEMENT
Le non-respect de la profondeur de vissage max. peut endommager le boîtier.
La contrainte de pression sur un boîtier endommagé peut entraîner sa rupture.
- Tenir compte des indications sur la profondeur max. de vissage des vis en cas d'utilisation de la fixation intégrée au pied du type 546.

Profondeur de vissage maximale des vis dans le robinet à bille

DN	10/15	20/25	32/40	50
Vis	M6	M6	M8	M8
Profondeur de vissage H (mm)	12	12	15	15



ATTENTION
Si la dilatation thermique ne peut avoir lieu en raison de changements de température, des forces linéaires et de flexion apparaissent.
Pour ne pas altérer le fonctionnement de la vanne :
- s'assurer que les forces sont absorbées par les points fixes situés à l'avant et à l'arrière de la vanne. Utiliser la plaque de fixation (30) pour fixer la vanne par l'avant. Grâce à cette plaque, les forces, éventuellement générées par l'actionnement de la vanne (par ex. couple de démarrage) sont absorbées. La transmission des forces d'actionnement sur le système de tuyauterie est évitée.

PRUDENCE
La pression d'essai d'une vanne ne doit pas dépasser la valeur 1,5 x PN (max. PN + 5 bars). Le composant présentant la valeur PN la plus faible dans le système de tuyauterie détermine la pression d'essai maximale autorisée dans la section de conduite.
- Pendant l'essai de pression, contrôler l'étanchéité des vannes et des raccords. Consigner les résultats par écrit.

Les essais de pression des robinets à bille et ceux du système de tuyauterie sont soumis aux mêmes instructions. Pour obtenir des informations détaillées, voir chapitre Mise en œuvre et installation des bases de planification.
- S'assurer que toutes les vannes se trouvent bien dans la position requise (ouverte ou fermée).
- Remplir le système de tuyauterie et le purger minutieusement.
- Après avoir effectué avec succès le contrôle d'étanchéité, évacuer le fluide utilisé pour l'essai.

7. Démontage

AVERTISSEMENT
Risque de blessure dû à une fuite incontrôlée du fluide
Si la pression n'a pas été complètement baissée, le fluide risque de fuir de manière incontrôlée.
Selon la nature du fluide, il existe un risque de blessure.
- Laisser la pression baisser totalement dans la conduite avant de démonter.
- Dans le cas de fluides toxiques, inflammables ou explosifs, vidanger et rincer totalement la conduite avant le démontage. Attention aux éventuels résidus.
- Assurer une collecte sécurisée des fluides à l'aide de mesures appropriées (par ex. raccordement d'un récipi ent collecteur). Une fois démonté, le robinet à bille doit être stocké ou désassemblé.
- Ouvrir à moitié le robinet à bille démonté (position 45°) et le laisser se vider en le plaçant à la verticale. Collecter le fluide.

- Après avoir démonté le robinet à bille de la conduite par desserrage des écrous d'accouplement (4) et s'être assuré de la vidange complète, exécuter les étapes **e – i** pour le démontage.
- Tenir compte du filetage à gauche de la pièce filetée (2).

8. Maintenance
- Contrôle régulier pour s'assurer de l'absence de fuite du fluide.
- Actionner une à deux fois par an des robinets à bille qui restent longtemps dans la même position, afin de contrôler leur bon fonctionnement.

En cas de mouvements de réglage fréquents il peut s'avérer nécessaire de remplacer des pièces à l'intérieur de la vanne. Pour ce faire, la vanne doit être entièrement démontée du système de tuyauterie. Les éléments d'étanchéité tels que la bille, le téton et la pièce filetée peuvent être remplacés, voir Pièces de rechange de GF Piping Systems.

PRUDENCE
Dégâts matériels et/ou risque de blessure.
Utiliser exclusivement des pièces de rechange d'origine prévues pour la vanne et fournies par GF Piping Systems.
- Commander les pièces de rechange en se référant aux indications figurant sur la plaque signalétiques.
- Ne pas utiliser de lubrifiant à base d'huile minérale ou de vaseline (pétrolatum).
- Respecter les consignes spécifiques du fabricant pour éviter tout problème de fuite des robinets à bille.
- Lubrifier les joints avec de la graisse à base de silicone ou de polysiloxane.
- Tous les joints (matériau par ex. EPDM, FPM) sont fabriqués à partir de matières organiques. Ils réagissent aux influences environnementales et doivent, par conséquent, être stockés dans leur emballage d'origine, dans un endroit frais, sec et sombre. Contrôler les joints avant le montage afin de détecter d'éventuels dégâts dus au vieillissement, comme des amorces de fissures et des durcissements.
- Ne pas utiliser de pièce de rechange défectueuse.

- Pour le montage des pièces détachées et le remplacement des joints, exécuter les étapes **k – s.**
- Serre la pièce filetée (2) de sorte que la bille puisse encore tourner librement.

9. Montage et actionnement du levier MF
En alternative du levier standard, il est possible de monter un levier multifonction (levier MF) verrouillable, voir Vue explosée du levier MF au chapitre 5. Pour ce faire, exécuter les étapes **t – w** :
- Une bague entretoise est sur la partie inférieure de la tige du levier (23). Vérifier que cette bague est correctement montée (blocage).

Procéder aux étapes **x – y** pour utiliser le levier MF:
x: pousser le bouton (24) dans le levier pour déverrouiller. Maintenir le bouton dans cette position : il est désormais possible de tourner le levier de 90°.
y: Le levier est verrouillé dans la position souhaitée et peut être sécurisé à l'aide d'un cadenas pour éviter toute manipulation non autorisée.

GF Piping Systems

Manual de instrucciones

Válvula de bola Tipo 546, accionada manualmente

Los datos técnicos son sin compromiso. Estos no contienen ninguna promesa de propiedades. Salvo modificaciones. Son válidas nuestras Condiciones Generales de Venta.

Obsérvese el manual de instrucciones
El manual de instrucciones forma parte del producto y es un elemento importante del concepto de seguridad.
- Lea y tenga en cuenta el manual de instrucciones.
- Guarde el manual de instrucciones junto con el producto de manera que esté siempre disponible.
- Entregue el manual de instrucciones en caso de transmitir el producto a otros usuarios.

Declaración de conformidad CE
El fabricante Georg Fischer Rohrleitungssysteme AG, 8201 Schaffhausen (Suiza) declara que las válvulas de bola del tipo 546, de conformidad con la norma armonizada de tipo EN ISO 16135:2001,
1. son accesorios a presión a tenor de la Directiva europea de equipos a presión 97/23/CE y cumplen con los requisitos de dicha directiva aplicables a las válvulas,
2. cumplen con los requisitos aplicables a las válvulas de la Directiva de productos de construcción 89/106/CE. El símbolo E en la válvula indica el cumplimiento mencionado (conforme a la directiva de equipos a presión solo pueden marcarse con E las válvulas de tamaño superior a DN 25). Está prohibido poner en servicio estas válvulas de bola hasta que se haya declarado la conformidad de toda la instalación en la que están montadas las válvulas de bola con una de las directivas europeas mencionadas. Toda modificación de la válvula de bola que afecte a los datos técnicos indicados y al uso conforme a su destino invalidará esta declaración del fabricante. Puede consultarse más información en los «Fundamentos para la planificación de Georg Fischer».

Schaffhausen, 01.01.2013

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1. Uso conforme a su destino
La válvula de bola del tipo 546 está concebida exclusivamente para cortar, conducir o regular el caudal de los fluidos autorizados dentro de los límites de presión y temperatura permitidos tras su instalación en un sistema de tuberías. El tiempo máximo de funcionamiento es de 25 años.

2. Acerca de este documento
2.1 Documentación complementaria
- Fundamentos para la planificación industrial de Georg Fischer

Estos documentos están disponibles en su filial de GF Piping Systems o en www.piping.systems.com.

2.2 Abreviaturas

PN	Presión nominal
DN	Dimensión

2.3 Indicaciones de advertencia y de seguridad

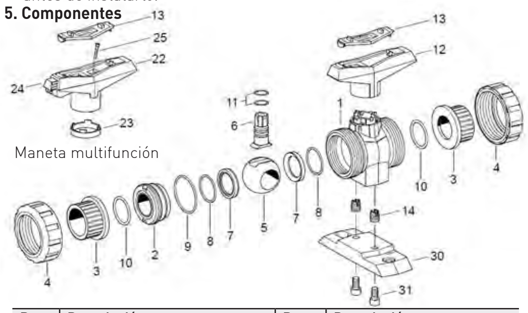
PELIGRO	• ¡Peligro inminente! Peligro de muerte o de sufrir lesiones muy graves en caso de inobservancia
ADVERTENCIA	• ¡Posible peligro! Peligro de sufrir lesiones graves en caso de inobservancia
PRECAUCIÓN	• ¡Situación peligrosa! Peligro de sufrir lesiones leves en caso de inobservancia
ATENCIÓN	• ¡Situación peligrosa! Peligro de que se produzcan daños materiales en caso de inobservancia

3. Seguridad y responsabilidad
- Utilizar el producto exclusivamente de forma conforme a su destino.
- No utilizar ningún producto dañado o averiado. Reemplazar de inmediato el producto dañado.
- Asegurarse de que el sistema de tuberías se instala por un profesional y se inspecciona con regularidad.
- Encomendar el montaje del producto y los accesorios únicamente a personas con la formación, los conocimientos o la experiencia necesarios.
- Informar con regularidad al personal sobre todas las cuestiones relacionadas con la normativa local vigente de seguridad laboral y protección medioambiental, especialmente en lo relativo a tuberías a presión.

Para las válvulas de bola se aplican las mismas normas de seguridad que rigen para el sistema de tuberías en el que se han instalado.

4. Transporte y almacenamiento
- Transporte y almacene el producto en el embalaje original cerrado.
- El producto se debe proteger de influencias físicas dañinas como la luz, el polvo, el calor, la humedad y la radiación ultravioleta.
- El producto y sus componentes no deben sufrir daños a consecuencia de influencias mecánicas o térmicas.
- Almacenar el producto con la posición de la maneta abierta (estado de entrega).
- Comprobar que el producto no ha sufrido daños durante el transporte antes de instalarlo.

5. Componentes



Pos.	Descripción	Pos.	Descripción
1	Carcasa	11	Junta del eje
2	Pieza roscada	12	Maneta estándar
3	Pieza de empalme	13	Clip de la maneta
4	Tuerca de unión	14	Casquillos con rosca
5	Bola	22	Maneta multifunción
6	Eje	23	Anillo distanciador
7	Junta de bola	24	Botón de desbloqueo
8	Junta de refuerzo	25	Tornillo de fijación (Torx)
9	Junta de la carcasa	30	Placa de fijación
10	Junta de la pieza de empalme	31	Tornillos de fijación

6. Instalación

ADVERTENCIA
Daños materiales si se utiliza la válvula de bola como válvula final. Si se hace funcionar la válvula de bola sin tuerca de unión ni pieza insertada en el lado cerrado y el lado abierto, puede averiarse la válvula de bola.
- Cerciorarse de que la válvula de bola se hace funcionar únicamente con las dos piezas insertadas y las dos tuercas de unión.

- Ejecutar una prueba de funcionamiento: cerrar la válvula de bola manualmente y volver a abrirla. Está prohibido montar válvulas de bola que presenten fallos de funcionamiento
- Montar la válvula de bola en el sistema siempre en posición de bola abierta.
- Cerciorarse de que la clase de presión, el tipo de conexión y las dimensiones de conexión son apropiados para las condiciones de aplicación.

ADVERTENCIA
La válvula de bola tipo 546 tiene dimensiones de montaje, conexiones y tuercas de unión específicas del producto.
El uso de otros componentes y dimensiones de montaje (diferentes a los previstos para el tipo 546) puede causar daños en el sistema de tuberías.
- Compruebe que los componentes disponibles se ajustan a las dimensiones y las especificaciones de montaje indicadas en la documentación técnica.

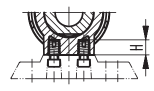
- No sacar la válvula de bola de su embalaje original hasta el momento del montaje. Cerciórese de que la válvula de bola y la tubería están alineadas para evitar solicitaciones mecánicas.
- Montarla válvula de bola, véanse las figuras **a – d**
- Deben observarse las normativas de unión para uniones encoladas, soldadas o roscadas; véanse las instrucciones de funcionamiento/encolado de las máquinas soldadoras y de los fabricantes de adhesivos.
- Unir las piezas de empalme a los extremos de la tubería en función de su material y su versión.
- Observar los pares de apriete de los tornillos de brida y otras informaciones adicionales indicados en los «Fundamentos para la planificación de Georg Fischer».

ADVERTENCIA
Daños materiales en la tuerca de unión o daños en la rosca si se utilizan pinzas u otras herramientas similares a causa de fuerzas de apriete demasiado intensas.
- Apretar las tuercas de unión manualmente sin utilizar herramientas.

ADVERTENCIA
Daños en la carcasa del material debidos a la inobservancia de la profundidad máxima de atornillado
La carga por compresión de una carcasa dañada puede causar su rotura.
- Si se utiliza el sistema de fijación integrado en la base del tipo 546, deben tenerse en cuenta las especificaciones de la profundidad de atornillado máxima de los tornillos.

Profundidad de atornillado máxima de los tornillos en la válvula de bola

DN	10/15	20/25	32/40	50
Tornillo	M6	M6	M8	M8
Profundidad de atornillado H (mm)	12	12	15	15



ATENCIÓN
Si se impide la dilatación térmica en caso de fluctuaciones de temperatura se pueden producir fuerzas longitudinales y de flexión.
Para no menoscabar el funcionamiento de la válvula:
- Cerciorarse de que estas fuerzas son absorbidas por puntos de anclaje adecuados situados delante o detrás de la válvula. Utilizar la placa de fijación (30) para fijar la válvula por delante. Con ella se absorben las fuerzas que se pueden generar durante el accionamiento de la válvula (p. ej. par inicial de arranque). Se impide la transmisión de las fuerzas de servicio al sistema de tuberías.

PRECAUCIÓN
La presión de prueba de una válvula no debe superar el valor 1,5 x PN (como máx. PN + 5 bar). El componente del sistema de tuberías con la PN más baja determina la presión de prueba máxima permitida en la sección de la tubería.
- Durante la prueba de presión, compruebe que las válvulas y las conexiones sean estancas. Anotar los resultados.

La prueba de presión de las válvulas de bola se rige por las mismas normas que el sistema de tuberías. Puede consultar información más detallada en el capítulo Manipulación e instalación de los «Fundamentos para la planificación de Georg Fischer».
- Cerciorarse de que todas las válvulas se encuentran en las posiciones abiertas o cerradas necesarias.
- Llenar el sistema de tuberías y evacuar el aire con cuidado
- Tras realizar con éxito la prueba de estanqueidad: retirar el fluido de comprobación.

7. Desmontaje

ADVERTENCIA
Peligro de sufrir lesiones debido a una desviación incontrolada del medio
Si la presión no se ha cortado por completo, el medio podría desviarse de forma incontrolada.
En función del tipo de medio, existe peligro de sufrir lesiones.
- Eliminar por completo la presión de la tubería antes de desmontarla.
- En el caso de medios tóxicos, inflamables o explosivos vacíe completamente la tubería y límpiela antes de desmontarla. Fíjese en que no queden residuos.
- una recogida segura del medio aplicando las medidas correspon dientes (.p ej. conexión de un recipiente de recogida). Guarde o des monte la válvula de bola después de haberla desmontado.

- Abrir la válvula de bola desmontada hasta la mitad (posición 45°) y en y dejar que se vacíe completamente en posición vertical. Recoger el medio que salga.
- Una vez se ha retirado la válvula de bola de la tubería quitando las tuercas de unión (4) y se pueda garantizar un vaciado completo, se deberán ejecutar los pasos **e – i** para el desmontaje.
- Tener en cuenta que la pieza roscada (2) tiene rosca a la izquierda.

8. Mantenimiento
- Comprobación periódica de que el medio no sale al exterior.
- Las válvulas de bola que están continuamente en la misma posición se deben accionar 1-2 veces al año para comprobar su capacidad de funcionamiento.

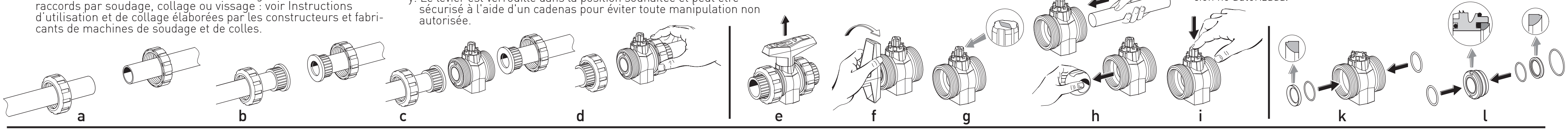
En caso de movimientos de regulación frecuentes puede ser necesario reemplazar piezas en el interior de la válvula. Para ello, es necesario desmontar la válvula del sistema de tuberías. Los elementos de sellado, la bola, el eje y la pieza roscada se pueden reemplazar, véanse los repuestos de GF Piping Systems.

PRECAUCIÓN
Daños materiales y/o peligro de lesiones.
En caso de sustitución solo deben utilizarse las piezas de repuesto originales de GF Piping Systems previstas para la válvula.
- Las piezas de repuesto se pueden solicitar con los datos indicados en la placa de características.
- No se deben utilizar nunca lubricantes con una base de aceite mineral o vaselina (petrolato).
- Tenga en cuenta las indicaciones especiales del fabricante relativas a válvulas de mariposa sin daños en el esmalte.
- Lubricar las juntas con grasa con base de silicona o policol.
- Todas las juntas (material p. ej. EPDM, FPM) son materiales orgánicos que reaccionan a las influencias medioambientales y, por tanto, se deben almacenar en su embalaje original en un lugar fresco, seco y oscuro. Compruebe que las juntas no presentan daños de envejecimiento, como fisuras y durezas, antes de montarlas.
- No utilizar repuestos defectuosos.

- Siga los pasos **k – s** para montar cada una de las piezas y reemplazar las juntas.
- Apretar la pieza atornillada (2) de modo que la bola todavía pueda girar por completo.

9. Montaje y accionamiento de la maneta MF
Como alternativa a la maneta estándar se puede montar una maneta multifunción (maneta MF) que se pueda bloquear y cerrar, véase la vista desarrollada de la maneta multifunción en el capítulo 5. Para ello seguir los pasos **t – w**:
- En la parte inferior del vástago de la maneta hay un anillo distanciador (23). Comprobar que esté bien ajustado en el vástago (retención).

Para manejar la maneta MF deben seguirse los pasos **x – y**:
x: Presionar el botón (24) de la maneta para desbloquearla. Mantener el botón es esta posición: ahora se puede desplazar la maneta en pasos de 90°.
y: La maneta se enclava en la posición correspondiente y se puede bloquear en esta posición con un candado para evitar una manipula ción no autorizada.



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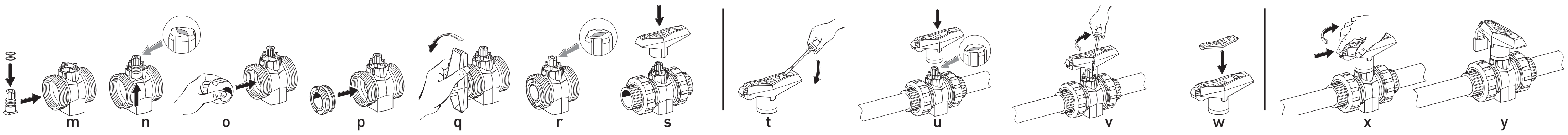


m n o p q r s t u v w x y

Manufacturer Manual Index

B1 – Keystone - Pneumatic Actuator Valve

B2 – GF Piping Systems – Ball Valve 546

B3 – FPZ – Compressor: SCL lateral channel blowers-exhausters

B4 – Trojan – UV 3000 PTP

B5 – GF Piping Systems – Metering Ball Valve Type 523

B6 – Wallace & Tiernan – Liquid Feeding Systems 100 Diaphragm Metering Pump

B7 – Hart – Prosonic S FMU90 Flow Measurement

B8 – Hach – sc100 Controller

B9 – Davey – Installation and Operating Instructions for HM Series Electric Pumps

B10 – Davey – Mukmova Manure & -trash‖ Pump

B11 – Filtec – Whakapapa WWTP Sand Filter Plant

B12 – (not used)

B13 – LVG3 – Bronze gate Valve

B14 – Conti – Ball Valves

B15 – ABAC - Compressor

B16 – ITT – Flygt 8050

B17 – Grundfos – SL1 and SLV pumps

GF Piping Systems

True Union Ball Valve
Type 546

General

- **Size**: ⅜"–4"
- **Material**: PVC, CPVC, PROGEF® Standard PP, ABS, SYGEF® Standard PVDF
- **Seat**: PTFE
- **Seals**: EPDM, FPM
- **End Connection**: Solvent cement socket, threaded, flanged, fusion spigot, fusion socket
- **Mounting**: Stainless steel threaded inserts
- **Standard Pack Quantity**: 1 valve

Key Certifications

- **NSF 61**: PVC and CPVC
- **FDA CFR 21 177.1520**: PP and PVDF
- **FDA CFR 21 177.2600**: EPDM and FPM
- **FDA CFR 21 177.1550**: PTFE
- **USP 25 Class VI (physiological non-toxic)**: PP and PVDF
- **ABS**: All materials

Specification

The Type 546 Ball Valve shall be true union and utilize a floating ball design. The ball shall be fully molded and full port with two way blocking capability. The stem shall be blowout proof, utilizing a double o-ring seal and a predetermined break point opposite the media side of the stem seals. The seat carrier shall be adjustable and reverse threaded. The handle shall double as a seat carrier adjustment or removal tool. The valve nut threads shall be of buttress type. Ball seats shall have an elastomeric backing o-ring and all elastomeric seals shall be of like material. ANSI flanged versions shall meet ANSI B16.5 150lb standards. All valves shall be tested in accordance to ISO9393 and designed to ISO16136 standards. All valves shall be manufactured under ISO9001 for Quality and ISO14001 for Environmental Management. Following assembly, every valve shall be tested and certified bubble tight exceeding Class VI standards.

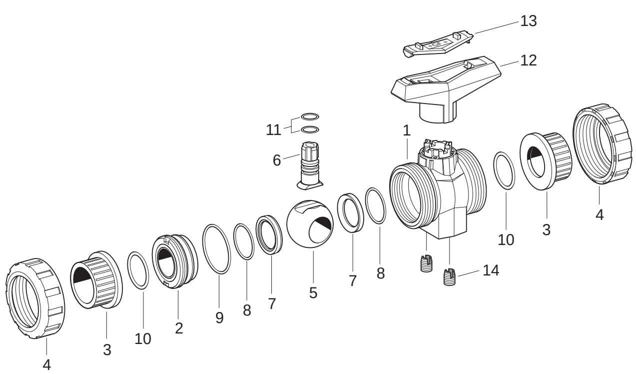
Material Specification

PVC valves shall meet ASTM D1784 cell classification 12454 standards. CPVC valves shall meet ASTM D1784 cell classification 23447-B standards. PP valves shall meet ASTM D5847-14 cell classification PP0510B66851 standards. ABS valves shall meet ASTM D3965 cell classification 42222 standards. PVDF valves shall be type 1, grade 2 according to ASTM D3222 standards. Valves of all materials shall be RoHS compliant.

Optional Features

- **Actuation**: Electric, pneumatic
- **Limit Switches**: Mechanical, inductive
- **Handle**: Lockable handle, handle extension
- **Mounting pad**: Additional mounting option for valve base
- **Universal Adapter Kit**: ISO mount for actuation
- **Seals**: Alternative materials available upon request
- **Seat**: PVDF
- **End Connection**: Alternatives available upon request
- **Control Ball**: For throttling applications available ⅜"-2"
- **Vented Ball**: For sodium hypochlorite use
- **Cleaned**: Silicone free/oil free

Components



Valve Components

Part	Description	Material
1	Valve body	PVC, CPVC, PP, ABS or PVDF
2	Seat carrier	PVC, CPVC, PP, ABS or PVDF
3	Valve end	PVC, CPVC, PP, PPn, ABS, PE or PVDF
4	Valve nut	PVC, CPVC, PP, ABS or PVDF
5	Ball	PVC, CPVC, PP, ABS or PVDF
6	Stem	PVC, CPVC, PP, ABS or PVDF
7	Seat	PTFE
8	Backing seal	EPDM or FPM
9	Body seal	EPDM or FPM
10	Face seal	EPDM or FPM
11	Stem seal	EPDM or FPM
12	Handle	Glass-filled PP
13	Handle clip	Glass-filled PP
14	Mounting insert	304 Stainless steel

Key Design Features

The Type 546 Ball Valve comes standard with stainless steel threaded inserts for easy and secure mounting. Valves are available without inserts upon request

The Type 546 Ball Valve stem utilizes a predetermined break point opposite the media side of the stem seals. This break point is a groove with an inner diameter that is less than the stem seal grooves. This ensures that if there is a stem failure, the failure will occur at that point and media will not leak to the outside of the valve.

The Type 546 Ball Valve seat carrier is reverse threaded while the valve nut utilizes a standard thread. This ensures that the seat carrier is not inadvertently tightened when the valve nut is tightened and avoids possible stem failures.

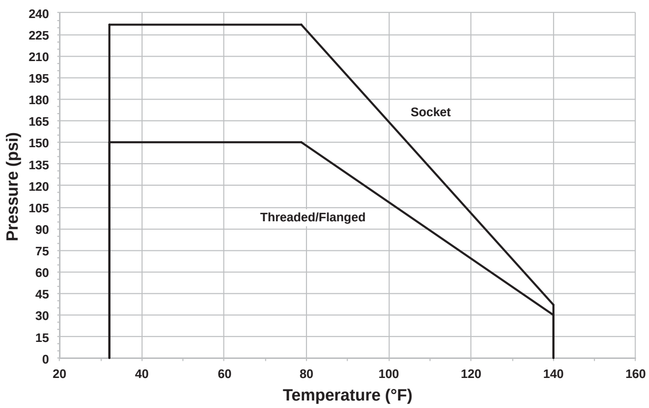
The valve handle doubles as a seat carrier adjustment tool by simply inserting the handle clip into the pre-molded notches on the seat carrier, making on-site maintenance quick and easy.

Technical Data

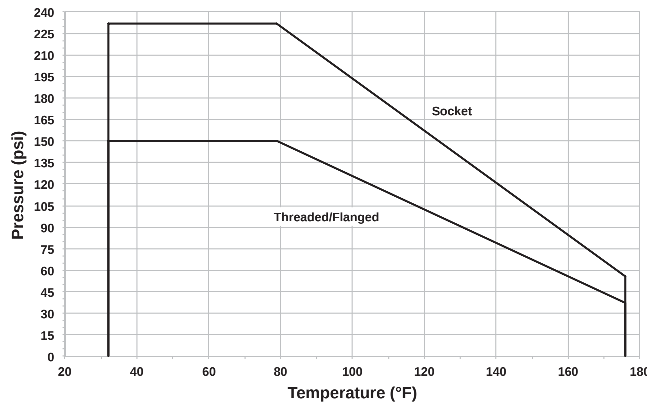
Pressure Temperature Curves

The following graphs are based on a 25 year lifetime water or similar media application

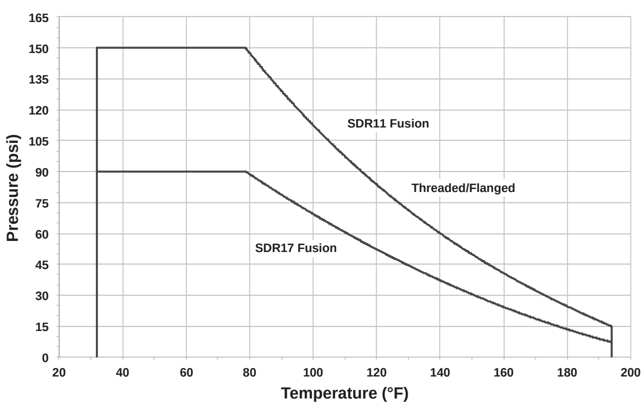
PVC



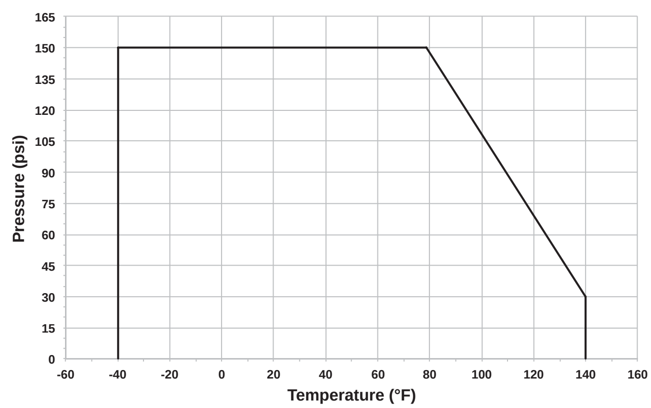
CPVC



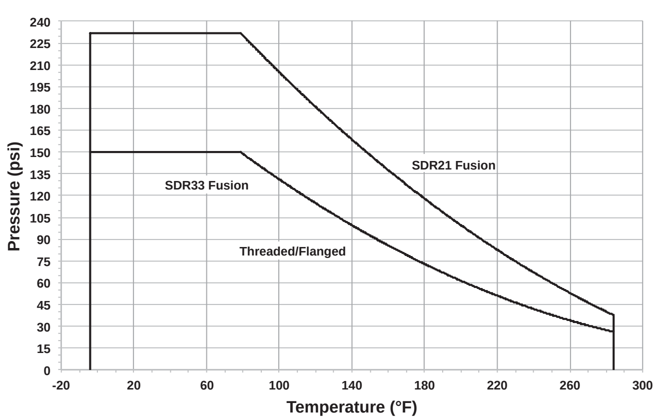
PP



ABS



PVDF



Pressure-Temperature

Material	Temperature Range (°F)	Max Pressure (psi)
PVC	32 to 140	232
CPVC	32 to 176	232
PP	32 to 176	150
ABS	-40 to 140	150
PVDF	-4 to 284	232

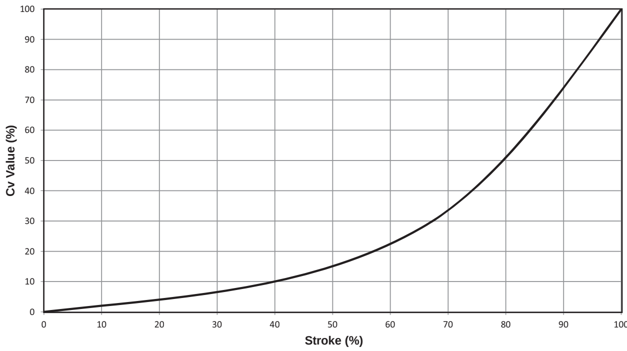
Vacuum Service

The Type 546 is rated for full vacuum service. Maximum differential pressure of 15psi at 122°F.

Flow

The following information is based on water applications at 68° F

Flow Characteristics



Cv Value

Size (inch)	d (mm)	Cv (gal/min)
⅜	16	5
½	20	13
¾	25	25
1	32	49
1¼	40	70
1½	50	112
2	63	217
2½	75	350
3	90	490
4	110	770

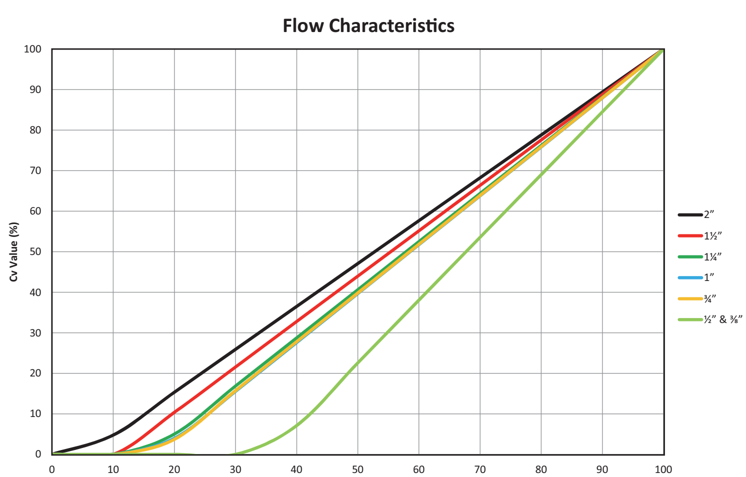
Vented Ball - Optional Feature

A vented ball is an optional feature with all variations of the Type 546 Ball Valve. This version of the valve has dedicated part numbers that utilize a special ball with a ⅛ inch hole. This ball is designed for applications in which the media requires out-gassing such as sodium hypochlorite. The hole functions as a vent for media that would normally be trapped inside a closed ball. The vent prevents potentially dangerous pressure from building up inside the valve. The vent is located on the seat carrier side of the ball valve and this side is recommended to be installed upstream.

Chemical applications vary from system to system and variations such as concentration, temperature and pressure need to be considered. It is the responsibility of the individual user to verify compatibility and Georg Fischer recommends that every application be verified and tested by internal experts or a third party.

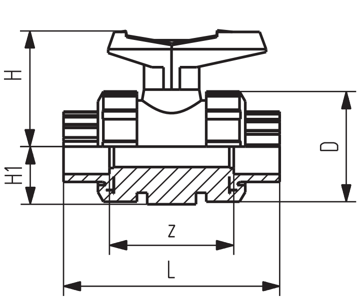
Control Ball- Optional Feature

The Type 546 Control Ball is a keyed design and is available in PVC, CPVC, PROGEF® Standard PP and SYGEF Standard® PVDF. This ball is designed for applications requiring flow control. The keyed orifice provides a nearly linear flow characteristic curve and is superior to V-notch designs. This ball is not bidirectional. The required installation direction is to have the keyed orifice downstream. The Type 546 Control Ball can be added to any Type 546 Ball Valve.

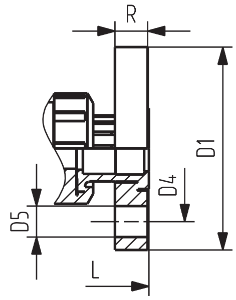


Dimensions

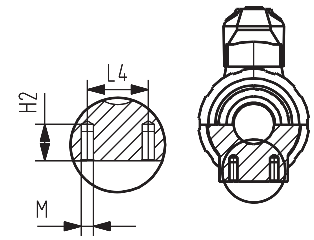
The following tables are shown in inches unless otherwise specified



Socket/threaded



Flanged



All configurations

All Materials

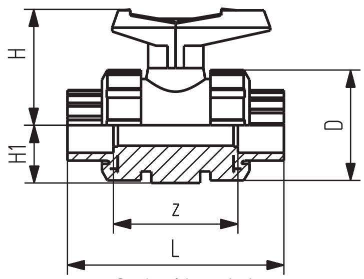
Size	d (mm)	D	H	H1	H2	L4	M
⅜	16	1.97	2.24	1.06	0.47	0.98	M6
½	20	1.97	2.24	1.06	0.47	0.98	M6
¾	25	2.28	2.64	1.18	0.47	0.98	M6
1	32	2.68	2.87	1.42	0.47	0.98	M6
1¼	40	3.31	3.54	1.73	0.59	1.77	M8
1½	50	3.82	3.82	2.01	0.59	1.77	M8
2	63	4.88	4.57	2.52	0.59	1.77	M8
2½	75	6.54	5.87	3.35	0.59	2.76	M8
3	90	7.87	6.34	4.13	0.59	2.76	M8
4	110	9.37	7.01	4.84	0.87	4.72	M12

PVC/CPVC

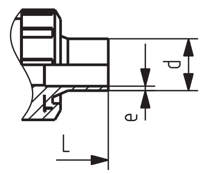
	Socket		Threaded		Flanged				
Size	**L**	**z**	**L**	**z**	**L**	**D1**	**D4**	**D5**	**R**
⅜	4.13	2.64	3.86	2.72	-	-	-	-	-
½	4.13	2.4	3.86	2.56	5.87	3.5	2.38	0.5	0.57
¾	4.76	2.76	4.37	2.92	6.5	3.88	2.75	0.5	0.58
1	5.24	2.99	5	3.23	7.24	4.25	3.13	0.5	0.66
1¼	6.06	3.54	5.79	3.85	8.11	4.63	3.5	0.5	0.69
1½	6.46	3.7	6.18	4.33	8.7	5	3.88	0.5	0.76
2	7.2	4.21	7.2	5.31	9.88	6	4.75	0.63	0.82
2½	9.17	5.67	9.21	6.54	12.24	7	5.5	0.63	0.98
3	10	5.94	10.04	6.88	13.5	7.5	6	0.63	1.02
4	11.85	6.85	11.89	8.42	15.63	9	7.5	0.63	1.11

ABS

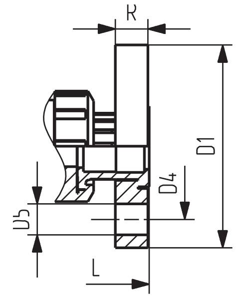
	Socket	
d (mm)	**L**	**z**
16	3.62	2.52
20	3.74	2.52
25	4.33	2.83
32	4.84	3.11
40	5.57	3.7
50	6.18	3.74
63	7.2	4.21
75	9.17	5.67
90	10	5.94
110	11.85	6.85



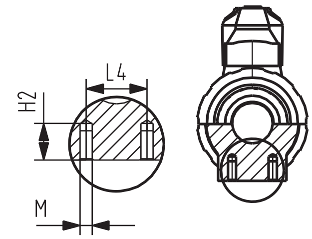
Socket/threaded



IR/butt fusion



Flanged



All configurations

PP

	Socket		IR/Butt		Threaded		Flanged				
d (mm)	**L**	**z**	**L**	**e**	**L**	**z**	**L**	**D1**	**D4**	**D5**	**R**
16	3.66	2.64	-	-	3.78	2.8	-	-	-	-	-
20	3.74	2.6	5.12	0.07	3.9	2.52	6.54	3.74	2.36	0.63	0.63
25	4.29	3.03	5.63	0.09	4.37	2.99	6.97	4.13	2.76	0.63	0.67
32	4.69	3.27	5.91	0.12	5	3.27	7.52	4.53	3.11	0.63	0.71
40	5.31	3.9	6.73	0.15	5.75	3.94	8.23	5.51	3.5	0.63	0.79
50	5.79	4.13	7.52	0.18	6.18	4.37	9.02	5.91	3.86	0.63	0.87
63	6.61	4.61	8.66	0.23	7.2	5.28	9.96	6.5	4.76	0.75	0.94
75	9.17	6.57	10.47	0.32	-	-	16.38	7.28	5.51	0.75	1.02
90	10	7.09	10.39	0.39	-	-	16.3	7.87	5.98	0.75	1.06
110	11.85	8.46	11.85	0.47	-	-	17.76	9.02	7.48	0.75	1.1

PVDF

	Socket		IR/Butt		Threaded		Flanged				
d (mm)	**L**	**z**	**L**	**e**	**L**	**z**	**L**	**D1**	**D4**	**D5**	**R**
16	3.66	2.64	-	-	3.78	2.72	-	-	-	-	-
20	3.74	2.6	5.12	0.07	3.9	2.52	6.85	3.74	2.36	0.63	0.63
25	4.29	3.03	5.63	0.07	4.37	2.99	7.44	4.13	2.76	0.63	0.67
32	4.69	3.27	5.91	0.09	5	3.27	7.83	4.53	3.11	0.63	0.71
40	5.31	3.9	6.73	0.09	5.75	3.98	9.25	5.51	3.5	0.63	0.79
50	5.79	4.13	7.52	0.12	6.18	4.37	9.57	5.91	3.86	0.63	0.87
63	6.61	4.61	8.66	0.12	7.2	5.31	10.28	6.5	4.76	0.75	0.94
75	9.17	6.57	10.47	0.14	-	-	16.77	7.28	5.51	0.75	1.02
90	10	7.09	10.39	0.17	-	-	16.77	7.87	5.98	0.75	1.06
110	11.85	8.46	11.85	0.21	-	-	19.17	9.02	7.48	0.75	1.1

GF Piping Systems
Tel. (714) 731-8800, Toll Free (800) 854-4090, Fax (714) 731-6201
us.ps@georgfischer.com, www.gfpiping.com

#1334-00 (3/15)

Printed in USA

Compressori-aspiratori a canale laterale 'SCL'

'SCL' lateral channel blowers-exhausters

aria in movimento

air in motion

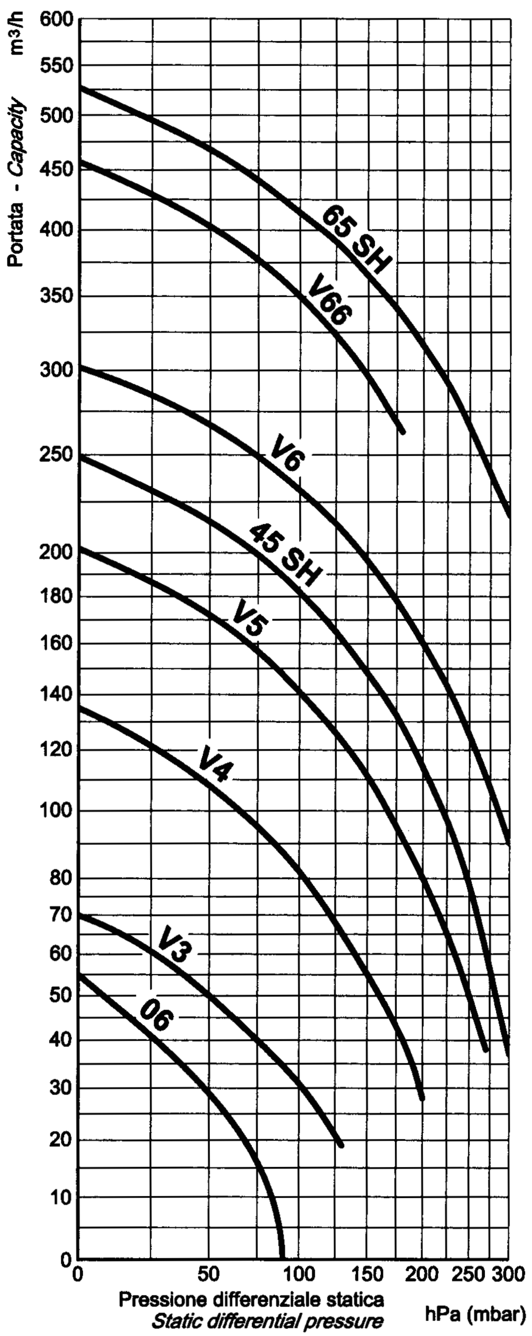
Catalogo tecnico

Technical catalogue

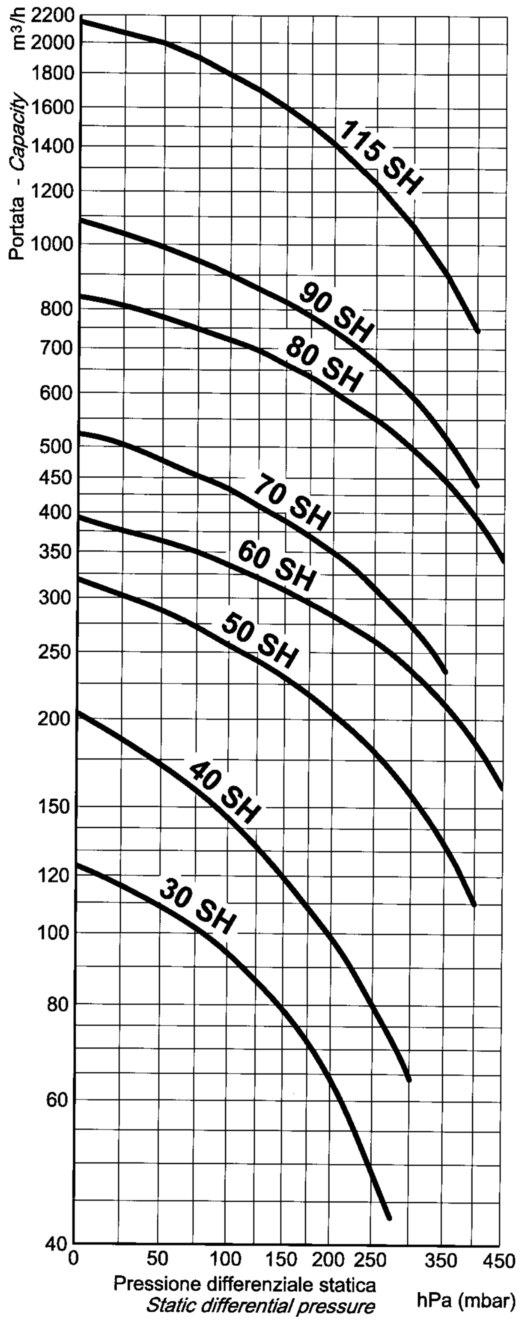
Compressori / Compressor 50 Hz

Caratteristiche di funzionamento/Performances for operation

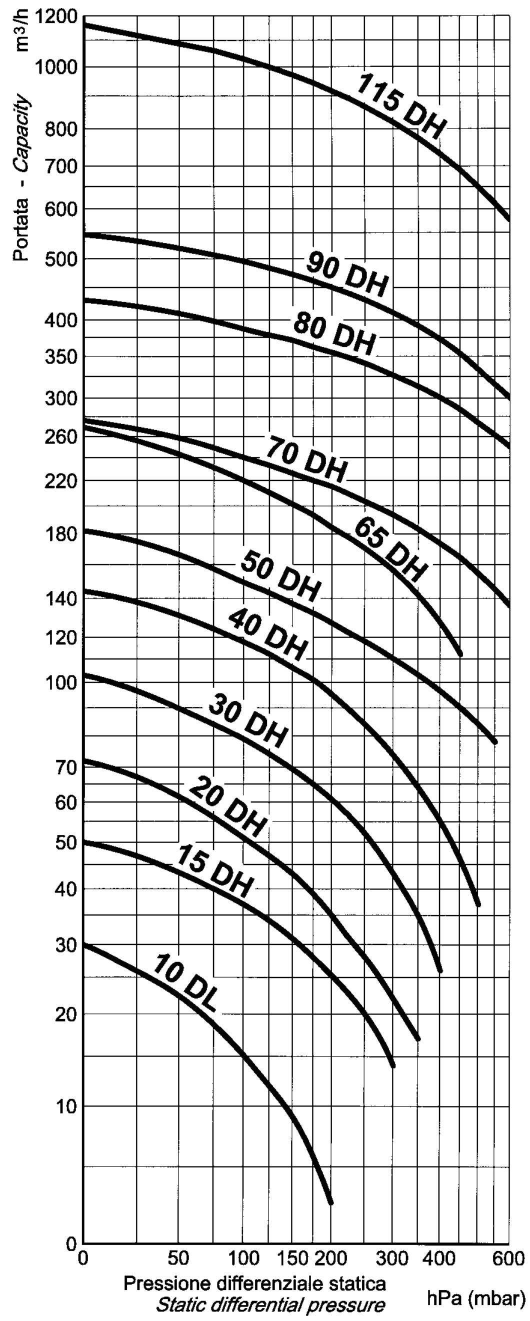
Δp mbar	0	50		75		100		125		150		175		200		225		250		300		350		400		450		500		550		600		Δp max		
SCL	m³/h	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	mbar	m³/h	kW
***MONOSTADIO* - SINGLE STAGE**																																				
06	55	29	0,2	16	0,2																													90	0	0,2
V3	70	50	0,37	40	0,37	31	0,37	21	0,37																									130	19	0,37
V4	135	108	0,75	95	0,75	82	0,75	68	0,75	55	1,1	43	1,1	28	1,1																			200	28	1,1
V5	202	172	1,5	157	1,5	141	1,5	126	1,5	111	1,5	95	1,5	80	1,5	65	2,2	50	2,2															270	38	2,2
V6	302	267	2,2	249	2,2	231	2,2	214	2,2	196	2,2	178	2,2	160	3	143	3	125	3	90	4													340	62	4
V66	457	403	4	377	4	350	4	323	4	296	4	268	4																					180	263	4
45 SH	249	215	1,1	199	1,5	182	1,5	165	2,2	148	2,2	132	2,2	114	2,2	97	2,2	78	3	37	3													300	37	3
65 SH	527	468	2,2	441	3	414	3	391	3	365	4	341	4	316	4	292	5,5	266	5,5	218	5,5													300	218	5,5
30 SH	124	109	0,75	102	1,1	94	1,1	86	1,1	78	1,1	72	1,5	64	1,5	56	1,5	49	1,5															275	43	1,5
40 SH	204	172	0,75	158	0,75	145	1,1	131	1,5	120	1,5	108	1,5	99	2,2	89	2,2	80	2,2	64	2,2													300	64	2,2
50 SH	319	286	2,2	272	2,2	256	2,2	243	3	230	3	217	3	204	3	192	4	180	4	156	4	133	5,5	110	5,5									400	110	5,5
60 SH	393	362	2,2	350	3	335	3	321	3	308	4	295	4	283	4	271	4	260	5,5	235	5,5	210	7,5	185	7,5	160	7,5							450	160	7,5
70 SH	522	477	3	453	3	433	3	409	4	389	4	369	4	350	5,5	331	5,5	310	5,5	273	7,5	235	7,5											350	235	7,5
80 SH	834	778	4	745	4	714	4	694	4	655	5,5	635	5,5	602	7,5	575	7,5	550	7,5	497	9	445	11	393	15	341	15							450	341	15
90 SH	1084	990	5,5	945	5,5	900	5,5	857	7,5	820	7,5	781	7,5	743	9	705	9	667	11	592	11	515	15	440	15									400	440	15
115 SH	2150	1998	15	1899	15	1800	15	1698	18,5	1600	18,5	1506	18,5	1412	22	1321	22	1233	22	1064	30	901	30	745	30									400	745	30
***BISTADIO* - DOUBLE STAGE**																																				
10 DL	30			19	0,37	15	0,37	12	0,37	9	0,37	6	0,37	2	0,37																			200	2	0,37
15 DH	50			40	0,55	37	0,55	34	0,55	31	0,55	28	0,55	25	0,55	23	0,55	20	0,55	14	0,55													300	14	0,55
20 DH	72			56	0,37	51	0,37	46	0,55	43	0,55	39	0,55	35	0,55	31	0,75	28	0,75	22	0,75	17	1,1											350	17	1,1
30 DH	103	90	0,37	84	0,55	79	0,55	74	0,55	70	0,55	65	0,75	61	0,75	57	0,75	52	0,75	43	1,1	35	1,1	26	1,5									400	26	1,5
40 DH	144	131	0,75	124	1,1	118	1,1	112	1,1	106	1,1	101	1,5	95	1,5	90	1,5	84	1,5	73	2,2	64	2,2	55	2,2	46	3	37	3					500	37	3
50 DH	182			157	2,2	149	2,2	143	2,2	137	2,2	132	2,2	127	2,2	122	2,2	118	3	110	3	103	3	97	4	90	4	84	4	78	4			550	78	4
65 DH	269			231	1,5	220	1,5	210	2,2	201	2,2	193	2,2	184	2,2	177	3	170	3	156	3	143	3	127	4	112	4							450	112	4
70 DH	276			249	2,2	240	2,2	233	3	226	3	220	3	215	3	209	3	202	3	193	4	183	4	173	5,5	164	5,5	154	5,5	145	7,5	136	7,5	600	136	7,5
80 DH	430			398	4	387	4	378	4	371	4	362	5,5	355	5,5	348	5,5	341	5,5	326	5,5	313	7,5	300	7,5	287	7,5	273	9	261	9	250	9	600	250	9
90 DH	546			507	4	495	4	483	5,5	472	5,5	461	5,5	450	5,5	440	5,5	430	7,5	410	7,5	391	7,5	372	9	353	9	333	11	315	11	300	11	600	300	11
115 DH	1119			1050	11	1028	11	998	11	970	11	943	11	916	11	891	15	866	15	819	15	774	18,5	731	18,5	690	22	650	22	612	30	576	30	600	576	30



Portata - Capacity m³/h
65 SH
V66
V6
45 SH
V5
V4
V3
06
Pressione differenziale statica
Static differential pressure
hPa (mbar)



Portata - Capacity m³/h
115 SH
90 SH
80 SH
70 SH
60 SH
50 SH
40 SH
30 SH
Pressione differenziale statica
Static differential pressure
hPa (mbar)

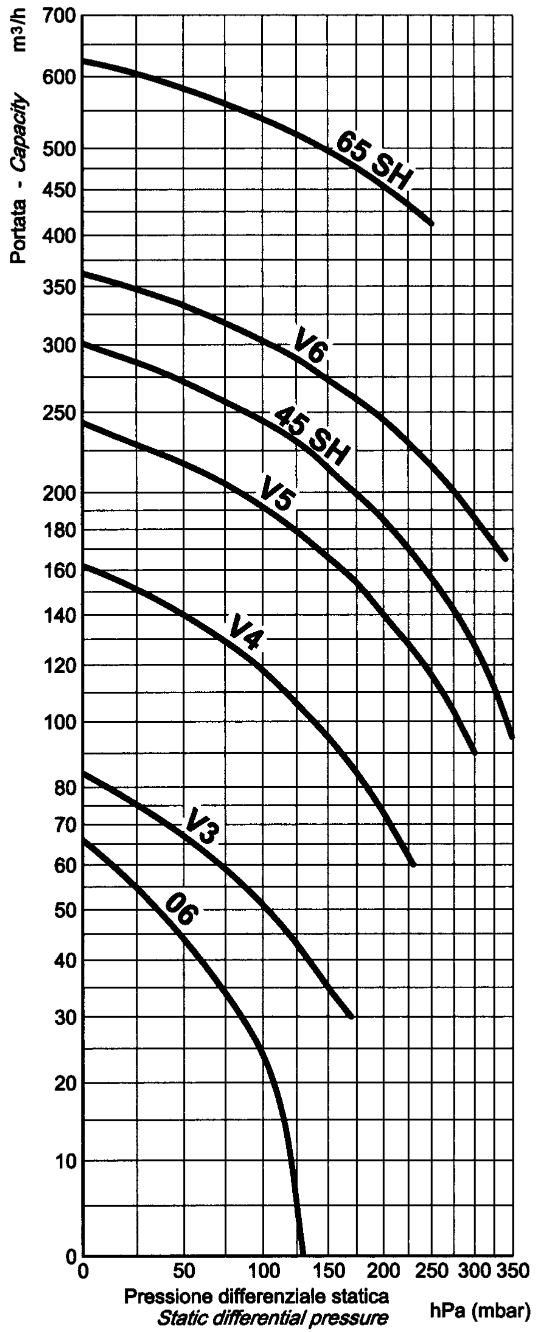


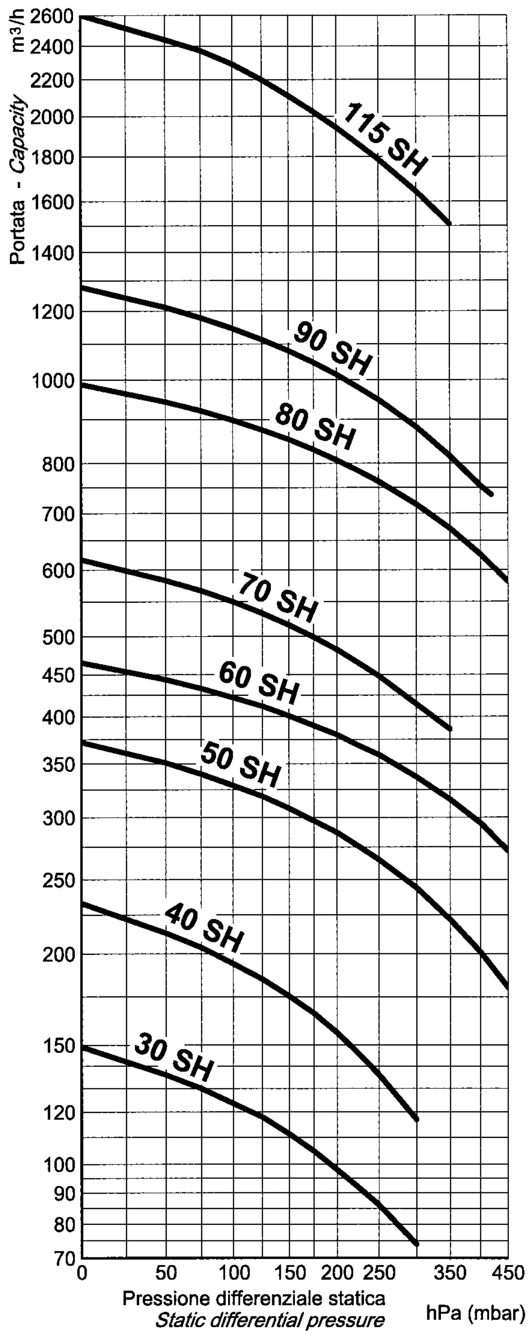
Portata - Capacity m³/h
115 DH
90 DH
80 DH
70 DH
65 DH
50 DH
40 DH
30 DH
20 DH
15 DH
10 DL
Pressione differenziale statica
Static differential pressure
hPa (mbar)

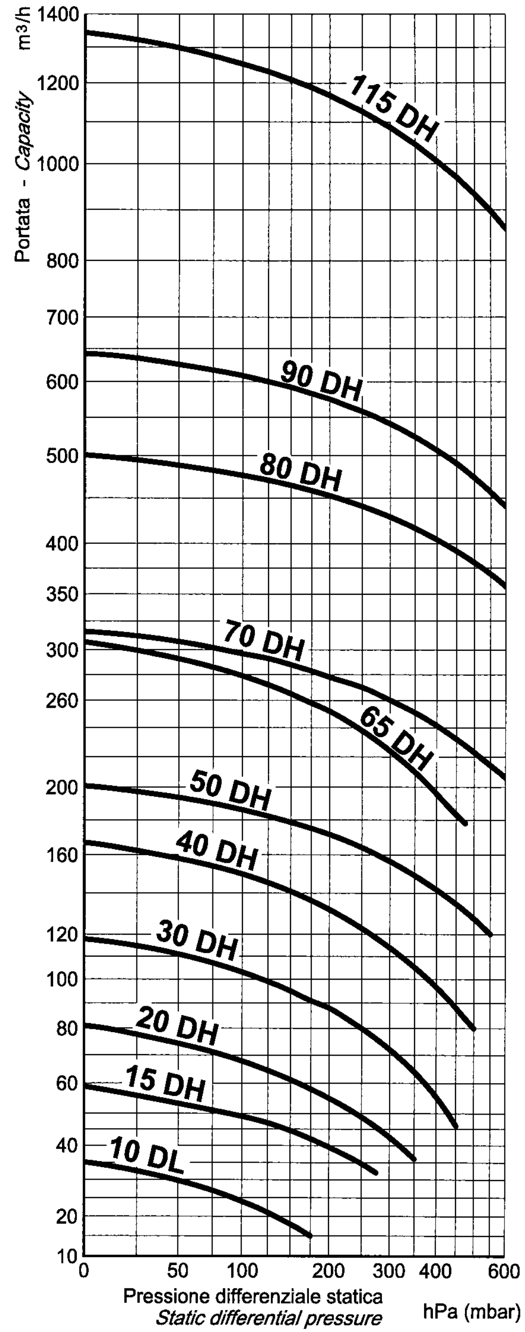
Compressori / Compressor 60 Hz

Caratteristiche di funzionamento/Performances for operation

Δp mbar	0	50		75		100		125		150		175		200		225		250		300		350		400		450		500		550		600		Δp max			
SCL	m^3/h	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	Mbar	m^3/h	kW	
06	66	44	0,23	34	0,23	24	0,4	5	0,4																									130	0	0,4	*MONOSTADIO* - SINGLE STAGE
V3	84	67	0,43	59	0,43	51	0,43	43	0,43	35	0,43																							170	30	0,43	
V4	162	140	0,9	129	0,9	118	0,9	106	0,9	95	1,3	84	1,3	73	1,3	62	1,3																	230	60	1,3	
V5	243	217	1,75	205	1,75	192	1,75	179	1,75	166	1,75	154	1,75	140	1,75	128	2,55	116	2,55	90	2,55													300	90	2,55	
V6	362	333	2,55	318	2,55	303	2,55	289	2,55	273	2,55	259	3,45	245	3,45	230	4,6	215	4,6	186	4,6													340	165	4,6	
45 SH	302	273	1,3	258	1,75	243	1,75	229	2,55	215	2,55	200	2,55	186	3,45	171	3,45	157	3,45	128	4,6	95	4,6											350	95	4,6	
65 SH	624	582	3,45	560	3,45	539	4,6	518	4,6	497	4,6	476	6,3	454	6,3	433	6,3	412	6,3															250	412	6,3	
30 SH	149	136	1,3	130	1,3	123	1,3	118	1,75	111	1,75	105	1,75	98	1,75	92	2,55	86	2,55	74	2,55													300	74	2,55	
40 SH	233	213	1,3	204	1,75	194	1,75	185	2,55	175	2,55	166	2,55	156	2,55	146	2,55	136	3,45	117	3,45													300	117	3,45	
50 SH	372	351	2,55	340	2,55	329	3,45	319	3,45	308	3,45	297	4,6	287	4,6	276	4,6	265	6,3	244	6,3	222	6,3	201	8,7	180	8,7							450	180	8,7	
60 SH	465	443	2,55	433	3,45	422	3,45	412	4,6	401	4,6	390	4,6	380	6,3	369	6,3	359	6,3	337	8,7	316	8,7	295	8,7	272	8,7							450	272	8,7	
70 SH	617	583	3,45	567	4,6	550	4,6	533	4,6	516	6,3	499	6,3	482	6,3	465	8,7	448	8,7	414	8,7	386	8,7											350	386	8,7	
80 SH	988	943	4,6	921	4,6	898	6,3	875	6,3	853	8,7	830	8,7	807	8,7	785	10,4	762	10,4	717	12,7	672	17,4	626	17,4	581	17,4							450	581	17,4	
90 SH	1278	1212	6,3	1179	8,7	1146	8,7	1113	8,7	1080	8,7	1047	10,4	1014	10,4	981	12,7	948	12,7	882	17,4	816	17,4	749	17,4									425	709	17,4	
115 SH	2600	2440	22	2372	22	2295	22	2200	30	2110	30	2024	30	1942	30	1864	30	1787	37	1644	37	1508	37											350	1508	37	
10 DL	35			27	0,43	24	0,43	21	0,43	18	0,43	15	0,43																					175	15	0,43	*BISTADIO* - DOUBLE STAGE
15 DH	59			51	0,63	49	0,63	47	0,63	44	0,63	42	0,63	39	0,63	37	0,63	34	0,63															275	32	0,63	
20 DH	81			71	0,63	68	0,63	65	0,63	62	0,63	58	0,9	55	0,9	52	0,9	49	0,9	42	0,9	36	1,3											350	36	1,3	
30 DH	118			107	0,9	103	0,9	99	0,9	95	0,9	91	0,9	88	0,9	84	0,9	80	1,3	72	1,3	64	1,3	57	1,75	46	1,75							450	46	1,75	
40 DH	167			154	1,3	150	1,3	145	1,3	141	1,75	136	1,75	132	1,75	127	1,75	123	2,55	114	2,55	105	2,55	97	3,45	88	3,45	80	3,45					500	80	3,45	
50 DH	201			190	2,55	186	3,45	182	3,45	179	3,45	175	3,45	171	3,45	168	3,45	164	4,6	157	4,6	149	4,6	142	4,6	135	6,3	127	6,3	120	6,3			550	120	6,3	
65 DH	307			286	2,55	279	2,55	272	3,45	265	3,45	258	3,45	252	3,45	245	3,45	238	3,45	224	4,6	210	4,6	196	4,6	183	6,3							475	178	6,3	
70 DH	316			302	2,55	297	2,55	293	3,45	288	3,45	283	3,45	278	3,45	274	4,6	270	4,6	260	4,6	251	6,3	242	6,3	232	6,3	223	8,7	214	8,7	206	8,7	600	206	8,7	
80 DH	501			482	4,6	475	4,6	470	6,3	464	6,3	458	6,3	452	6,3	446	6,3	440	6,3	428	8,7	416	8,7	404	8,7	392	10,4	379	10,4	369	10,4	357	12,7	600	357	12,7	
90 DH	643			617	4,6	609	6,3	600	6,3	592	6,3	583	6,3	575	6,3	566	8,7	558	8,7	541	8,7	524	10,4	507	10,4	490	12,7	473	12,7	456	12,7	440	17,4	600	440	17,4	
115 DH	1343			1275	15	1252	15	1231	15	1209	15	1188	18,5	1167	18,5	1146	18,5	1126	18,5	1086	22	1046	22	1008	30	970	30	933	30	897	30	861	30	600	861	30	


m³/h
Portata - Capacity
65 SH
V6
45 SH
V5
V4
V3
06
Pressione differenziale statica
Static differential pressure
hPa (mbar)


m³/h
Portata - Capacity
115 SH
90 SH
80 SH
70 SH
60 SH
50 SH
40 SH
30 SH
Pressione differenziale statica
Static differential pressure
hPa (mbar)


m³/h
Portata - Capacity
115 DH
90 DH
80 DH
70 DH
65 DH
50 DH
40 DH
30 DH
20 DH
15 DH
10 DL
Pressione differenziale statica
Static differential pressure
hPa (mbar)

Aspiratori /Exhausters 50 Hz

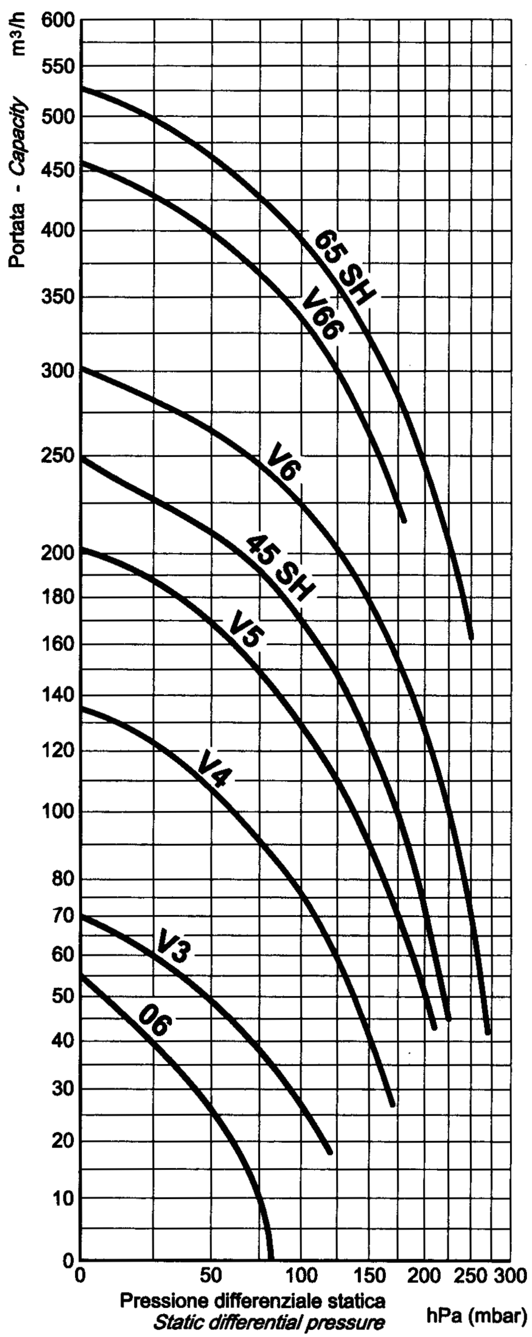
Caratteristiche di funzionamento/Performances for operation

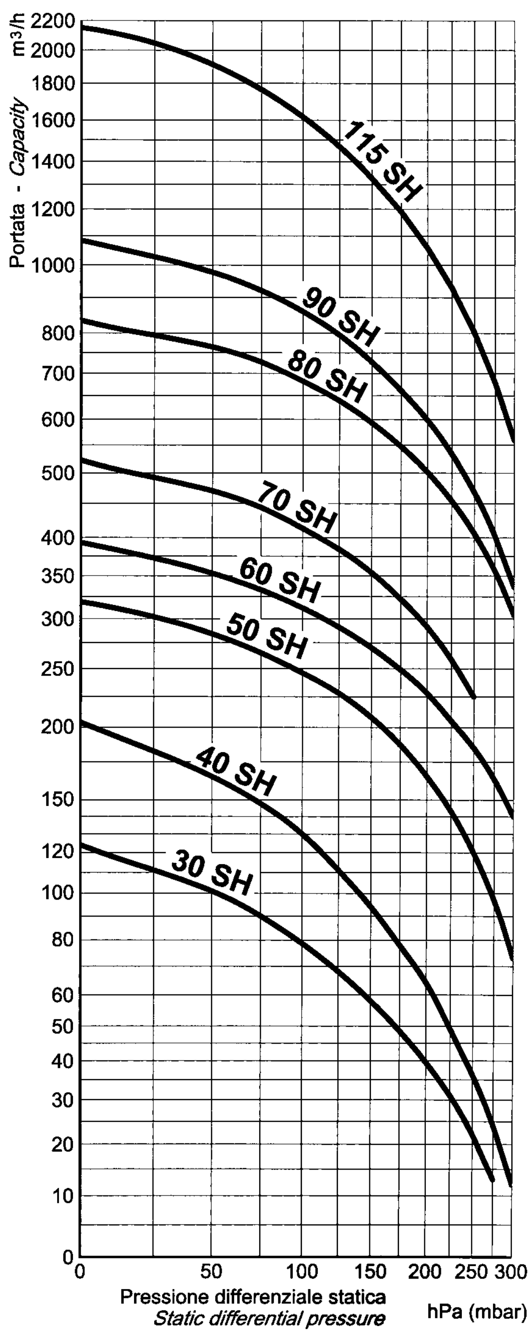
MONOSTADIO - SINGLE STAGE

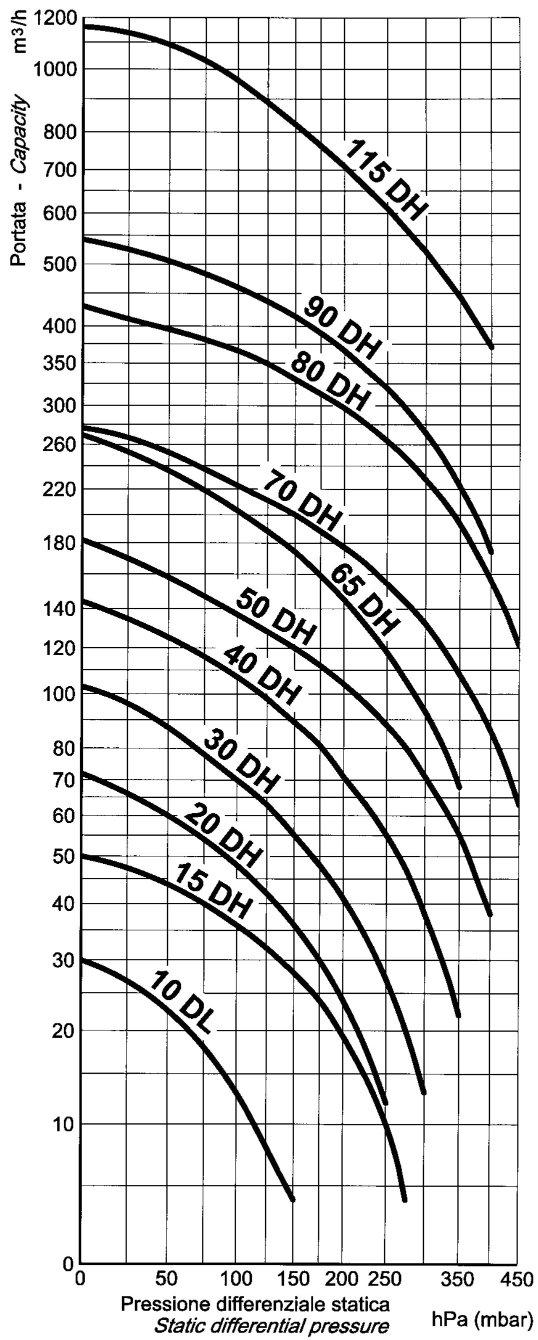
Δp mbar	0	50		75		100		125		150		175		200		225		250		275		300		325		350		375		400		450		Δp max		
SCL	m³/h	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	mbar	m³/h	kW
06	55	26	0,2	10	0,2																													82	0	0,2
V3	70	49	0,37	38	0,37	27	0,37																											120	18	0,37
V4	135	107	0,75	91	0,75	76	0,75	59	0,75	41	1,1																							170	27	1,1
V5	202	169	1,5	149	1,5	129	1,5	110	1,5	90	1,5	70	1,5	51	1,5																			210	43	2,2
V6	302	264	2,2	245	2,2	224	2,2	202	2,2	178	2,2	153	2,2	127	3	100	3	70	3															270	42	4
V66	457	398	4	367	4	335	4	300	4	262	4	224	4																					180	216	4
45 SH	249	210	1,1	192	1,5	170	1,5	148	2,2	123	2,2	99	2,2	72	2,2	45	2,2																	225	45	2,2
65 SH	527	462	2,2	427	3	393	3	358	3	321	4	284	4	244	4	205	5,5	163	5,5															250	163	5,5
30 SH	124	101	0,75	90	1,1	78	1,1	68	1,1	57	1,1	48	1,5	39	1,5	31	1,5	22	1,5	13	1,5													275	13	1,5
40 SH	204	165	0,75	148	0,75	130	1,1	111	1,5	94	1,5	78	1,5	64	2,2	49	2,2	36	2,2	24	2,2	12	2,2											300	12	2,2
50 SH	319	284	2,2	265	2,2	246	2,2	228	3	208	3	187	3	165	3	143	4	120	4	97	4	73	4											300	73	4
60 SH	393	353	2,2	333	3	312	3	291	3	270	4	249	4	228	4	205	4	185	5,5	163	5,5	140	5,5											300	140	5,5
70 SH	522	470	3	444	3	413	3	384	4	354	4	322	4	291	5,5	258	5,5	225	5,5															250	225	5,5
80 SH	834	764	4	727	4	682	4	639	4	593	5,5	547	5,5	501	7,5	454	7,5	406	7,5	356	9	304	9											300	304	9
90 SH	1084	977	5,5	921	5,5	859	5,5	795	7,5	727	7,5	661	7,5	598	9	533	9	467	11	402	11	336	11											300	336	11
115 SH	2150	1858	15	1764	15	1611	15	1466	18,5	1325	18,5	1190	18,5	1056	22	927	22	801	22	678	30	559	30											300	559	30

BISTADIO - DOUBLE STAGE

Δp mbar	0	50		75		100		125		150		175		200		225		250		275		300		325		350		375		400		450		Δp max		
SCL	m³/h	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	m³/h	kW	mbar	m³/h	kW
10 DL	30			18	0,37	13	0,37	8	0,37	4	0,37																							150	4	0,37
15 DH	50			40	0,55	36	0,55	32	0,55	28	0,55	24	0,55	18	0,55	15	0,55	10	0,55	4	0,55													275	4	0,55
20 DH	72			54	0,37	48	0,37	42	0,55	36	0,55	30	0,75	24	0,75	18	0,75	12	0,75															250	12	0,75
30 DH	103			78	0,55	70	0,55	63	0,55	55	0,55	48	0,75	41	0,75	34	0,75	27	0,75	20	1,1	13	1,1											300	13	1,1
40 DH	144			116	1,1	107	1,1	98	1,1	89	1,1	81	1,5	71	1,5	63	1,5	55	1,5	47	2,2	38	2,2	30	2,2	22	2,2							350	22	2,2
50 DH	182			147	2,2	137	2,2	128	2,2	120	2,2	112	2,2	104	2,2	96	2,2	88	3	80	3	71	3	63	3	55	3	46	4	38	4			400	38	4
65 DH	269			219	1,5	203	1,5	188	2,2	174	2,2	159	2,2	145	2,2	131	3	118	3	105	3	93	3	81	3	68	3							350	68	3
70 DH	276			237	2,2	223	2,2	211	3	200	3	188	3	177	3	166	3	154	3	143	4	132	4	120	4	108	4	97	5,5	86	5,5	63	5,5	450	63	5,5
80 DH	430			381	4	366	4	349	4	330	4	313	5,5	297	5,5	280	5,5	263	5,5	246	5,5	228	5,5	211	5,5	193	7,5	174	7,5	156	7,5	121	7,5	450	121	7,5
90 DH	546			483	4	460	4	437	5,5	414	5,5	390	5,5	366	5,5	341	5,5	319	7,5	295	7,5	271	7,5	247	7,5	222	7,5	199	9	174	9			400	174	9
115 DH	1119			978	11	929	11	873	11	822	11	762	11	708	11	658	15	610	15	566	15	523	15	483	18,5	444	18,5	407	18,5	371	18,5			400	371	18,5


Portata - Capacity m³/h
65 SH
V66
V6
45 SH
V5
V4
V3
06
Pressione differenziale statica
Static differential pressure
hPa (mbar)


Portata - Capacity m³/h
115 SH
90 SH
80 SH
70 SH
60 SH
50 SH
40 SH
30 SH
Pressione differenziale statica
Static differential pressure
hPa (mbar)

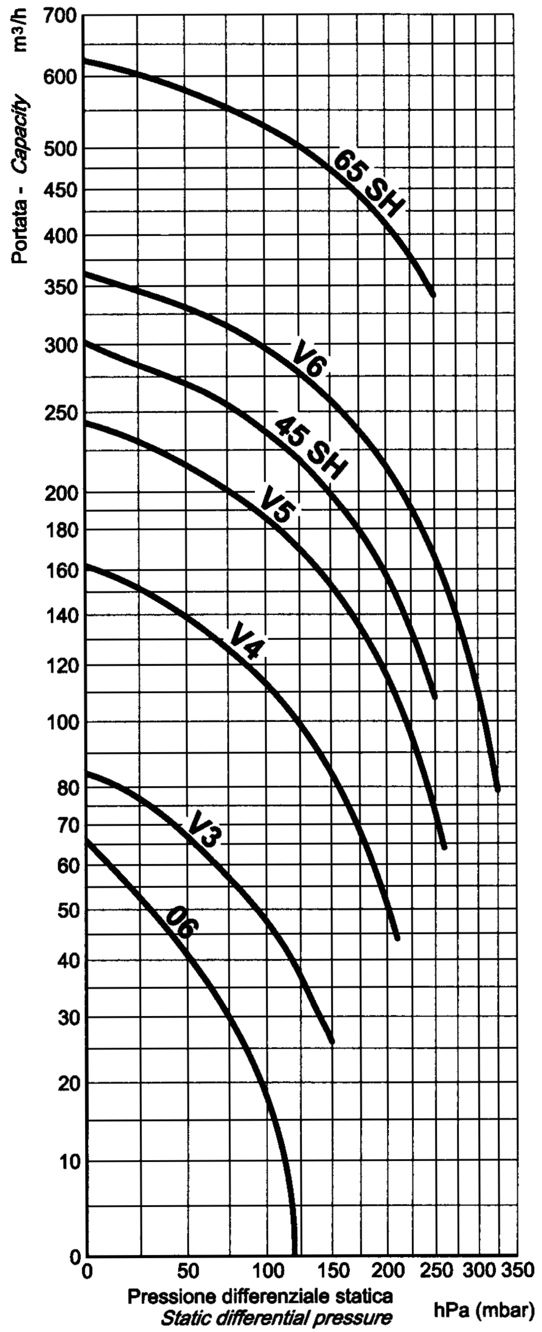

Portata - Capacity m³/h
115 DH
90 DH
80 DH
70 DH
65 DH
50 DH
40 DH
30 DH
20 DH
15 DH
10 DL
Pressione differenziale statica
Static differential pressure
hPa (mbar)

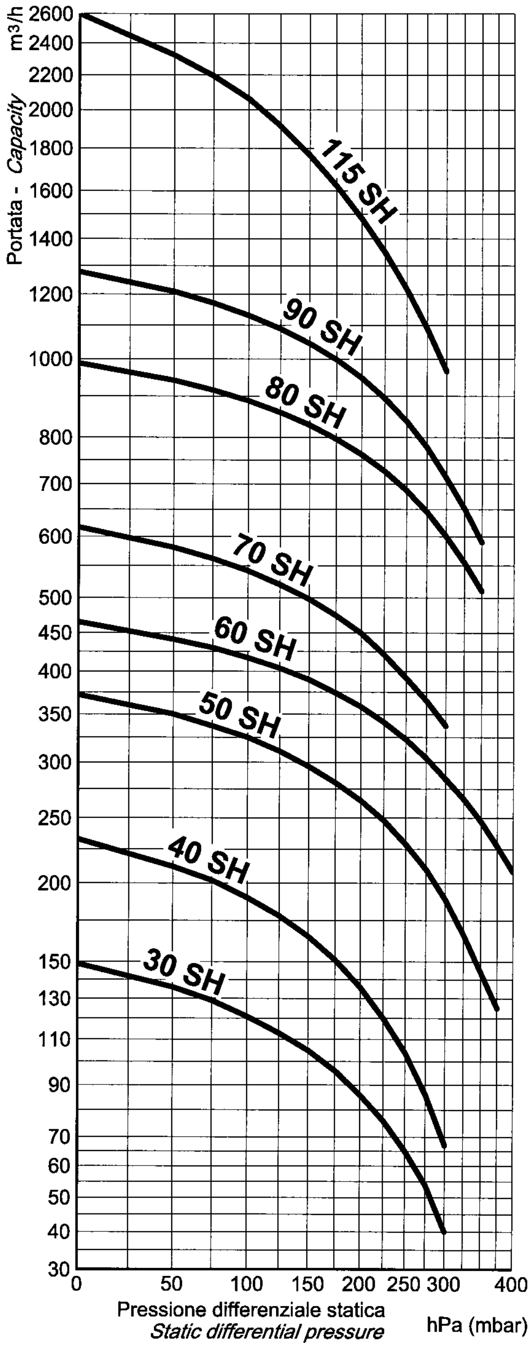
Aspiratori /Exhausters 60 Hz

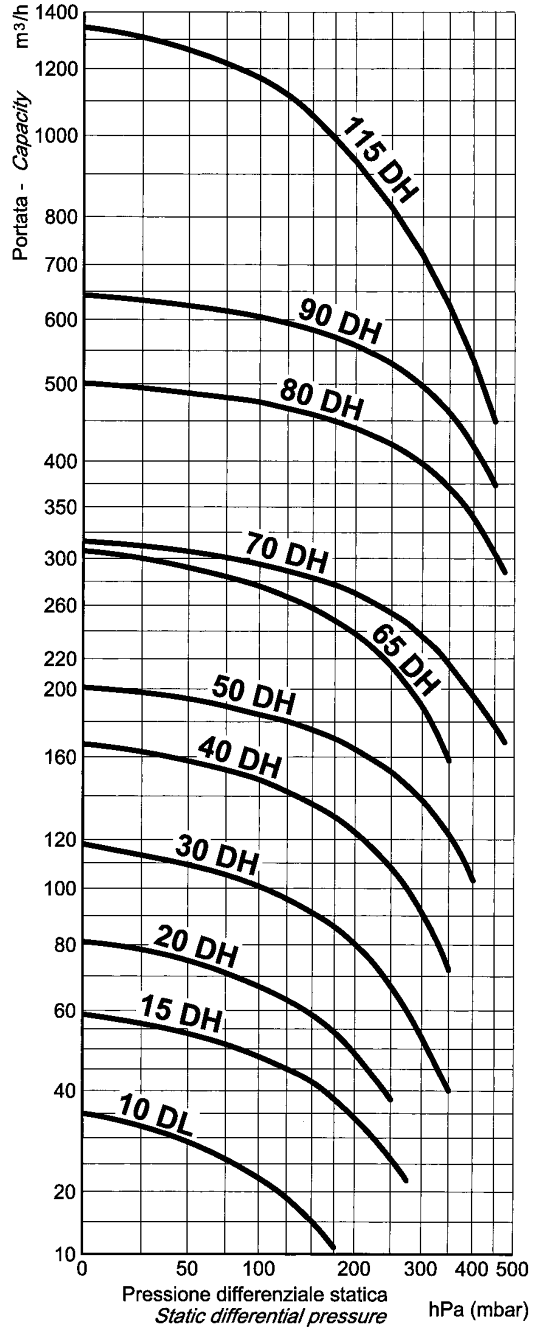
Caratteristiche di funzionamento/Performances for operation

	Δp mbar	0	50		75		100		125		150		175		200		225	
	SCL	m^3/h	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW
MONOSTADIO - SINGLE STAGE	06	66	41	0,23	30	0,23	18	0,4										
	V3	84	67	0,43	57	0,43	48	0,43	37	0,43	26	0,43						
	V4	162	139	0,9	126	0,9	113	0,9	99	0,9	84	1,3	68	1,3	51	1,3		
	V5	243	216	1,75	201	1,75	186	1,75	170	1,75	153	1,75	135	1,75	116	1,75	95	2,55
	V6	362	331	2,55	315	2,55	297	2,55	278	2,55	258	2,55	237	3,45	215	3,45	191	4,6
	45 SH	302	270	1,3	255	1,75	237	1,75	219	2,55	199	2,55	179	2,55	157	3,45	133	3,45
	65 SH	624	579	3,45	554	3,45	529	4,6	503	4,6	474	4,6	444	6,3	412	6,3	378	6,3
	30 SH	149	136	1,3	129	1,3	121	1,3	113	1,75	105	1,75	96	1,75	86	1,75	76	2,55
	40 SH	233	212	1,3	202	1,75	190	1,75	178	2,55	165	2,55	151	2,55	136	2,55	120	2,55
	50 SH	372	350	2,55	337	2,55	325	3,45	311	3,45	296	3,45	281	4,6	265	4,6	248	4,6
	60 SH	465	441	2,55	430	3,45	417	3,45	404	4,6	390	4,6	374	4,6	359	6,3	341	6,3
	70 SH	617	581	3,45	562	4,6	542	4,6	520	4,6	498	6,3	474	6,3	450	6,3	421	8,7
	80 SH	988	941	4,6	915	4,6	888	6,3	859	6,3	829	8,7	796	8,7	762	8,7	726	10,4
	90 SH	1278	1209	6,3	1171	8,7	1131	8,7	1089	8,7	1045	8,7	998	10,4	948	10,4	894	12,7
	115 SH	2600	2322	22	2200	22	2067	22	1913	30	1765	30	1621	30	1482	30	1349	30
BISTADIO - DOUBLE STAGE	10 DL	35			26	0,43	23	0,43	19	0,43	15	0,43	11	0,43				
	15 DH	59			51	0,63	48	0,63	45	0,63	42	0,63	38	0,63	34	0,63	30	0,63
	20 DH	81			71	0,63	67	0,63	63	0,63	58	0,63	54	0,9	49	0,9	43	0,9
	30 DH	118			106	0,9	101	0,9	96	0,9	91	0,9	86	0,9	80	0,9	74	0,9
	40 DH	167			153	1,3	148	1,3	142	1,3	136	1,75	130	1,75	123	1,75	115	1,75
	50 DH	201			189	2,55	184	3,45	180	3,45	175	3,45	170	3,45	164	3,45	158	3,45
	65 DH	307			284	2,55	276	2,55	267	3,45	258	3,45	248	3,45	238	3,45	227	3,45
	70 DH	316			301	2,55	295	2,55	289	3,45	283	3,45	277	3,45	270	3,45	262	4,6
	80 DH	501			481	4,6	475	4,6	466	6,3	458	6,3	449	6,3	440	6,3	430	6,3
	90 DH	643			615	4,6	605	6,3	594	6,3	583	6,3	571	6,3	558	6,3	544	8,7
	115 DH	1343			1217	15	1170	15	1121	15	1054	15	991	18,5	932	18,5	875	18,5

Δp mbar	250		275		300		325		350		375		400		450		Δp max		
SCL	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	m^3/h	kW	mbar	m^3/h	kW
06																	120	0	0,4
V3																	150	26	0,43
V4																	210	44	1,3
V5	73	2,55															260	64	2,55
V6	166	4,6	139	4,6	110	4,6	79	4,6									325	79	4,6
45 SH	108	3,45															250	108	3,45
65 SH	341	6,3															250	341	6,3
30 SH	65	2,55	54	2,55	40	2,55											300	40	2,55
40 SH	104	3,45	86	3,45	67	3,45											300	67	3,45
50 SH	229	6,3	210	6,3	189	6,3	166	6,3	142	6,3	125	6,3					375	125	6,3
60 SH	323	6,3	304	6,3	283	8,7	266	8,7	247	8,7	227	8,7	208	8,7			400	208	8,7
70 SH	392	8,7	365	8,7	337	8,7											300	337	8,7
80 SH	687	10,4	645	12,7	600	12,7	555	12,7	510	17,4							350	510	17,4
90 SH	838	12,7	777	12,7	712	17,4	651	17,4	590	17,4							350	590	17,4
115 SH	1217	37	1089	37	965	37											300	965	37
10 DL																	175	11	0,43
15 DH	26	0,63	22	0,63													275	22	0,63
20 DH	38	0,9															250	38	0,9
30 DH	67	1,3	60	1,3	52	1,3	46	1,3	40	1,3							350	40	1,3
40 DH	108	2,55	100	2,55	91	2,55	82	2,55	72	2,55							350	72	2,55
50 DH	152	4,6	145	4,6	138	4,6	130	4,6	122	4,6	113	4,6	103	4,6			400	103	4,6
65 DH	215	3,45	202	4,6	189	4,6	174	4,6	158	4,6							350	158	4,6
70 DH	254	4,6	246	4,6	236	4,6	227	6,3	216	6,3	205	6,3	193	6,3	177	6,3	475	168	6,3
80 DH	420	6,3	409	8,7	397	8,7	384	8,7	370	8,7	355	8,7	339	8,7	304	10,4	475	288	10,4
90 DH	530	8,7	514	8,7	500	8,7	479	10,4	460	10,4	439	10,4	417	10,4	373	12,7	450	373	12,7
115 DH	821	18,5	769	22	719	22	670	22	623	22	578	30	534	30	449	30	450	449	30


m³/h
Portata - Capacity
700
600
500
450
400
350
300
250
200
180
160
140
120
100
80
70
60
50
40
30
20
10
0
65 SH
V6
45 SH
V5
V4
V3
06
0
50
100
150
200
250
300
350
Pressione differenziale statica
Static differential pressure
hPa (mbar)


m³/h
Portata - Capacity
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
700
600
500
450
400
350
300
250
200
150
130
110
90
70
60
50
40
30
115 SH
90 SH
80 SH
70 SH
60 SH
50 SH
40 SH
30 SH
0
50
100
150
200
250
300
400
Pressione differenziale statica
Static differential pressure
hPa (mbar)


m³/h
Portata - Capacity
1400
1200
1000
800
700
600
500
400
350
300
260
220
200
160
120
100
80
60
40
20
10
115 DH
90 DH
80 DH
70 DH
65 DH
50 DH
40 DH
30 DH
20 DH
15 DH
10 DL
0
50
100
200
300
400
500
Pressione differenziale statica
Static differential pressure
hPa (mbar)

Informazioni tecniche / Technical information

PRINCIPIO DI FUNZIONAMENTO:
I compressori - aspiratori a canale laterale (SCL) sono sviluppati sulla base della teoria del deflusso rigenerativo.
Dato il particolare principio di funzionamento e le caratteristiche costruttive, nei compressori – aspiratori a canale laterale non esistono parti a contatto tra rotore e statore, pertanto gli evidenti vantaggi che si possono riscontrare sono:

- *Funzione senza usura*
- *Nessuna necessità di lubrificazione*
- *Minima manutenzione*
- *Funzionamento silenzioso*
- *Assenza di pulsazioni nel fluido*

COSTRUZIONE:
La costruzione standard, realizzata con corpi e girante in lega d'alluminio, è prevista in esecuzione monoblocco, con giranti equilibrate dinamicamente direttamente calettate sull'albero motore.
I motori elettrici, dimensionati per servizio continuo, sono a due poli, asincroni trifase e monofase, con classe d'isolamento F – Tropicalizzata e protezione IP54 o IP55 secondo le esigenze, costruiti secondo norme IEC con voltaggi standard V230/400-50Hz – V265/460-60Hz. per potenze fino a 4 kW compresi e V400/690-50Hz. – V440/760-60Hz. per potenze oltre i 4 kW; tensioni diverse su richiesta.
Inoltre sono disponibili compressori – aspiratori atti al comando a mezzo cinghie e pulegge che permettono l'accoppiamento a diversi tipi di motore (antideflagranti, a scoppio, idraulici, ecc..) e consentono la variazione delle velocità di rotazione fino a 4.500 rpm, con conseguente incremento delle prestazioni.
FPZ progetta e costruisce macchine speciali per il convogliamento di gas ad alta pressione o alta temperatura, per gas tecnici, corrosivi, ecc.. utilizzando materiali diversi dallo standard con trattamento superficiale degli stessi e impiego di diversi sistemi di tenuta.
In particolare è stata sviluppata una serie dedicata che prevede:

- *Costruzione in lega d'alluminio*
- *Impregnazione di tutte le parti di contenimento del gas*
- *Sigillatura dei piani d'unione delle parti*
- *Supportazione a sbalzo con doppia tenuta sull'albero*

DATI TECNICI:
I dati caratteristici riportati si intendono per il convogliamento di gas avente all'aspirazione temperatura di 15°C, densità normale di 1.23 Kg/mc e pressione assoluta di 1013 mbar.
Le caratteristiche sono soggette a variazione in funzione di fattori quali:

- *Variazione della pressione assoluta di mandata rispetto 1013 mbar (aspirazione)*
- *Variazione della pressione assoluta d'aspirazione rispetto 1013 mbar (compressione)*
- *Funzionamento a carico misto (compressione in mandata e contemporaneamente depressione in aspirazione).*
- *Convogliamento di fluido avente densità diversa da quella considerata (1.23 Kg/mc)*
- *Variazione della velocità di rotazione rispetto alla velocità relativa a 50Hz (2900 rpm) e a 60Hz (3500 rpm)*

Dati soggetti a variazione senza obbligo di preavviso.
Tolleranza sui valori indicati +/- 10%

OPERATING PRINCIPLE
The lateral channel blowers-exhausters (SCL) have been developed on the theory of the regenerative flow.
Due to their unique principle of operation and design, there is no contact between rotating and stationary parts.
The main advantages are the following:

- *No wearing parts*
- *no lubrication required*
- *minimum maintenance*
- *silent operation*
- *smooth air flow*

CONFIGURATION
The standard design, with housing and impeller made from aluminium alloy, is a direct drive configuration, with a dynamically balanced impeller and fitted directly on the motor shaft.
The electric motors are 2-poles, single and three phase, rated for continuous service. Insulating class "F" – Tropicalized ,with protection IP54 or IP55 as required and are built to IEC standards.
Standard voltage is V230/400-50Hz – V265/460-60hz till 4 kw inclusive and V400/690-50hz – V440/760.-60hz from 5,5 kw and above
Different voltages are available upon request
Separate v-belt drive blowers are also available that provide for the coupling to various motor (explosion-proof, hydraulic and gas engine) where a speed of 4500 rpm can be reached with subsequent higher performances.
FPZ also design and produce special blowers for the handling of gases having high pressure and temperature, or specialty /corrosive composition, by incorporating specific materials including special surface treatments and use of different seal types.
Particularly a dedicated range was developed:

- *manufacturing material is the aluminium alloy*
- *impregnation of all parts in contact with the gas*
- *sealing of union parts*
- *overhang mounting with double mechanical seal on the shaft*

PERFORMANCES
The data provided refers to the handling of gas having inlet temperature of 15°C, normal density of 1,23 kg/m3 and absolute pressure of 1013 mbar.
This data can change in accordance with the following factors:

- *Any variation in absolute outlet pressure of 1013 mbar (suction)*
- *Any variation in absolute inlet pressure of 1013 mbar (discharge)*
- *Operation using inlet and outlet simultaneously (back pressure at discharge port and suction at the inlet port)*
- *Handling of fluid having different density from 1.23 kg/m3.*
- *Variation in speed of rotation in relation to the basic one at 50 hz (2900 rpm) and 60 hz (3500 rpm)*

Data can be changed whitout notice.
Tolerances on given values: +/- 10%

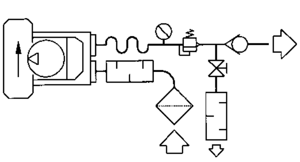
SCL TMD GOR

SCL COR

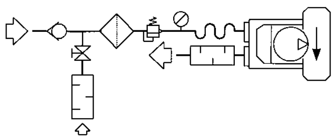
SCL 15DH

SCL SH/DH

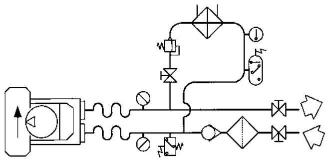
Schemi di installazione / Installation sketches



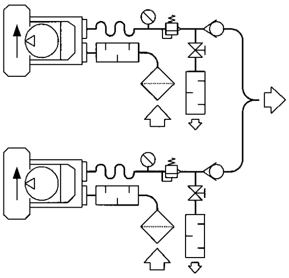
Compressore
Pressure service



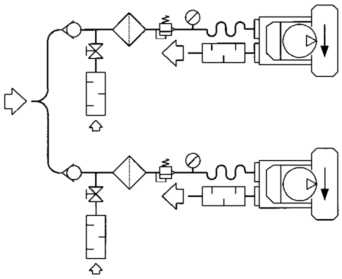
Aspiratore
Vacuum service



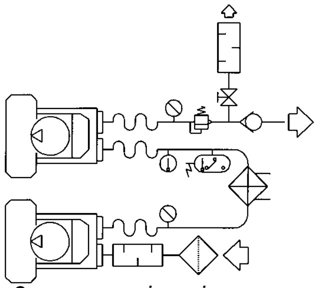
Trasferimento gas
Gas transfer



Compressore in parallelo
Parallel pressure service



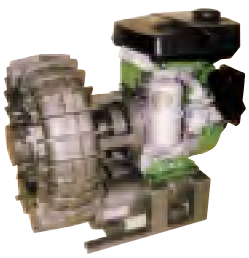
Aspiratore in parallelo
Parallel vacuum service



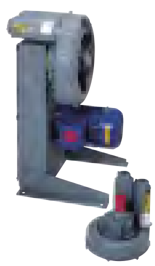
Compressore in serie
Parallel pressure service

DN / *TIPO - SCL -TYPE*	1/2"	3/4"	1"	1" 1/4	1" 1/2	2"	3"	4"	5"
	10 DL	15 DH	06	V3 20DH	V4 30SH 30DH 40DH	V5 V6 V66 40SH 45SH 50SH 50DH	60SH 65SH 65DH 70SH 70DH	80SH 80DH 90SH 90DH	115SH 115DH
ACCESSORI - ACCESSORIES									
Filtro aria a secco Dry air filter					FV 5	FV 6			
Filtro aria a ciclone Cyclone air filter					FC 5	FC 6	FC 8	FC 9	
Filtro di aspirazione per interni Indoor intake filter				FA 4	FA 5	FA 6			
Filtro di aspirazione a cartuccia Cartridge intake filter	FL 1	FL 2	FL 3	FL 4	FL 5	FL 6	FL 8	FL 9	FL 10
Manicotto flessibile Flexible coupling			MF 3	MF 4	MF 5	MF 6	MF 8	MF 9	MF 10
Manicotto portagomma Sleeve	MP 1	MP 2	MP 3	MP 4 MP 4V	MP 5 MP 5V	MP 6	MP 8	MP 9	MP 10
Flangia filettata Threaded flange			TF 3	TF 4 TF 4V	TF 5 TF 5V	TF 6	TF 8	TF 9	
Manometro - Vuotometro Pressure - Vacuum gauge	MC 010 - MV 010								
Valvola di sicurezza Safety valve	VRL 3			VRL 6			VRL 8	VRL 9	
Valvola di non ritorno Non return valve	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 8	VC 9	
Silenziatore supplementare Additional silencer				SI 4 SS 4	SI 5 SS 5	SI 6 SS 6	SI 8 SS 8		
Collettore Manifold				CA 4 CA 4V	CA 5 CA 5V	CA 6 CA 6V CT 66	CA 8 CT 88	CA 9 CT 89	CA 10

SCL con cabina afona
SCL with sound-hood



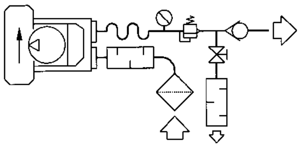
SCL con motore diesel
SCL with diesel motor



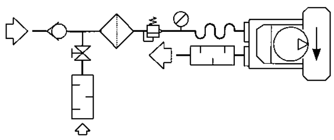
SCL "V" COR/ST

SCL "V" GVR/GOR

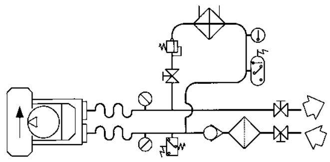
Schemi di installazione / Installation sketches



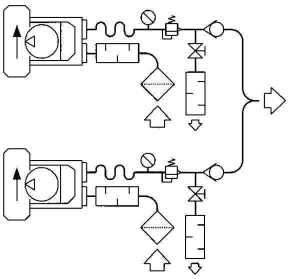
Compressore
Pressure service



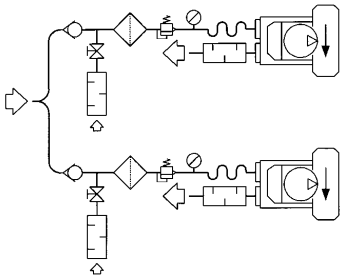
Aspiratore
Vacuum service



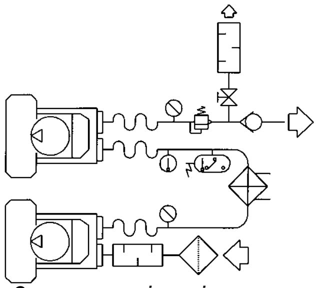
Trasferimento gas
Gas transfer



Compressore in parallelo
Parallel pressure service



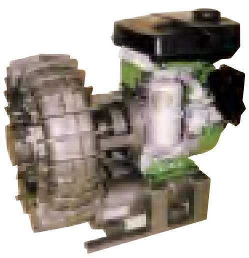
Aspiratore in parallelo
Parallel vacuum service



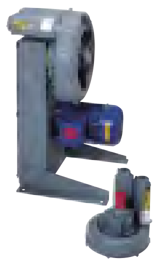
Compressore in serie
Parallel pressure service

DN	1/2“	3/4“	1“	1“ 1/4	1“ 1/2	2“	3“	4“	5“
TIPO - SCL -TYPE	10 DL	15 DH	06	V3 20DH	V4 30SH 30DH 40DH	V5 V6 V66 40SH 45SH 50SH 50DH	60SH 65SH 65DH 70SH 70DH	80SH 80DH 90SH 90DH	115SH 115DH
ACCESSORI - ACCESSORIES									
Filtro aria a secco Dry air filter					FV 5	FV 6			
Filtro aria a ciclone Cyclone air filter					FC 5	FC 6	FC 8	FC 9	
Filtro di aspirazione per interni Indoor intake filter				FA 4	FA 5	FA 6			
Filtro di aspirazione a cartuccia Cartridge intake filter	FL 1	FL 2	FL 3	FL 4	FL 5	FL 6	FL 8	FL 9	FL 10
Manicotto flessibile Flexible coupling			MF 3	MF 4	MF 5	MF 6	MF 8	MF 9	MF 10
Manicotto portagomma Sleeve	MP 1	MP 2	MP 3	MP 4 MP 4V	MP 5 MP 5V	MP 6	MP 8	MP 9	MP 10
Flangia filettata Threaded flange			TF 3	TF 4 TF 4V	TF 5 TF 5V	TF 6	TF 8	TF 9	
Manometro - Vuotometro Pressure - Vacuum gauge	MC 010 - MV 010								
Valvola di sicurezza Safety valve	VRL 3			VRL 6			VRL 8	VRL 9	
Valvola di non ritorno Non return valve	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 8	VC 9	
Silenziatore supplementare Additional silencer				SI 4 SS 4	SI 5 SS 5	SI 6 SS 6	SI 8 SS 8		
Collettore Manifold				CA 4 CA 4V	CA 5 CA 5V	CA 6 CA 6V CT 66	CA 8 CT 88	CA 9 CT 89	CA 10

SCL con cabina afona
SCL with sound-hood



SCL con motore diesel
SCL with diesel motor

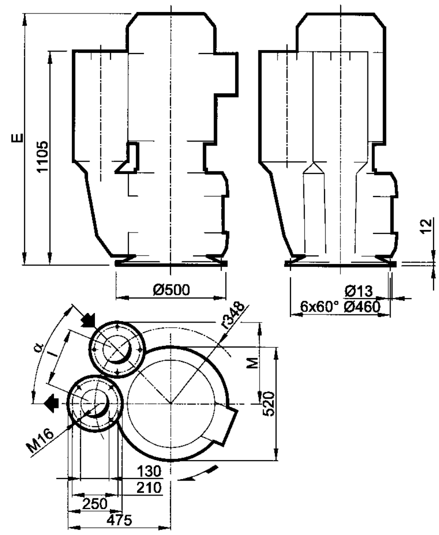


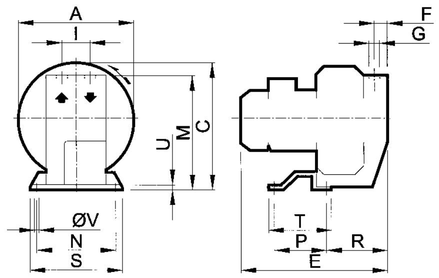
SCL “V” COR/ST

SCL “V” GVR/GOR

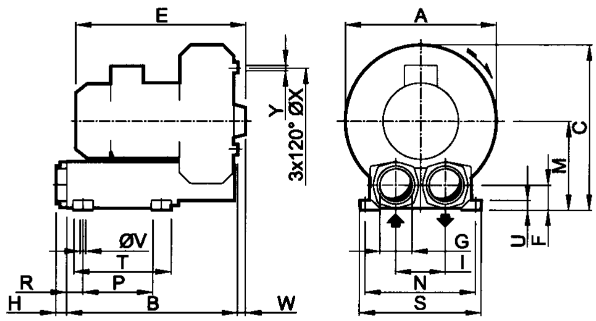
Ingombri / Dimensions

TIPO TYPE	E	I	M	α	KG
115SH	1320	266	371	45°	505
115DH	1320	492	475	90°	507





TIPO TYPE	A	C	E	F	G	I	M
10DL	220	256	300	23	G 1/2"	58	230
15DH	250	282	335	30	G 3/4"	64	258
TIPO TYPE	**N**	**P**	**R**	**S**	**T**	**U**	**V**	**KG**
10DL	180	120	90	210	144	2,5	9	10
15DH	180	120	120	210	144	2,5	9	12,5



TIPO TYPE	A	B	C	E	F	G	H	I	M	N	P	R	S	T	U	V	W	X	Y	KG
06	222	160	229	235	26	G 1"	18	80	111									136	M5	7
V3	246	214	246	240	41	G 1"1/4	18	90	130	205	83	75	230	130	3	10	6	140	M6	10
V4	292	236	298	290	46	G 1"1/2	18	115	154	225	95	70	255	155	3	12	5	175	M6	16
V5	334	296	345	300	54	G 2"	18	120	180	260	115	98	295	195	4	14	5	200	M8	25
V6	380	308	386	380	54	G 2"	18	125	198	290	140	85	325	210	4	15	5	240	M10	36
V66	380	404	386	470	54	G 2"	18	125	198	290	140	85	325	340	4	15	23	-	-	44
30SH	350	395	362	360	53	G 1"1/2	18	105	187	245	185	55	270	235	20	10	-	290	M6	27
40SH	350	402	362	420	53	G 2"	18	105	187	245	185	55	270	235	20	10	-	290	M6	31
45SH	350	440	370	465	53	G 2"	18	105	195	245	185	55	270	235	20	10	-	225	M8	40
50SH	420	432	445	505	53	G 2"	18	105	235	245	185	55	270	235	20	10	-	295	M8	59
60SH	520	510	554	510	72	G 3"	25	170	294	380	235	60	415	290	30	14	-	390	M8	75
65SH	426	525	458	490	65	G 3"	25	135	245	300	235	58	340	285	30	14	-	265	M8	60
70SH	520	525	554	515	72	G 3"	25	170	294	380	235	60	415	290	30	14	-	390	M8	75
80SH	520	650	560	660	82	G 4"	25	170	300	380	325	60	415	380	30	14	-	360	M10	104
90SH	520	670	560	670	82	G 4"	25	170	300	380	325	60	415	380	30	14	-	360	M10	107
20DH	290	355	310	350	45	G 1"1/4	18	90	165	210	150	45	230	195	20	10	-	150	M6	22
30DH	320	420	347	390	53	G 1"1/2	18	105	187	245	185	55	270	235	20	10	-	180	M6	26
40DH	350	440	370	465	53	G 1"1/2	18	105	195	245	185	55	270	235	20	10	-	225	M8	37
50DH	420	432	445	505	53	G 2"	18	105	235	245	185	55	270	235	20	10	-	295	M8	53
65DH	426	525	458	485	68	G 3"	25	135	245	300	235	58	340	285	30	12	-	265	M8	62
70DH	520	525	554	520	75	G 3"	25	170	294	380	235	60	415	290	30	14	-	390	M8	77
80DH	520	650	560	620	80	G 4"	25	170	300	380	325	60	415	380	30	14	-	360	M10	95
90DH	520	670	560	670	80	G 4"	25	170	300	380	325	60	415	380	30	14	-	360	M10	108

NOTE D'INGOMBRO
Le dimensioni d'ingombro sono espresse in mm.
I dati riportati si intendono non impegnativi e soggetti a variazione senza obbligo di preavviso.
Le quote "E" e i pesi si intendono come dimensioni massime, riferiti al motore installato di massima potenza.

OVERALL DIMENSIONS
Overall dimensions are in mm
Due to continuous product improvement, we reserve the right to change data without notice
Data relating to the "E" dimensions refers to the maximum e-motor installed.

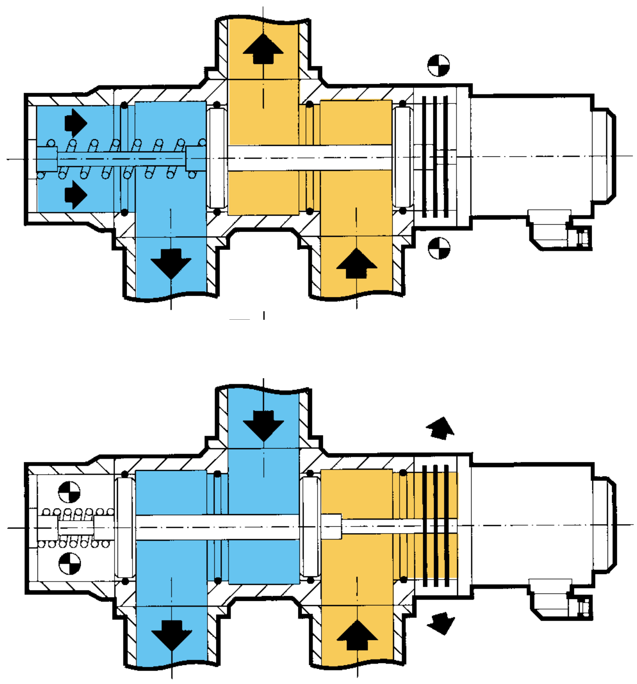
Accessori / Accessories

VALVOLE DI INVERSIONE:
Le valvole di inversione flusso FPZ (Serie VS), sono dispositivi impiegati per variare in tempi nell'ordine di 0.10 sec. ca. la direzione del flusso nella condotta di utilizzo e possono essere direttamente accoppiate ai compressori - aspiratori a canale laterale o montate in linea.
Opportunamente installate sulla bocca di mandata o di aspirazione possono anche operare da scambiatrici di direzione del flusso.
Costruite in lega di alluminio, sono comandate da elettromagnete alimentato a 24 Volt in c.c. o in alternativa 220 Volt in c.a. monofase o con attuatori pneumatici.
La configurazione della valvola con doppio comando pneumatico permette inoltre una fase neutra durante la quale il flusso è completamente riciclato in macchina.

FLOW CONVERTING DEVICES
FPZ flow converting valves "VS" , are devices used to change –virtually in 0,10 sec.ca – the flow direction in the main pipeline. These valves can be directly fitted on the blower or mounted in-line.
When mounted on discharge or suction side of the blower, they can be used as exchangers of the flow's direction.
The material of construction is aluminium alloy; the drive can be 24 vd.c or alternatively 220 a.c.. single phase or with pneumatic actuators.
The configuration with double pneumatic drive allows the blower to operate in "Neutral" where the flow is totally recycled inside the unit.

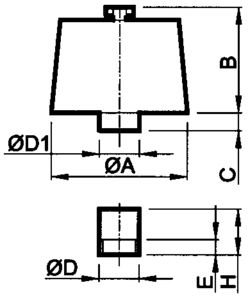
SCL con valvola deviatrice di flusso
SCL with flow deflecting device

Valvola d'inversione con elettromagnete
Flow converting device with electromagnet



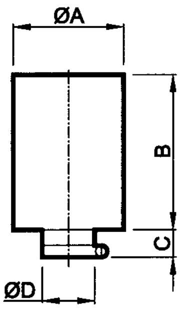
SCL con valvola d'inversione con comando pneumatico
SCL with flow converting device pneumatic drive

Accessori / Accessories



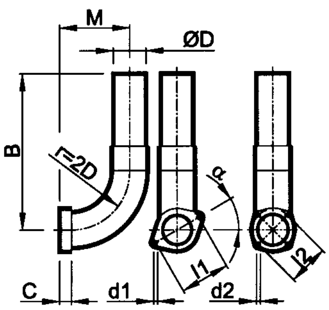
Filtro di aspirazione a cartuccia / Cartridge intake filter

TIPO TYPE	DN	D	D1	A	B	C	E	H	CART.
FL 1	1/2"	G 1/2"	21	75	62	23	15	100	CF 1
FL 2	3/4"	G 3/4"	27	150	105	23	15	130	CF 4
FL 3	1"	G 1"	33	150	105	23	15	130	CF 4
FL 4	1" 1/4	G 1" 1/4	42	150	105	23	15	200	CF 4
FL 5	1" 1/2	G 1" 1/2	48	180	155	23	15	200	CF 5
FL 6	2"	G 2"	60	230	155	23	15	200	CF 6
FL 8	3"	G 3"	89	280	180	35	15	200	CF 8
FL 9	4"	G 4"	114	410	330	35	15	200	CF 9
FL 10	5"	G 5"	140	410	330	35	15	200	CF 10



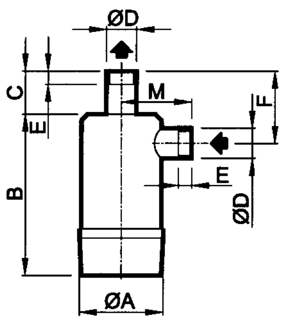
Filtro di apirazione per interni / Indoor intake filter

TIPO TYPE	DN	D	A	C	B
FA 4	1" 1/4	42	126	23	126
FA 5	1" 1/2	48	152	23	217
FA 6	2"	60	152	23	217



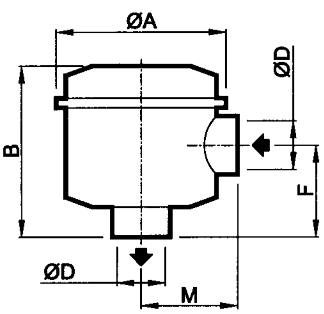
Collettore / Manifold

TIPO TYPE	DN	D	B	C	M	l1	d1	α	l2	d2
CA 4	1" 1/4	42	220	15	90	75	14	30°	-	-
CA 4V	1" 1/4	42	220	15	90	64	14	0°	-	-
CA 5	1" 1/2	48	260	15	110	85	14	45°	-	-
CA 5V	1" 1/2	48	260	15	110	75	14	0°	-	-
CA 6	2"	60	320	15	135	85	14	45°	-	-
CA 6V	2"	60	320	15	135	85	14	0°	-	-
CA 8	3"	88	380	15	185	-	-	-	120	14
CA 9	4"	113	400	20	235	-	-	-	150	18
CA 10	5"	140	450	20	300	-	-	-	210	18



Filtro aria a ciclone / Cyclone air filter

TIPO TYPE	DN	D		A	B	C	E	F	M	CART.	COPPIA STAFFE COUPLE OF MOULDING
FC 5	1" 1/2	G 1" 1/2	48	146	312	81	22	129	126	CL 5	FS 5
FC 6	2"	G 2"	60	178	341	91	22	144	156	CL 6	FS 6
FC 8	3"	G 3"	88	220	453	102	22	172	157	CL 8	FS 8
FC 9	4"	G 4"	114	276	493	128	22	208	225	CL 9	FS 9

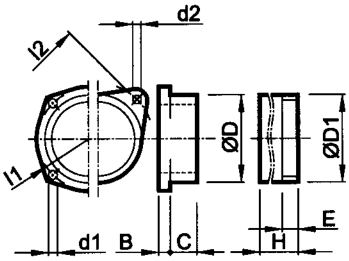


Filtro aria a secco / Dry air filter

TIPO TYPE	DN	D	A	B	F	M	CART.
FV 5	1" 1/2	G 1" 1/2	176	200	112	100	CV 5
FV 6	2"	G 2"	200	258	131	111	CV 6

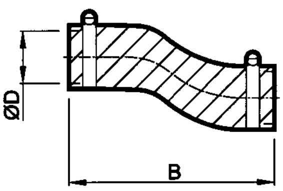
Accessori / Accessories

Manicotto portagomma / Sleeve



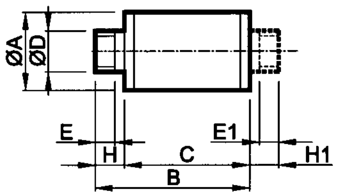
TIPO TYPE	DN	D	D1		B	C	E	H	l1	d1	l2	d2
MP 1	1/2"	-	G 1/2"	21	-	-	15	100	-	-	-	-
MP 2	3/4"	-	G 3/4"	27	-	-	15	100	-	-	-	-
MP 3	1"	33	-	-	10	25	-	-	-	-	55	13
MP 4	1" 1/4	42	-	-	10	25	-	-	-	-	75	13
MP 4V	1" 1/4	42	-	-	10	25	-	-	-	-	64	13
MP 5	1" 1/2	48	-	-	10	25	-	-	-	-	85	13
MP 5V	1" 1/2	48	-	-	10	25	-	-	-	-	75	13
MP 6	2"	60	-	-	10	25	-	-	-	-	85	13
MP 8	3"	88	-	-	13	32	-	-	120	13	-	-
MP 9	4"	-	G 4"	114	-	-	20	100	-	-	-	-
MP 10	5"	-	G 5"	140	10	210	20	-	210	18	-	-

Manicotto flessibile / Flexible coupling



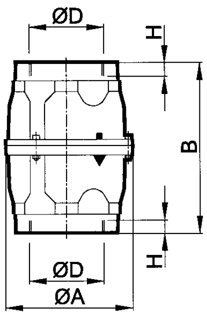
TIPO TYPE	DN	D	B
MF 1	1/2"	20	200
MF 2	3/4"	26	200
MF 3	1"	32	200
MF 4	1" 1/4	45	200
MF 5	1" 1/2	50	250
MF 6	2"	64	250
MF 8	3"	89	330
MF 9	4"	114	330
MF 10	5"	140	330

Silenziatore supplementare / Additional silencer



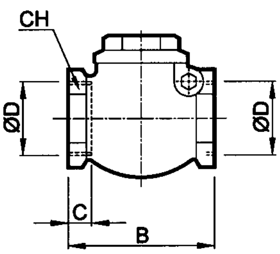
TIPO TYPE	DN	D	A	B	C	E	H	E1	H1
SI 4	1" 1/4	G 1" 1/4	70	190	140	15	50	15	50
SI 5	1" 1/2	G 1" 1/2	80	200	170	20	30	20	30
SI 6	2"	G 2"	90	230	200	20	30	20	30
SI 8	3"	G 3"	152	485	400	20	85	20	85
SS 4	1" 1/4	G 1" 1/4	70	190	140	15	50	-	-
SS 5	1" 1/2	G 1" 1/2	80	200	170	20	30	-	-
SS 6	2"	G 2"	90	230	200	20	30	-	-
SS 8	3"	G 3"	152	485	400	20	85	-	-

Valvola di sicurezza / Safety valve



TIPO TYPE	DN	D	A	B	H
VRL 3	1"	G 1"	70	120	15
VRL 6	2"	G 2"	100	167	19
VRL 8	3"	G 3"	135	190	22
VRL 9	4"	G 4"	160	206	25

Valvola di non ritorno / Non return valve



TIPO TYPE	DN	D	B	C	CH
VC 1	1/2"	G 1/2"	47	8	25
VC 2	3/4"	G 3/4"	52	8	32
VC 3	1"	G 1"	62	10	38
VC 4	1" 1/4	G 1" 1/4	74	10	47
VC 5	1" 1/2	G 1" 1/2	86	10	55
VC 6	2"	G 2"	97	12	67
VC 8	3"	G 3"	133	12	95
VC 9	4"	G 4"	180	20	124

Edizione 2001 GB/I

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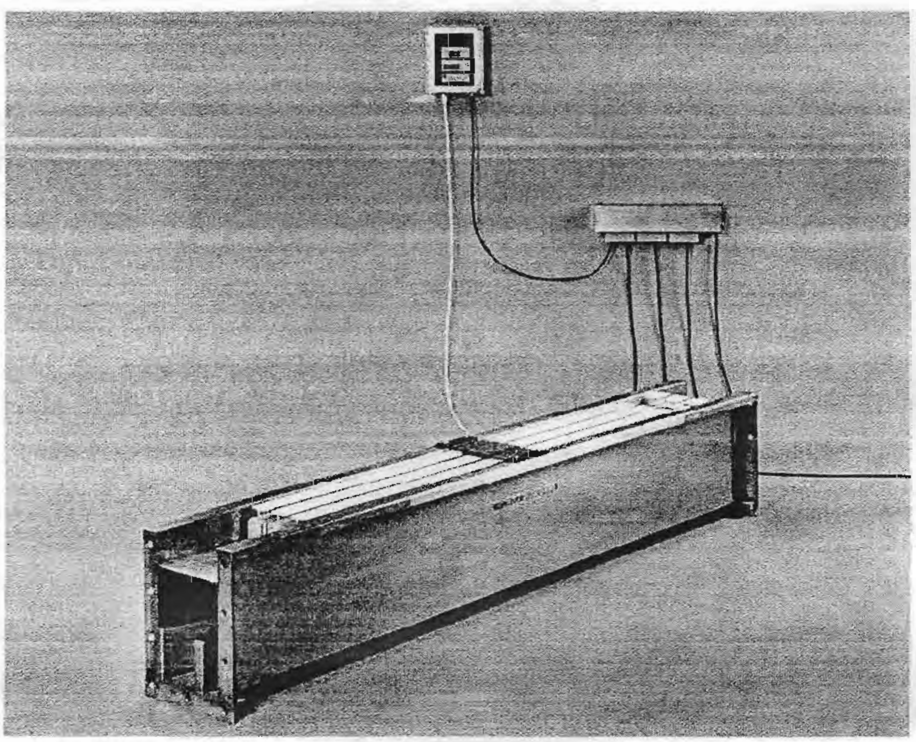
TROJANUV3000™ PTP

OPERATION AND MAINTENANCE MANUAL



PROJECT:
610858

SYSTEM TYPE:
UV3025K PTP SYS

The TrojanUV3000™PTP in this manual, may be covered by one or more of the following United States (US) or Canadian (CDN) Patents:

US 5,006,244
US 4,872,980
CDN 1,327,877

FOREIGN PATENTS HAVE BEEN GRANTED AND OTHER PATENTS ARE PENDING.

Preface iii

PREFACE

General Information

Congratulations on your purchase of the TrojanUV3000™PTP.

This Operation and Maintenance (O&M) Manual provides instructions on how to operate the system and carry out routine maintenance.

The objective of this manual is to provide simple, clear, and complete instructions. It is backed by Trojan Technologies Inc.'s commitment to offer superior customer support. Every effort has been taken to ensure the accuracy and completeness of information in this manual.

If you do not understand any of the information or procedure explanations in this manual, call your local Trojan Certified Service Representative or Trojan Technologies Inc. for assistance.

Do not undertake operation of equipment unless you fully understand the contents of this manual, are familiar with equipment operation, and are trained in electrical and mechanical safety. Any maintenance or repair to equipment **must** be performed by a qualified operator/electrician, or a Trojan Service Representative.

Your common sense and good judgment are crucial to the safe and successful operation and maintenance of the TrojanUV3000™PTP.

1. Read the Warnings, Precautions and General Lockout Procedure in this section before operating or performing any maintenance on this equipment.
2. Read procedures thoroughly before starting.
3. Review all warnings and cautions that accompany any procedure and review warnings and precautions section each time you prepare to perform maintenance on the TrojanUV3000™PTP.

Four types of notices are used in this manual.

	DANGER
	Contains information that if not heeded, will cause death or serious injury to personnel.
	WARNING
	Contains information that if not heeded, could cause death or serious injury to personnel.
	CAUTION
	Contains information that if not heeded, may cause immediate injury or equipment damage.

Note:	***Provides comments which clarify information (e.g. On some models the valve is at the rear of the unit.)***

This section of the O&M Manual contains important contacts, warnings and precautions, MSDS sheets general lockout procedures, a list of acronyms, glossary of terms, and description of the operator's kit.

Chapter 1 - provides an introduction into the theory of ultraviolet light disinfection.

Chapter 2 - is an overview of the TrojanUV3000™PTP components and operation. This section also includes the Replacement Parts List and instructions for ordering parts.

Chapters 3 – 5 - provide instructions for the storage, handling, installation, start up and shut down of the UV System.

Chapters 6– 11 - provide details for the operation, maintenance, and specifications of the major components of the TrojanUV3000™PTP including the Power Distribution Receptacles, UV Module, and UV Sensor.

Chapter 12 - provides instructions on wastewater sampling techniques.

Chapter 13 - is a guide for trouble shooting the UV System.

Chapter 14 - provides a logbook to assist the operator in maintaining the TrojanUV3000™PTP system. Trojan suggests that copies be made of the logs, checklists and charts in this section to use as reference when performing system checks and routine maintenance.

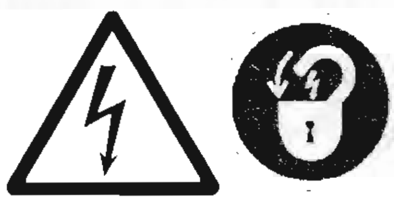
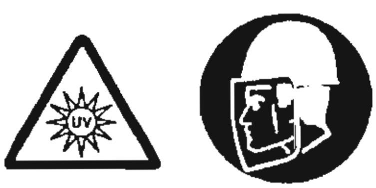
Important Contacts

TROJAN TECHNOLOGIES INC.

Head Office (Canada) 3020 Gore Road London, Ontario Canada N5V 4T7 Toll Free Number: 1-888-220-6118 (USA and Canada Only) Fax: 519-457-3030 For contact information specific to your UV System and region, please refer to our website. http://www.trojanuv.com	**Europe** Laan van Vredestein, 160 2552 DZ, The Hague, Netherlands Telephone: 31-70-391-3020 Fax: 31-70-391-3330 For projects in Continental Europe
Your Local Representative ________________ ________________ ________________ ________________	**United Kingdom** TrojanUV Technologies UK Ltd., 5, De Salis Court Hampton Lovett Droitwich, Worcestershire England, WR9 OQE Telephone: + 44-1-905-771117 Fax: + 44-1-905-772270 For projects in the England, Scotland, Wales and Ireland ONLY

Warnings And Precautions

Please read warnings and precautions before proceeding with operation, maintenance or repair of the equipment. Always follow local safety codes and ensure tools and personal protective equipment are in good condition and properly fitted and tested.

DANGER	
	*Electrical Hazard!* ***LOCK OUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment. The power sources may include electrical, hydraulic, or stored energy. Refer to the general lock out and tag procedures in this manual.***
	WARNING
	*UV Hazard! Wear UV resistant face shield!* ***Unprotected exposure to ultraviolet light can cause severe burns to burns to eyes and skin. Never look directly at the energized lamps unless you are wearing a UV resistant face shield.*** ***As added protection, or for short term exposures, wear tight fitting UV resistant glasses with contiguous side shields, at all times when there is a potential exposure to ultraviolet light. Wear glasses when servicing equipment.***
	*Wear Protective Gloves! Always wear protective gloves when working on equipment.*
	*Wear Safety Boots! Always wear protective footwear when working on equipment.*

	**WARNING**
	*Wear Ear Protection! The Trojan System UV3000PTP™ does not produce a harmful level of noise, but users are cautioned that they should wear hearing protection as appropriate to protect against other noise that may be present at a wastewater or water treatment plant.*
	*Corrosive! The Limeaway Cleaning Agent contains phosphoric acid. Avoid inhalation, ingestion, or exposure to eyes and skin. Wear appropriate clothing and personal protective equipment.*
	*Wear Hard Hat! Wear an approved hard hat and other personal protective equipment that is required according to construction site, wastewater or water treatment plant safety regulations.*
	*Slip Hazard! Module surfaces, grating, walkways and channel walls may be slippery when wet or ice covered.*
	*Fall Hazard! Use care when working around open channels. Replace safety grating after lifting modules.*
	*Trip Hazard! Stay alert and be aware of potential trip hazards before working on equipment.*
3~	*Three Phase Alternating Current!*

	*Single Phase Alternating Current!*
	*On (Supply)*
	*Off (Supply)*
	*Protective Earth Terminal!*
	*Consult your technical manual before servicing equipment!*
 	*Hot Surface! Allow electronic power supply and lamps to cool before handling.* *Burn Hazard! Do not touch stainless steel equipment unless you are wearing protective gloves. Stainless Steel surfaces exposed to sunlight will become very hot and can cause burns!*

⚠	**CAUTION**
⚠	*Do not spray water in or around the Power Distribution Receptacles when lids are open.* *Do not use abrasive pads if manually cleaning quartz sleeves. Abrasive pads could scratch the sleeves and cause damage to the system* *If performing a manual cleaning of the quartz sleeve, ensure the sleeve is dry on the inside before assembling lamp assembly. Traces of wet alcohol could result in the formation of a coating after the lamps are turned on.* *Use only Trojan approved cleaning agents. Other cleaning agents are not recommended and their use could jeopardize disinfection or damage the system.*
	*Observe precautions when handling electrostatic sensitive devices.*

General Lockout Procedures

The following procedure is the minimum requirement. Additional precautions should be taken depending on site-specific protocols. Always check with the plant manager and senior electrician for additional precautions.

WARNING

Wear Eye Protection!

Wear UV Resistant Face Shield when working on or near the UV equipment.

WARNING

Hand Protection!

Wear proper gloves and clothing when servicing equipment.

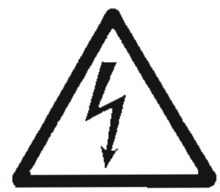
WARNING

Foot Protection!

Wear proper foot protection before entering a wastewater treatment plant.

Lock-Out and Tag Procedure

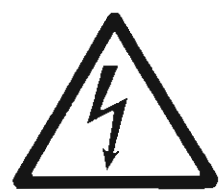
1. Locate and identify electrical supply to equipment. Identify specific breakers that service Trojan Technologies Inc. equipment. If you are unsure, contact plant electrician or maintenance personnel to locate correct electrical supply.



DANGER

Be aware that the panel may be fed from multiple sources!

2. While standing to the side of the electrical panel move the disconnect switch to OFF.
3. Attach your lock and safety tag to disconnect switch. Include your name, date and time, and work to be performed on tag.
4. Return to System Monitor and verify correct power source has been locked out.



DANGER

The equipment may have stored energy! Ensure that all parts have stopped moving and any stored capacitance has been effectively drained.

5. Proceed to work area and visually check to ensure equipment is OFF.
6. Double check with a multimeter at equipment that PDR's have been de-energized.
7. It is now safe to work on the system.

After Service Work Is Complete

1. Ensure all equipment is in OFF position.
2. Clear any tools or debris from work area.
3. Remove all lockout devices and tags.
4. While standing to the side of the electrical panel move the disconnect switch to the ON position.
5. Notify plant manager or site electrician that work is complete and system has been restarted.

List of Acronyms/Glossary

^{o}**C** – Degrees Celsius
^{o}**F** – Degrees Fahrenheit
~ - Single Phase Alternating Current
%T - percent Transmittance
#L - # Lamp (ie. 3L – 3 Lamp)
△ - Delta
ε - Edison
100%T - 100 percent Transmittance
3~ - Three Phase Alternating Current
3R - Type 3R
4 - Type 4
4X - Type 4X

A - Amps
AC - Alternating Current
ACK - Acknowledge
ALC – Automatic Level Controller
ANSI - American National Standards Institute
A/R - As Required
ASTM - American Society for Testing & Materials
Bar - Barometric Pressure
BSP - British Standard Pipe
CE - Conformitée Européenne (European Conformity)
CCB - Communications Control Board
cm - Centimeters
COMM - Communications
CPU - Central Processing Unit
CSA - Canadian Standards Association
c/w - Complete With
D - Disabled
DC – Direct Current
DNA - Deoxyribonucleic Acid
DP - Distribution Panel
DWG. - Drawing
E - Enabled
EC - E-Coli
EL. - Elevation
ELPD - Earth Leakage Protection Device
EMI - Electro Magnetic Interference
EOL - End of Life
EPA - US Environmental Protection Agency
EPDM - Ethylene-propylene-diene rubber
EPROM -Erasable Programmable Read Only Memory
Est. - Estimated
EXT - Extend
FC - Fecal Coliform
Ft. - Foot/Feet
FWP - Fixed Weir Plate
G# - Generation # (ie. G1 - Generation 1)
GND - Ground
GPD – Gallons / Day
gpm - US Gallons Per Minute
GUI - Graphical User Interface
Hp - Horsepower
Hrs - Hours
Hz - Hertz
in. - Inch(es)
in·lb- Inch pound
I/O - Input/Output
JIS – Japanese Industrial Standards
kPA - Killopascals
kVA - Kilovolt amps
kW – Kilowatts
kWh - kilowatt hours
Lb·ft - Pound Foot
LED - Light Emitting Diode
LOC - Local
LPM - Liters / minute
L/s - Liters / second
M - meters
mA - Milli Amp
MAX - Maximum
M^{3}/Day - Cubic Meters per Day
MCB - Module Control Board
MGD - Million Gallons / Day
mg/l - Milligrams per liter
MIN - Minimum
mJ/cm^{2} - Millijoules per squared centimeter
mL - Milliliters
MLD - Million Liters per Day
mm - Millimeters
MSDS - Material Safety Data Sheets
mW/cm^{2} - Milliwatts per squared centimeter
mWs/cm2 - Milliwatt seconds per squared centimeter
NO. - Number
nm - nanometer
N·m - Newton meter
NPT - National Pipe Thread
O&M - Operation and Maintenance
OEM - Original Equipment Manufacture
OI - Operator Interface
ph - Phase
PLC - Programmable Logic Controller
PPM - Parts per Million
PREV – Previous
PSi - Pounds per Square Inch
PSS - Point Source Summation
Qty. - Quantity
REM - Remote
RET - Retract
REV. - Revision
RCB - Relay Control Board

RNA - Ribonucleic Acid
SCADA - System Control and Data Acquisition
SCC - System Control Center
sec - Second
SPEC - Specification
SPSS - Single Point Source Summation Method
SST - Stainless Steel
Temp - Temperature
TC - Total Coliform
TSS - Total Suspended Solids
TVSS - Transient Voltage Surge Suppressor
TYP. - Typical
UI - User Interface
UPS - Uninterrupted Power Supply
UV3PTP - UV3000™PTP
UL – Underwriters Laboratory
UV - Ultraviolet
UVT - On-line UV Transmittance Monitor
V - Volts
VA - Volt amps
VAC - Volts Alternating Current
VDC - Volts Direct Current
w - Wire
w/ - With
W/o - Without
WL - Water Level
W/m^2 - Watts per meter squared
Y - Wye

Operator's Kit

An operator's kit is provided with each Trojan System UV3000PTP™ .The following items are included in the kit:

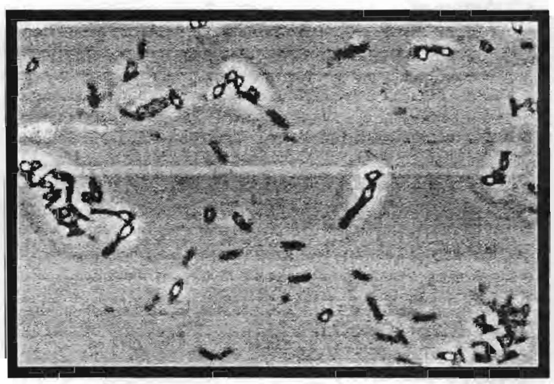
1. One clear UV face shield.
2. Four pairs of disposable vinyl gloves.

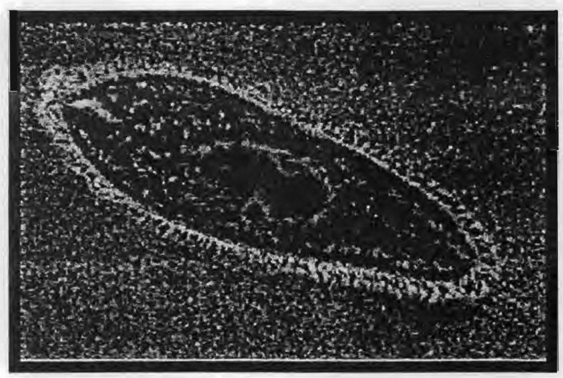
A Trojan approved cleaning agent is supplied with your TrojanUV3000™PTP System, but it is not included in the Operator's Kit.

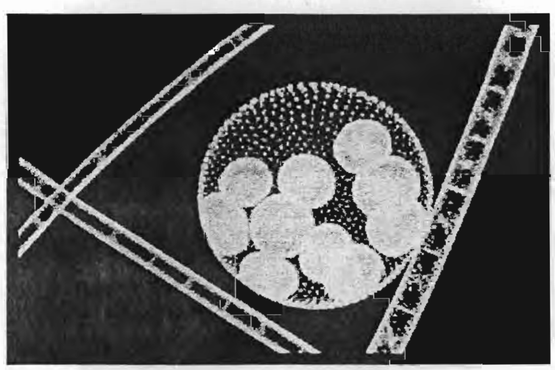
Material Safety Data Sheets

Chapter 1

INTRODUCTION TO UV THEORY







1 Introduction To UV Theory 1-1

1 INTRODUCTION TO UV THEORY

1.1 What Is Ultraviolet Light?

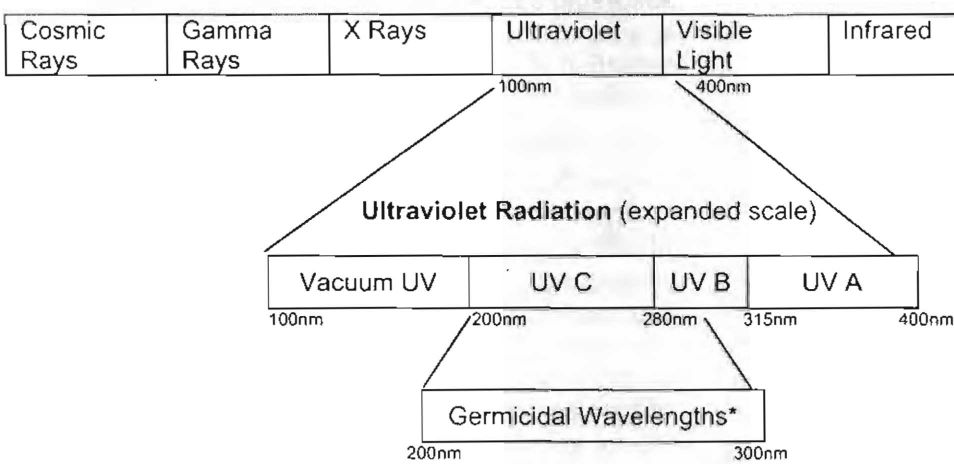
Ultraviolet (UV) light is the portion of the electromagnetic spectrum with wavelengths between 100 and 400 nanometers (nm). Germicidal wavelengths are located in the spectral region of 200nm to 300nm. The low-pressure mercury lamp radiation is essentially monochromatic with its output at 253.7nm. The medium-pressure mercury lamp is polychromatic with germicidal output spread over different wavelengths.

1.3 How Does UV Light Disinfect?

Microorganisms are inactivated by UV light as a result of photochemical damage to nucleic acids.

Cellular RNA and DNA absorb the high energy associated with short wavelength UV radiation. The absorption of UV energy, most strongly in the wavelength range of 240 to 280nm, results in the formation of new bonds between adjacent nucleotides, creating doubled structures or dimers in the nucleic acid. Dimerization of adjacent pyrimidines, particularly thymine in the case of DNA, is the most common photochemical damage. Formation of numerous thymine dimers in the DNA of bacteria and viruses prevents replication and results in cell death.

Electromagnetic Spectrum



*Peak effectiveness approximately 260-265nm

1.2 Disinfection vs. Sterilization

Disinfection is the reduction of pathogens (disease causing microorganisms) to non-infectious levels, whereas sterilization is the total inactivation of all living cells and viruses.

The amount of cell damage depends on the dose of UV energy absorbed by the microorganisms and their resistance to UV. Most bacteria and viruses require relatively low UV doses for inactivation. In general, bacteria are more sensitive than viruses, and the protozoan parasites *Cryptosporidium* and *Giardia* are more sensitive to UV than most bacteria. Gram-negative bacilli are more sensitive than gram-positive cocci and bacterial spores.

1.4 Factors Affecting UV Disinfection

The UV dose delivered by a disinfection system is a product of UV intensity (milliwatts per square centimeter) and retention (exposure) time in seconds:

UV Dose = Intensity X Time

The units of dose are milliwatt seconds per square centimeter (mW.s/cm^2) or millijoules per square centimeter (mJ/cm^2).

"UV intensity" is affected by:

- wastewater quality,
- microbial inactivation kinetics,
- equipment/lamp configuration, and
- lamp age and sleeve fouling.

Temperature and pH do not affect UV disinfection.

Wastewater Quality

Common wastewater parameters that impact UV intensity are:

- UV Transmittance (%T), resulting from the presence of UV-absorbing organic and inorganic compounds (e.g., nitrate, iron).
- Total suspended solids (TSS) or more correctly, the characteristics of the particles that make up the TSS such as:
  - particle size distribution,
  - the number of particles in each size range,
  - particle optical properties.

UV Transmittance

UV Transmittance (UVT or %T) is a measure of the ability of the wastewater to transmit UV light. It is both a measure of water quality and an important design factor for sizing UV equipment.

Wastewater, with a higher UVT, requires less UV energy input to disinfect. Reduced transmittance in wastewater effluent results in a lower UV intensity delivered through the effluent. The absorption of UV by the water is sometimes referred to as UV demand. Since UV dose = Intensity X Exposure Time, a reduced intensity due to water absorption of UV can be compensated for by increasing the retention time, increasing the number of lamps in the reactor, or increasing the lamp intensity (by increasing power to the lamps or changing to more powerful lamps).

UV Transmittance is measured with a UV spectrophotometer set at a wavelength of 254nm. The transmittance of a sample in a one-centimeter path length quartz cuvette is read as a percentage compared to pure water (set at 100%). A 60% UVT means that the intensity entering the cuvette has fallen to 60% of that value in passing through one centimeter of sample water.

Transmittance decreases in the presence of UV absorbing substances and particles that either absorb or scatter UV light. This results in a reduction of available UV energy for disinfection.

Wastewater transmittance also depends on the concentration of industrial process waste relative to the total plant flow. Industries that influence UV transmittance include textile, printing, pulp and paper, food processing, meat and poultry processing, photo developing, and chemical manufacturing. The presence of UV-absorbing particles, dissolved organics and inorganics in the wastes of these industries will reduce transmittance.

Treatment process chemicals can also influence UVT. Wastewater treatment processes may use metal salts for enhanced solids removal, phosphate reduction and odor control. Dissolved aluminum salts have no effect on UV transmittance, and flocculated solids containing aluminum do not show an increased resistance to UV disinfection relative to similar particles without aluminum.

Iron in water absorbs UV directly, fouls sleeves, and provides a protective shield by adsorption onto suspended solids and bacterial clumps. Increased resistance to UV is experienced when there are increased amounts of iron associated with solids.

Wastewater transmittance depends on upstream treatment processes. In general, suspended growth processes produce effluents with transmittances that range from 60% to 65%. Fixed film processes range from 50% to 55%T and lagoons from 35% to 45%T.

Total Suspended Solids (TSS)

The Total Suspended Solids are composed of bacteria-laden particles of varying number and size. The solids enclose the interior bacteria, making it more difficult for UV or chemicals to disinfect wastewaters with higher levels of TSS. High TSS wastewaters generally also have larger particles that are more difficult to disinfect. In addition, increased iron content in the solids can result in shielding or protection of bacteria from UV. The protection by particles is directly related to the number, distribution of sizes, bacterial density, and chemical composition of the particles. Particles also reduce UV intensity in an effluent by absorbing and scattering UV light. These factors contribute to an increased UV demand in wastewater.

The measurements of particle size distribution in wastewater effluents are used to indicate filter and clarifier performance. Typically, particle sizes are related to the type of upstream wastewater process. Sedimentation and filtration result in a decrease in both the number and mean size of particles. Smaller particles are generally easier to disinfect unless they are laden with iron or otherwise optically dense.

Microbial Inactivation Kinetics - The UV Dose Response Curve

As shown in the below figure, low UV doses typically produce a rapid decrease in bacteria numbers. The linear relationship of log (surviving microbial counts) versus UV dose is typical first-order kinetics.

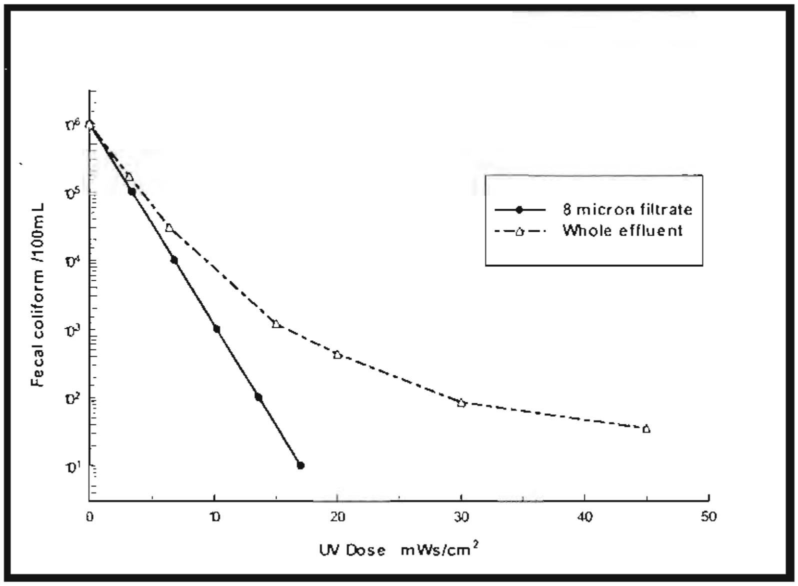
At higher doses a deviation or tailing occurs due to shielding of microbes within particles. The particles provide protection to microbes so that higher UV doses are required to penetrate and kill all the bacteria within the particles.

There is a bacterial density beyond which additional inactivation cannot be economically achieved. This is because some of the particles are large, or so opaque to UV that sufficient UV dose cannot be delivered to the most internal bacteria in these particles to cause inactivation. Surviving bacteria in a particle result in one microbial count for that particle when microbiological counts are performed. There is a diminishing return to applying additional dose due to the very slow accumulation of dose by these core microbes.

In such cases, alterations in up-stream processes that significantly improve effluent quality will have the added benefit of decreasing the UV dose required to achieve a desired disinfection limit.

Sedimentation and filtration result in a decrease in TSS levels, (decreased particle sizes and numbers). The figure shows that the result of filtration is a decrease in the UV dose required to achieve a given disinfection target.

Typical UV Dose-Response Curve for Filtered and Unfiltered Wastewater



UV Equipment Configuration

The UV reactor is configured to optimize the number of UV lamps required to provide a specific dose in the water quality being treated, and for the required hydraulic capacity. Optimal equipment configuration will produce adequate turbulent flow (mixing) and minimal headloss.

Lamp spacing is selected to control the water layer around the quartz sleeve and to provide the optimum average intensity for the water quality being treated and the headloss limitations.

Lamp Age and Sleeve Fouling

UV intensity gradually decreases with time and use due to lamp aging and sleeve fouling. This is factored into the design, so that equipment will maintain the required UV dose throughout the life of the UV lamps.

For proper performance, UV lamps should be replaced after the specified lamp life in the warranty.

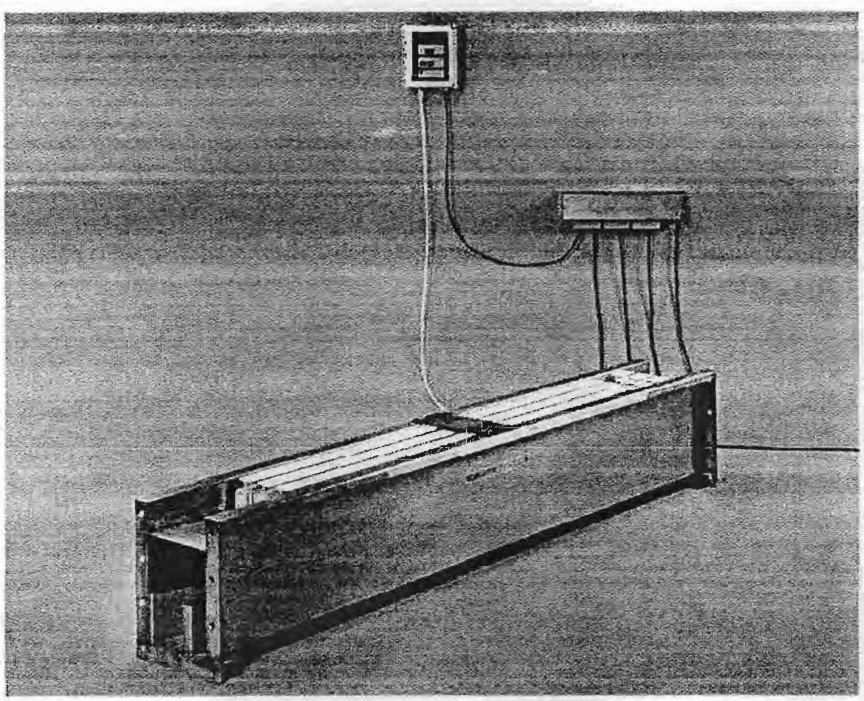
Lamp life depends on the number of ON/OFF cycles used for flow pacing during disinfection. Uniform intensity in a system can be managed with a staged lamp replacement schedule.

An accumulation of inorganic and organic solids on the quartz sleeve decreases the intensity of UV light that enters the surrounding water. The fouling rate varies with process and effluent types and may be more rapid in the presence of high concentrations of iron, calcium and magnesium ions.

Some Trojan systems have an Automatic Cleaning System option that combines chemical and mechanical cleaning and significantly reduces operator maintenance time.

Chapter 2

SYSTEM OVERVIEW



2 SYSTEM OVERVIEW

2.1 Models and Variations

Trojan UV3000™PTP configurations vary depending on site requirements and system model selected. Refer to the following chart for applicable model and variations.

TrojanUV3000™PTP Model	Variations
K Models	- Stainless Steel Channel - Single Bank - Standard Flow - Level Control Weir located in channel
K-1 Models	- Poured Concrete Channel (By Others) - Single Bank - Standard Flow - Level Control Weir without flared channel
D____K Models	- Stainless Steel Channel - 2 Banks (in series) - Double the Standard Flow - Level Control Weir located in transition box
D____K-1 Models	- Poured Concrete Channel (By Others) - 2 Banks (in series) - Double the Standard Flow - Level Control Weir with flared channel

2.2 System Components

The Trojan UV3000™PTP is simple to monitor, service, and operate; yet it is reliable and technologically advanced.

Note:	***The Trojan UV3000™PTP is designed to be turned "ON" and left "ON". Do not alter this system to allow for module or bank cycling.***

The Trojan UV3000™PTP is made up of several components:

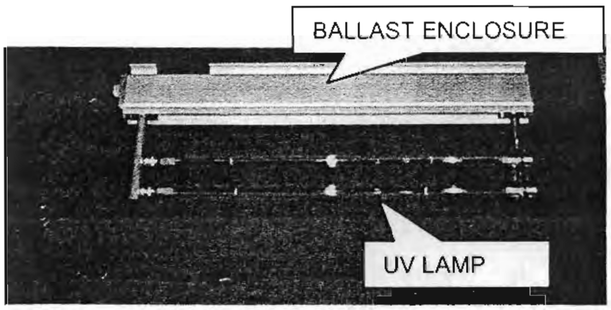
- UV Module including:
  - UV Lamps
  - Quartz Sleeves, Springs, Spacers
  - Lamp Holder Seal Assembly
- UV Channel options:
  - Stainless Steel Channel (Type K Models only)

    or

  - Concrete Channel by others (Type K-1 Models only)
- Transition Boxes (optional when stainless steel channel is used)
- Turn Box (optional for Type K and D___K Models only)
- Power Distribution Receptacle
- Monitoring System UV Sensor (optional)
- Level Control Weir
- UV Module rack (included with Stainless Steel Channel)

UV Module

The UV module is the basic unit of the flow-through UV bank. A bank is made up of UV modules placed in parallel within a single channel. The module/bank configuration is determined by Trojan based on relevant information collected from the site.



UV modules consist of a 316 stainless steel frame that holds the high-intensity UV lamps in position, and houses all connecting wires, in a watertight ballast enclosure.

UV Lamps

Trojan supplies 36 and 64 - inch long UV lamps. The UV output after one year is approximately 80% of the output after the 100 - hour burn-in period. It should also be noted that frequent cycling shortens the life of the lamps.

Quartz Sleeves, Springs, Spacers

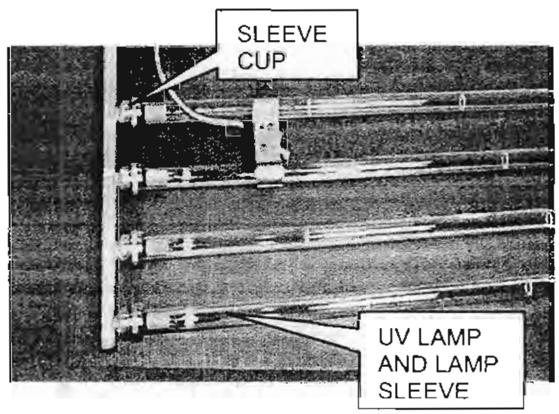
The quartz sleeves are made out of Type 214 clear fused quartz circular tubing. They are rated for UV Transmittance of 89% and are not subject to solarization.

The sleeves protect the lamps from breakage and in conjunction with the spacer rings they provide insulation. This assures minimum lamp temperature variations, which could affect the lamps performance.

The spring at the closed end of the sleeve pushes the lamp against the lamp holder (at the opposite end of the lamp) to provide good electrical contact.

Lamp Holder Seal Assembly

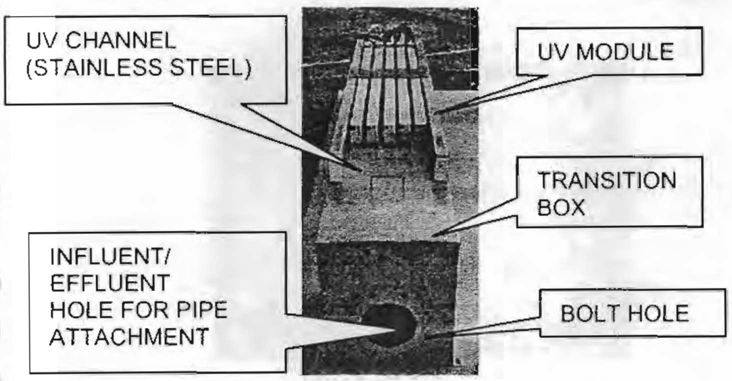
The open end of the lamp sleeve is sealed by means of a stainless steel type 316 sleeve nut which threads onto a sleeve cup and compresses the sleeve o-ring. The knurled surface of the sleeve nut allows a positive handgrip for tightening; it does not require any tools for removal.The lamp is held in place by means of the molded lamp holder, which incorporates a triple seal. The lamp holder seals against the inside of the quartz sleeve to act as a second seal in series with the external o-ring seals. Another seal on the lamp holder isolates and seals the lamp from the module frame and all other lamps in the module.



In the event of a quartz sleeve fracture, the seals of the lamp holder prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

Stainless Steel Channel Option (Type K Models Only)

The stainless steel channel is typically made out of 14 gauge stainless steel and comes complete with drain, UV module support rack and downstream serpentine weir.



Due to variations in effluent quality and flow characteristics, debris tends to settle at the bottom of the channel.

The channel (and transition boxes, if provided) should always be thoroughly cleaned after any plant upset.

Concrete Channel Option (Type K-1 Models Only)

For some TrojanUV3000™PTP systems a poured concrete channel (by others) rather than a Trojan supplied stainless steel channel may have been selected.

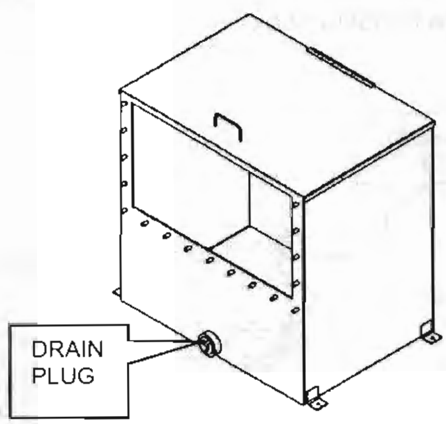
Note:	*Poured concrete channels are required when a stainless steel channel is not provided. Trojan does not recommend that concrete be poured around a* TrojanUV3000™PTP *stainless steel channel, Transition or Turn Box.*

For installations with a concrete UV channel, stainless steel channel(s) and transition boxes will not be provided. UV module racks and level control weirs will need to be installed by others.

Refer to the following table for reference on models that are available for a concrete channel installation.

TrojanUV3000™PTP Model	Stainless Steel Channel & Transition Boxes provided (K Models)	Concrete channels provided by others (Stainless Steel Channel & Transition Boxes not provided) (K-1 Models)
3025 – 3300 & D3025 – D3300	✓	N/A
3400 to 3001 & D3400 to D3001	✓	✓

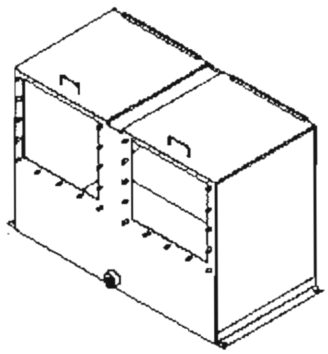
Transition Boxes (Type K Models Only - optional)



For installations where a stainless steel channel is used, optional Transition Boxes can be provided for each end of the stainless steel channel.

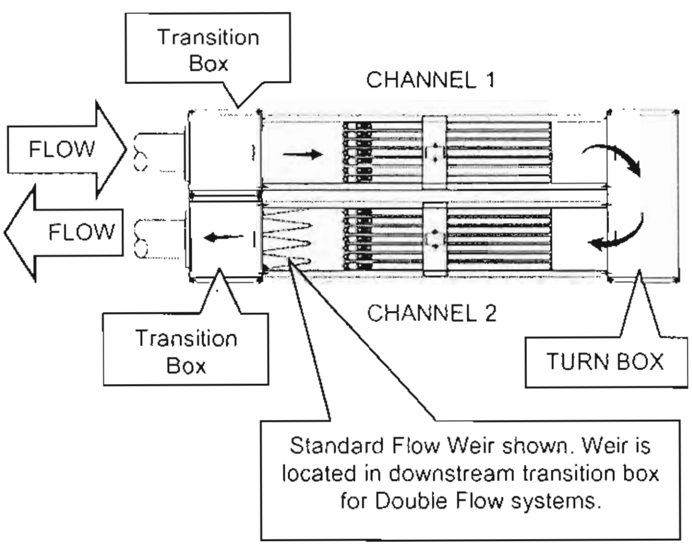
Transition boxes are designed to provide transition between the UV channel and flanged inlet and outlet pipes. The inlet transition box helps to ensure a plug flow condition that is conducive to more efficient disinfections. The transition boxes should be subjected to the same periodic maintenance as the channel.

Turn Box (Type K Models Only - optional)



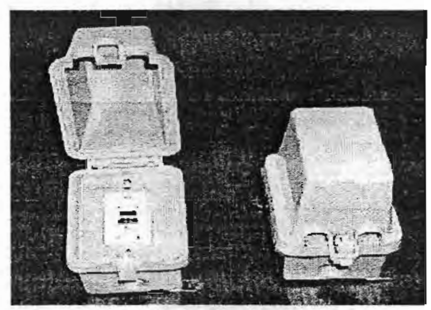
A stainless steel turn box is provided to connect two channels in a U-shape configuration. This is an optional configuration for all Stainless Steel Models (both standard and double flow).

Effluent flow enters the upstream transition box, passes through the first channel, enters the turn box where the flow is reversed 180°, passes through the second channel, to exit through a downstream transition box. Refer to details below.



Power Distribution Receptacle (optional)

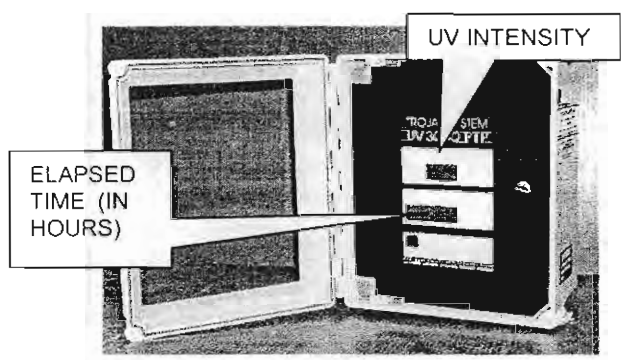
The PDR consists of duplex ground fault interrupter receptacle that can be mounted in a location which allows convenient hook-up of UV Modules. The PDR is provided with a weatherproof cover. However, direct water sprays should be avoided.

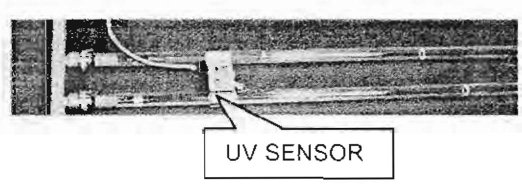


Monitoring System UV Sensor (optional)

The submersible UV Sensor measures the UV intensity within each bank of UV lamp modules.

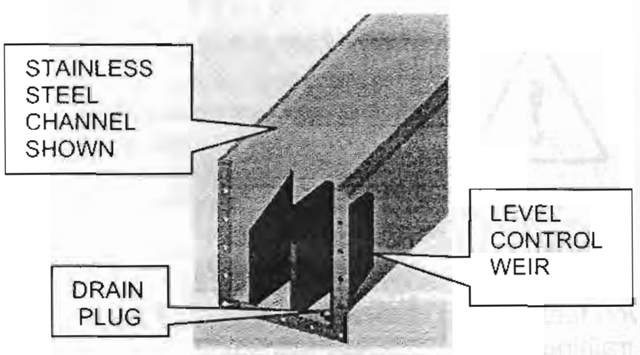
The UV Sensor is mounted on a representative UV lamp module.The UV Sensor is calibrated in the factory and should not be altered, or its calibration changed.





Level Control Weir

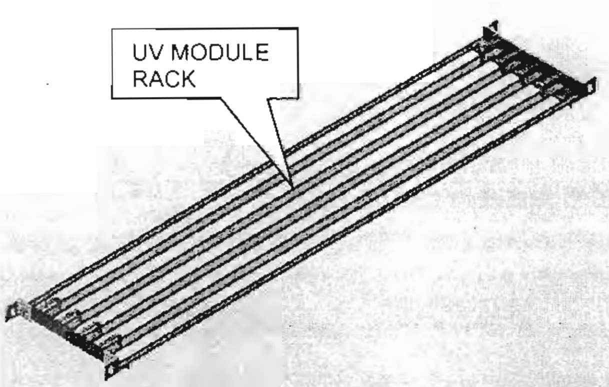
A water level control weir controls the effluent level within the UV channel. Depending on the TrojanUV3000™PTP model provided and its configuration, the level control weir will be preinstalled in either the stainless steel channel or transition box or ready to install in a concrete channel by others if a stainless steel channel and transition boxes are not supplied.



(Type K Shown) Weir configuration and location may differ depending on UV System configuration.

UV Module Rack

The UV Module Rack is a stainless steel support frame, which supports each bank of UV modules. For stainless steel channel installations, the rack comes welded in place to the inside of the channel. For concrete channel installations, a stainless steel support rack will be provided for bolting into the channel by others.



2.3 Maintenance Summary

Do not undertake operation, repairs or maintenance of equipment unless you are familiar with the operation and servicing of technical equipment and are trained in electrical and mechanical safety.

	CAUTION
⚠	*If you do not completely understand any of the information or procedures in this manual, call your local Trojan Representative or Trojan Technologies Inc. for assistance.*

If you feel you are not competent in your level of training, skill or comprehension of this manual's instructions, have the work done by a qualified operator or a Trojan Certified Service Representative. Common sense and good judgment are crucial to safe and successful operation and maintenance of the equipment.

- Read the Warnings and Precautions section and the General Lockout Procedure before operating or performing any maintenance on this equipment.
- Read the procedures thoroughly before starting.
- Review the Warnings and Cautions that accompany the procedures each time you prepare to perform maintenance on the TrojanUV3000™PTP.

2.4 Maintenance Log

Each plant is responsible for maintaining the equipment Maintenance Log. The Maintenance Log documents all maintenance activity performed on the TrojanUV3000™PTP. A copy of a log will have been provided to your plant on the day of the initial startup.

Note:	*Failure to maintain this Maintenance Log will void system warranties.*

For maintenance procedures concerning individual components, see the applicable chapter.

A copy of your maintenance log may be requested to process warranty claims.

Regular Checks

Regular system monitoring will be an internal requirement at each site. Check the system component maintenance routines as outlined in this manual.

2.5 Introducing Troubleshooting

Do not undertake operation, repairs or maintenance of equipment unless you are familiar with the operation and servicing of technical equipment and are trained in electrical and mechanical safety.

⚠	**CAUTION** *If you do not completely understand any of the information or procedures in this manual, call your local Trojan Representative or Trojan Technologies Inc. assistance.*

If you feel you are not competent in your level of training, skill, or comprehension of this manual's instructions, have the work done by a qualified operator or a Trojan Certified Service Representative. Common sense and good judgment are crucial to safe and successful operation and maintenance of the equipment.

- Read the Warnings and Precautions section and General Lockout Procedure before operating or performing any maintenance on this equipment.
- Read the procedures thoroughly before starting.
- Review the Warnings and Cautions that accompany the procedures each time you prepare to perform maintenance on the TrojanUV3000™PTP.

For more information, see the Trouble Shooting Guide Chapter in this manual.

2.6 Replacement Parts List

How to Order Replacement Parts

To order replacement parts, contact your local Trojan Representative or Trojan Technologies Inc. To access information to your local Trojan Representative, or Trojan Technologies Inc., please visit www.trojanuv.com, and review the service& support segment.

Be prepared to provide the following:

- Model number and Serial number from front of O & M.
- Part number and part location.

Note:	*If the replacement part does not appear on the list below, call your local Trojan Representative or Trojan Technologies Inc.*

The following list applies to common replacement parts for the TrojanUV3000™PTP.

Note:	*For System Monitor replacement parts, contact your local Trojan Representative or Trojan Technologies Inc.*

Part Description	Part Number	Location
Operator's Kit Complete (Face shield/ Disposable Gloves)	906015-320	Optional Equipment and Parts
Face Shield	906002	
Lime-A-Way (Minimum Purchase 4 – 4 Litre Containers)	901286	
UV Module 2 Lamp 36" Long	308021	
UV Module 2 Lamp 64" Long	308022	
UV Module 4 Lamp 64" Long	308023	
Models # 3025K to # 3075K Use 34" lamps and 900 mm Domed sleeves		
Models # 3100K to # 3001M Use 64" lamps and 1610 mm Domed sleeves		
UV Lamp 34" Long UV3614 (Package of Four)	302417-004	
UV Lamp 64" Long UV6414 (Package of Four)	302418-004	
Quartz Sleeve 900mm Domed (Package of Four)	302108-004	
Quartz Sleeve 1610mm Domed (Package of Four)	302208-004	
Ballast 120v/60 Hz	302403	
LED Module Circuit Board (MCB) For 2 Lamp UV Module	308012	
LED Module Circuit Board (MCB) For 4 Lamp UV Module	308011	
Power Cord	308195	
Sleeve Cup Nut	302312	
Lamp Holders/Seal Socket Assembly	316018	
O-Ring Sleeve Support	302314	
O-Ring Sleeve Seal	302300	
Monitor Assembly (includes UV Sensor)	321159	Monitoring System
Monitor Enclosure Assembly	308799	
UV Sensor Assembly – 20ft	015200	
UV Sensor Bracket Kit	015306	
Monitoring System Circuit Board	308772	
Power Distribution Receptacle Assembly	308162	Power Distribution Receptacle (PDR)
Ground Fault Circuit Interrupter	261125	
Receptacle Enclosure	306337	

Note:	*Using non-approved replacement parts in your UV system may affect the equipment reliability and void both the original warranty and performance guarantee. Please contact your local representative referenced under the prefix of this manual for details on pricing and availability.*

Chapter 3

EQUIPMENT HANDLING AND STORAGE INSTRUCTIONS

3 Equipment Handling and Storage Instructions 3-1

3 EQUIPMENT HANDLING AND STORAGE INSTRUCTIONS

3.1 Handling Instructions

The TrojanUV3000™PTP is typically delivered to the site by truck. The components of the system are packed in wooden crates. A forklift may be used to unload these crates.

The wooden shipping crates are labeled with the component name and symbols showing a glass to indicate fragile and an umbrella to indicate that the crates and their contents should be kept dry.

The TrojanUV3000™PTP is usually shipped in one crate depending on the size of the system and optional equipment provided. For larger systems, transition boxes (if required) and cleaning racks (if required) will be crated separately.

Do not unpack the equipment until ready for installation.

Complete crates weigh from 375lbs (170kg) to 1015lbs (460kg) depending on the system size. The Monitor System weighs 15lbs (6.8kg).

	CAUTION
⚠	*Do not stack or top load the shipping crates.*

Read the following instructions that list the proper removal procedure for each component and how they are shipped.

If transportation of the UV equipment between the storage location and the installation location is required, a flatbed truck is to be used, and the equipment must be properly secured. Use proper loading and unloading procedures to load and unload equipment from the flatbed.

Note:	*Improper handling of equipment during removal from flatbed may result in a void of warranty.*

Module Rack and Modules.

- Shipped together.
- Shipped with stainless steel UV Channel (optional)
- Mass dependent upon system configuration. See Submittal manual for specific weights.
- The channel with module rack and module is to be lifted using a four point lifting sling and a stationary overhead crane for channel placement. Smaller systems can be lifted by hand.
- When no channel is provided, rack and modules can be lifted using a 4-point, lifting sling.

System Monitor (if applicable)

- Care should be taken not to dent or mark the monitor.
- Weighs 15 lbs (6.8kg)

Power Distribution Receptacle (PDR)

- Shipped in same crate as the module rack and modules.
- Mass dependent upon system configuration. See Submittal manual for specific weights.

Optional Equipment

- Cleaning rack shipped in a separate crate.
- UV Photometer is an industrial control system housed in a panel. Care should be taken not to dent or mark the panel.
- It is recommended that equipment be unpacked just prior to mounting and that there be minimal handling of the equipment after unpacking.

Spare Parts

- Mass dependent upon system configuration. See Submittal manual for specific weights.
- Depending on size and number of spare parts, they could be shipped in a separate crate.

3.2 Equipment Storage

Trojan Technologies Inc. recommends indoor storage of the TrojanUV3000™PTP equipment. The equipment should be stored in a dry warehouse. Heating is not necessary during storage. However, prior to system start up the equipment must be warmed to an ambient minimum temperature of 60°F (15°C).

Storage volume is estimated to be 300 cubic feet or 10 cubic meters. Storage will depend on size of the system.

If indoor storage is not possible, the UV Modules, PDR, Channel (if applicable), transition boxes (if applicable), and cleaning equipment (if applicable) may be stored outdoors under the following conditions:

- Equipment is stored on high ground that is not susceptible to flooding.
- Equipment is elevated a minimum of 6 inches (150 mm) above the ground, or as appropriate to avoid wet conditions.
- Equipment is completely covered with waterproof tarps to prevent exposure to the elements (i.e. rain, snow, sand, etc.).

Note:	*Tarps should be tight fitting, fastened securely, and inspected weekly to ensure the equipment is properly covered and protected.*

All other equipment including the System Monitor, and UV Photometer (if applicable), and spare parts should be stored as follows:

- In a dry warehouse.
- Heating is not necessary. Prior to start up, however, the equipment must be warmed up to an ambient temperature of 60°F (15°C) minimum.

Chapter 4

INSTALLATION PROCEDURES

4 INSTALLATION PROCEDURES

4.1 General Installation Instructions

Note:	*Not all the information in this section applies to your TrojanUV3000™PTP as systems vary. Installation instructions appear on the following pages.*

Note:	*The dimensions and location of the system components may vary.*

The TrojanUV3000™PTP is straightforward to install. No special tools are required other than those used in the day-to-day operation of a mechanical and electrical contracting firm. An appropriately sized crane may be required for off loading and installation of the unit. Size is dependent upon each project configuration.

Installation of the TrojanUV3000™PTP varies depending on site conditions and the system model provided. Refer to following installation procedures found in this chapter, and follow the one most applicable to the equipment provided:

- 4.2 - Stainless Steel Channel Installation (W/out Turn orTransition Boxes)
- 4.3 - Stainless Steel Channel Installation (c/w Transition Boxes)
- 4.4 - Stainless Steel Channel Turn Box Installation Option
- 4.5 - Concrete Channel Installation

The following general steps are to be followed by the contractor.

- For installation where Stainless Steel Channels will not be used, a Concrete UV Channel is to be poured by others according to the dimensions specified on the drawings supplied by Trojan Technologies Inc. or by others.
- Necessary equipment interconnections need to be allowed for prior to pouring the concrete pad (if applicable), as identified in the drawings supplied by Trojan Technologies Inc. or by others. There are no special requirements beyond that required for a typical electrical panel (electrical service, communication, etc.)

4.2 Stainless Steel Channel Installation Option (W/out Turn or Transition Boxes)

This procedure is for installations where a stainless steel UV Channel has been provided without Transition or Turn boxes.

Note:	*Before installing the channel, remove the UV Modules from the channel. Store them in a safe place.*

1. Bolt downstream flange (weir side of the channel) to the plate prior to discharge. Connection of the channel flange and plate prior to discharge must be water tight sealed.
2. Use supplied gasket and apply outdoor sealant between gasket and flange surfaces.
3. Support channel in two places (UV3025K - UV3075K) or in three equally distant places (UV3100K - UV3001M).

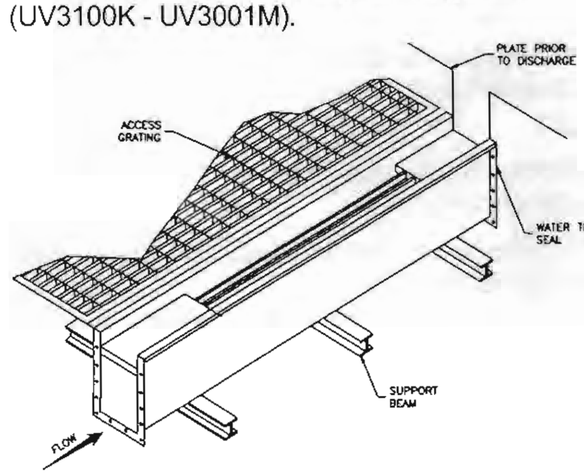


Figure 1

CHANNEL BOLTED TO PLATE PRIOR TO DISCHARGE

4.3 Stainless Steel Channel Installation Option (c/w Transition Boxes)

This procedure is for installations where a stainless steel UV Channel has been provided with Transition Boxes.

Note:	*Before installing the channel and optional Transition Boxes, remove the UV Modules from the channel. Store them in a safe place.*

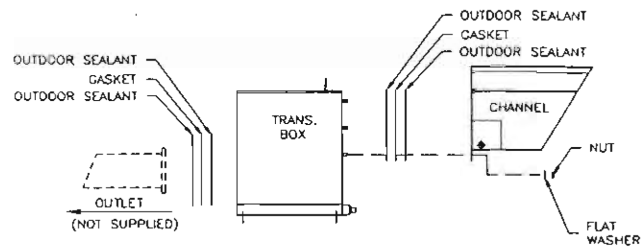
Note:	*For some installations a Turn Box may be used. For installations where a Turn Box is used note the following:* *Refer to Figure 4.4 Stainless Steel Channel Installation Option(c/w Turn Box and Transition Boxes) for installation details.*

Note:	*Poured concrete channels are required when a stainless steel channel is not provided. Trojan does not recommend that concrete be poured around a TrojanUV3000™PTP stainless steel channel, transition or turn box.*

1. Make sure the channel flange and Transition Box flange connection surfaces are clean and dry.
2. Apply outdoor sealant between the gasket and flange surfaces.
3. Assemble channel and Transition Boxes. (See Figures 2 and 3).

Figure 2

ASSEMBLY OF TRANSITION BOX AND CHANNEL



4. If a Turn Box has been supplied to connect multiple channels, follow procedure 4.4 Stainless Steel Channel Turn Box Installation Option. For installations without a Turn Box, proceed to next step.
5. Tighten channel flange, gasket and Transition Box together using hardware provided. A channel with Transition Boxes forms a self-supporting structure, which is bolted to the concrete slab through bottom angles of Turn Box and Transition Boxes.

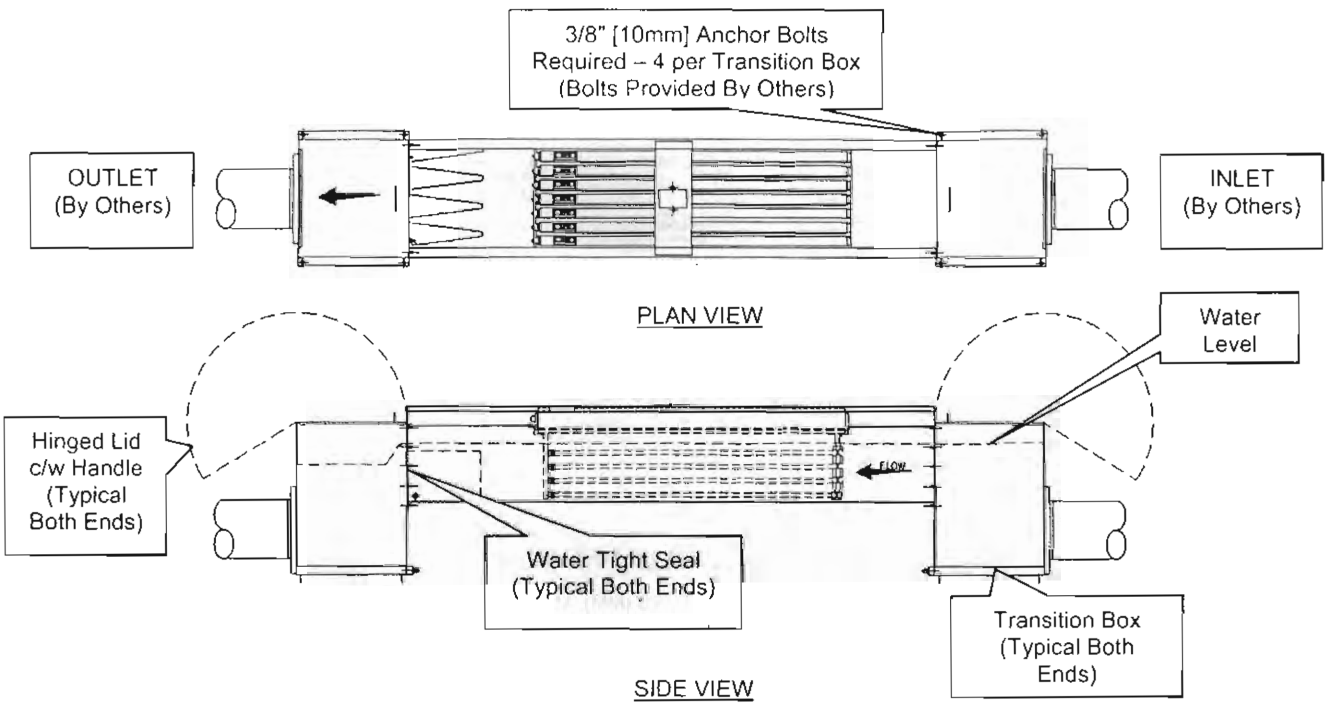
Note:	*The recommended torque for bolting the channel to the transition and the pipe flange to the transition box is 55 inch lbs.*

6. Connect round flange to Transition Box. Use suitable gasket and outdoor sealant.
7. Bolt channel down on slab with Transition Boxes. (See Figure 3). For installations with Turn Boxes refer to following pages for Figure 7.

Refer to Figure 3 found on following page.

Figure 3

STAINLESS STEEL CHANNEL C/W TRANSITION BOXES



8. Ensure the channel is level with a tolerance of ¼"(6mm) at either end. (See figure 4).

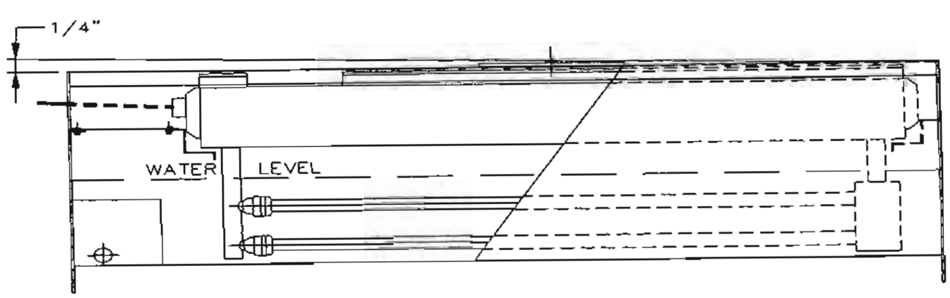


Figure 4

9. Ensure that the weir is in a free discharge at peak flow. Minimal distance (dimension FD) is shown in Figure 5.
10. Ensure correct water level heights (dimension HD) as shown in Figure 5.
11. Insert UV Modules back into the channel and plug them into suitable outdoor outlet.

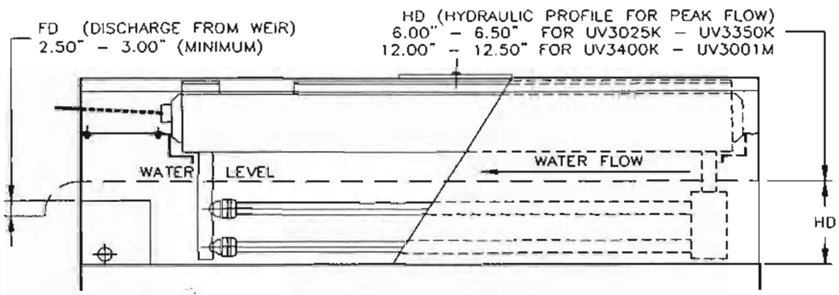


Figure 5

FREE DISCHARGE AND HYDRAULIC PROFILE VERIFICATION

(TO CONVERT INCHES TO MILLIMETRES (MM), MULTIPLY BY 25.4))

4.4 Stainless Steel Channel Turn Box Installation Option

This procedure is for installations where stainless steel UV Channels have been provided with a Turn Box.

Note:	*Before installing the channel and optional Transition Boxes, remove the UV Modules from the channel. Store them in a safe place.*

Note:	*Turn Boxes do not require connection to a pipe flange.* *Turn Boxes are connected to the UV Channel and mounted the same as Transition Boxes.*

Note:	*Poured concrete channels are required when a stainless steel channel is not provided. Trojan does not recommend that concrete be poured around a TrojanUV3000™PTP stainless steel channel, transition or turn box.*

1. If not complete, follow procedure 4.3 Stainless Steel Channel Installation Option (c/w Transition Boxes) before proceeding.
2. Make sure Turn Box flange surfaces are clean and dry.
3. Apply outdoor sealant between the gasket and flange surfaces.
4. Assemble channels and Turn Box (see Figures 6 and 7 on next page.

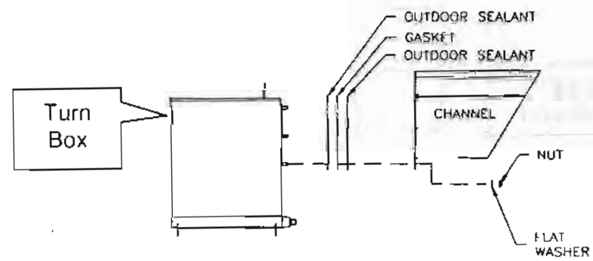


Figure 6

ASSEMBLY OF TURN BOX AND CHANNEL

5. Tighten channel flanges, gaskets and Turn Box together using hardware provided.

Note:	*The recommended torque for bolting the channel to the turn box is 55 inch lbs.*

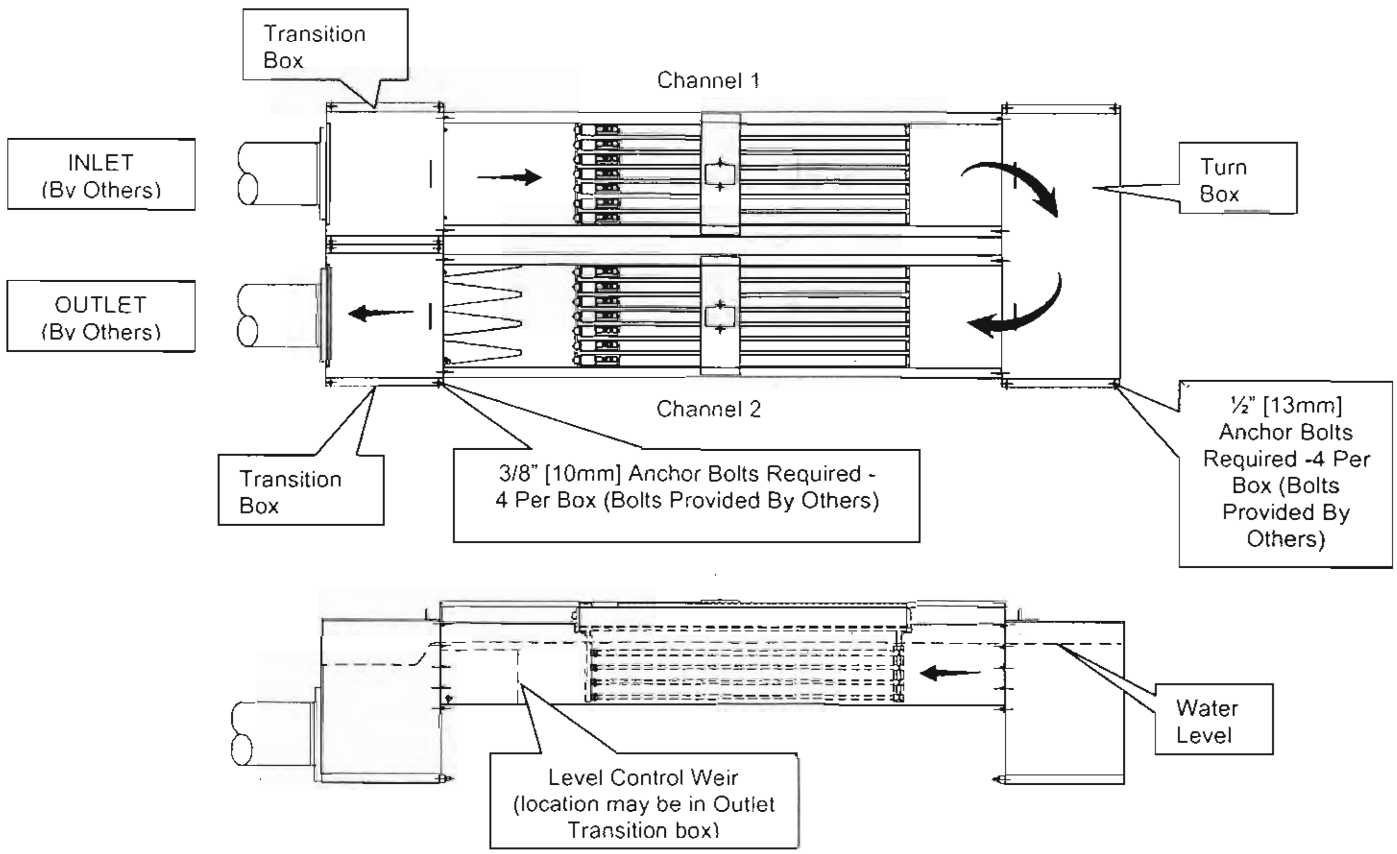
6. Return to procedure 4.3 Stainless Steel Channel Installation Option (c/w Transition Boxes) and follow steps 5-14 to complete installation instructions.

Refer to Figure 7 found on following page.

Figure 7

STAINLESS STEEL CHANNEL C/W TRANSITION BOXES AND TURN BOX

(Plan View and Side View)



4.5 Concrete Channel Installation Option

Note:	*Poured concrete channels are required when a stainless steel channel is not provided. Trojan does not recommend that concrete be poured around a TrojanUV3000™PTP stainless steel channel, transition or turn box.*

For 3400k-1, 3600K-1, 3800K-1 and 3001K-1 TrojanUV3000™PTP models, stainless steel channels and transition boxes are not provided. UV Module Racks and Level Control Weirs are to be installed by others in a poured concrete channel also by others. For details, follow the procedure below.

1. Secure UV rack to channel walls with 3/8" (10mm) anchor bolts. The center-line of the anchor bolt should be mounted 15 3/4"(400mm) from channel floor.
2. Verify correct height of rack install UV modules. The dimension from the bottom of the channel to the top of the top quartz sleeve should be 11"(279mm). An additional reference dimension is from channel floor to center of first lamp of 1 1/2"(38mm)
3. Anchor level control weir to channel floor and walls with 3/8"(10mm) anchor bolts. Grout around all outside edges to ensure a watertight seal.

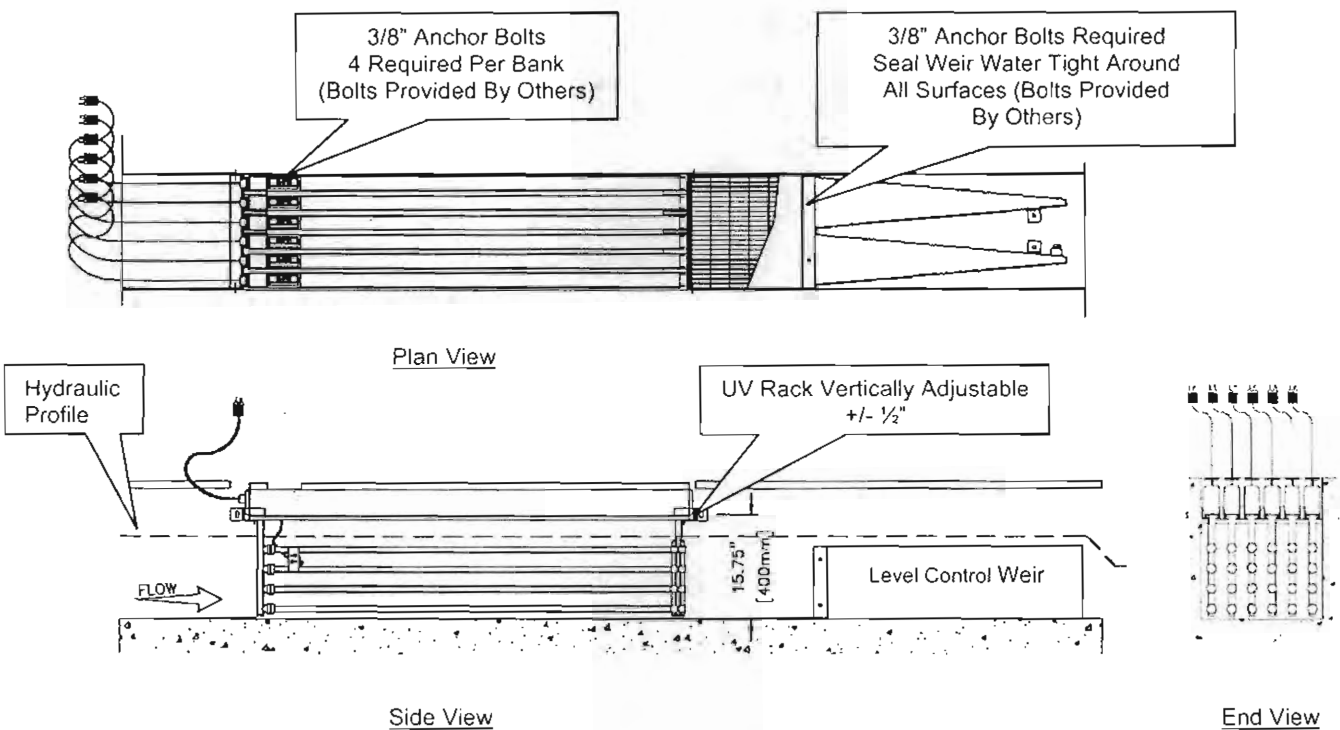


Figure 7

CONCRETE CHANNEL INSTALLATION

(TO CONVERT INCHES TO MILLIMETRES (MM), MULTIPLY BY 25.4))

4.6 Power Distribution Receptacle - PDR (optional)

The UV module power cords fasten to the respective receptacles on the optional PDR. The power cords from the UV Sensor plug into the optional System Monitor.

4.7 Equipment Interconnections

The TrojanUV3000™PTP interconnections are shown in the drawings supplied by Trojan Technologies Inc. or by others.

In general the following connections are made:

- One main power feed terminated at the service entrance for each of the splitter panels.
- One power supply is to be terminated at the System Monitor.
- One power supply is to be provided for each PDR.

Once checked, the TrojanUV3000™PTP is ready for official commissioning and operator training by the Trojan Representative.

Chapter 5

START UP AND SHUT DOWN

5 START UP AND SHUT DOWN

? HOW TO INFO

5.1 Start Up UV System

This procedure applies to the start up of the UV system after it has been installed and initially started up by an authorized Trojan Representative. Typically, this would be after the system has been shut down for maintenance, or in the case of seasonally operated systems, is being started up for the beginning of the disinfection season. In either case, the modules are not in the channel prior to the start up procedure.

1. Inspect the UV channel to ensure that it is clean and clear of debris.
2. Ensure that there is adequate effluent flow through the UV channel.
3. Inspect the modules for the following items:
   - Modules, sleeves and UV Sensor are clean.
   - Sleeves are not cracked.
   - Sleeve nuts are hand–tight.
   - Module power cable strain–relief on each module is hand–tight.
   - Module power cables are clean and free of debris.
4. Place the modules in the UV channel. Depending on the size of the modules and local codes this may require two people.
5. Locate and energize supply breakers for PDR's and Monitor.

⚠	**CAUTION**
	UV lamps will be energized! Unprotected exposure to UV light can cause severe burns to the eyes and skin.

6. Press the Test button on each PDR to verify Ground Fault Circuit Interruption (GFCI). Press the reset button on each PDR to re-energize. If any PDR's do not trip the GFCI, contact your local Trojan Certified Service Representative or Trojan Technologies Technical Support Center for assistance.

⚠	**CAUTION**
	Do not plug in any modules into a PDR that you suspect does not have adequate GFCI protection.

7. Verify that the Monitor is energized by inspecting the LED display. If display is not energized, consult the troubleshooting guide in this manual.
8. Plug the modules into their respective PDR. Verify that the modules are energized by inspecting the lamps status LEDs.
9. Plug the UV sensor into the receptacle at the base of the Monitor.
10. Wait 15 minutes and ensure that the UV intensity reading on the Monitor is OK.
11. Record the UV intensity and lamp hours in a maintenance log book for reference.
12. If you have any questions call your local Trojan Certified Service Representative or Trojan Technologies Technical Support Center.

5.2 Shut Down UV System

1. Unplug modules from the PDR's.

	CAUTION
	UV lamps will be energized! Unprotected exposure to UV light can cause severe burns to the eyes and skin.

2. Unplug the UV sensor from the base of the Monitor.
3. Remove each module from the channel.
4. Clean the sleeves of any debris or residue using a garden hose, a non-abrasive cloth or cleaning pad. Be sure to not spray directly at the module end caps, and ensure that the module power cable is kept dry.
5. Use the Lime-A-Way to wipe down the sleeves using a non-abrasive cloth or cleaning pad.

Note:	***Only use industrial grade Lime-A-Way as it is the only cleaning agent approved by Trojan Technologies for this application.***

	WARNING
	Corrosive! The Cleaning Agent contains phosphoric acid. Wear appropriate clothing and personal protective equipment.

6. Allow the sleeves drying time. If there is any residue or hazing clean them again with the Lime-A-Way.
7. De-energize the Monitor and PDR power supply breakers. Lock and tag-out as required by local safety code.

	DANGER
	Electrical Hazard! ***LOCKOUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment.***

8. Clean the UV channel of any debris.
9. The UV system is now ready for servicing or winterization.

5.3 Shut Down for Extended Periods

The TrojanUV3000™PTP **should always be left on.** It is not designed to be cycled on/off except for maintenance and troubleshooting. If your wastewater treatment plant operates on a seasonal basis refer to the below section to winterize the UV equipment.

UV Modules

The primary concern for UV modules during the winter season is the potential for damage to the quartz sleeves and lamps if effluent is allowed to freeze. Where possible, de-water the channel before winterization, or remove modules from the channel.

Following removal, each module should be cleaned immediately to prevent dirt and debris from drying onto the quartz sleeves and stainless steel frame.

	WARNING
	Corrosive! The Cleaning Agent contains phosphoric acid. Wear appropriate clothing and personal protective equipment.

UV Monitor System

When de-energizing a monitor that has been outdoors, the enclosure may accumulate condensation over the winter season. This problem may be compounded if the power conduit to the monitor enclosure is not properly sealed.

Note:	*Remove the monitor board and place it in an ESD bag or container and store in a clean, dry location.*

De-water Channel and Winterize UV System

1. Bypass effluent from entering channel.
2. De-water the UV channel before de-energizing banks to ensure untreated effluent is not discharged.
3. De-energize module banks by unplugging the modules from the PDR's.
4. If in an outdoor location, remove the monitor board and place it in an ESD bag or container and store in a clean, dry location.

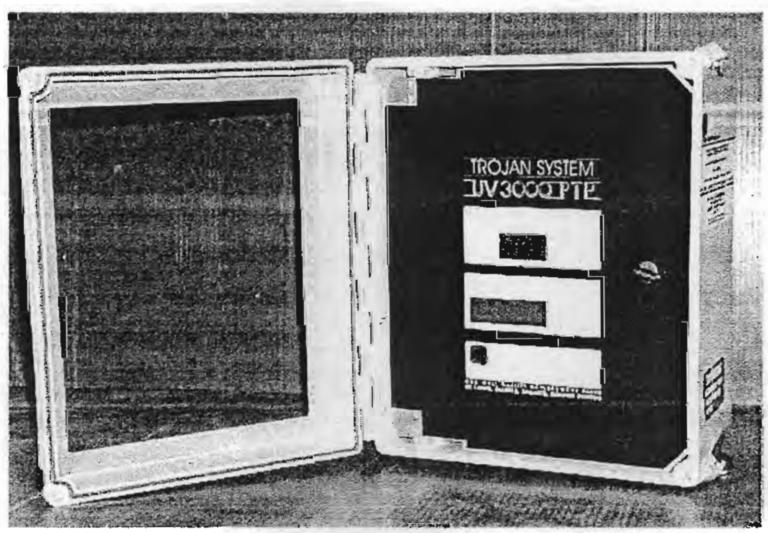
Winterize UV System Without De-watering Channel

1. De-energize module banks by unplugging the modules from the PDR's.
2. Remove UV modules from the channel and store in an indoor location.
3. If in an outdoor location, remove the monitor board and place it in an ESD bag or container and store in a clean, dry location.

Chapter 6

SYSTEM MONITOR

(OPTIONAL)



6 SYSTEM MONITOR

6.1 System Monitor Overview

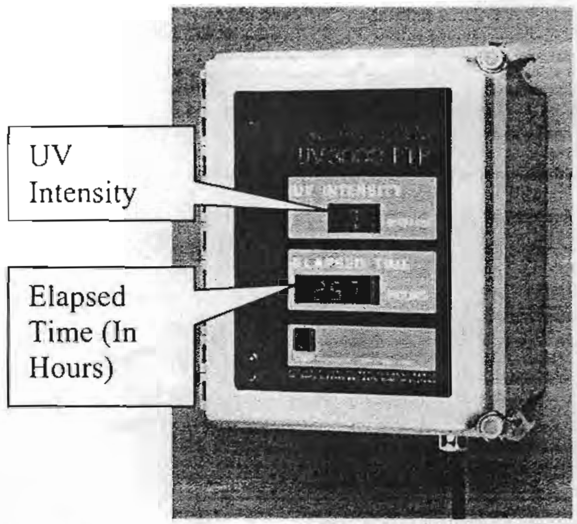
Description

The operation of the Trojan UV3000™PTP is monitored at the System Monitor.

The optional monitoring system provides add-on monitoring capabilities for all models of the Trojan UV3000™PTP series.

The monitoring system offers the following features:

- A submersible UV Sensor that continuously monitors the UV intensity produced in each bank of UV lamp modules.
- A 3 character display that indicates UV intensity in milliwatt per square centimeter (mW/cm2). This display will flash when the intensity drops below the Low UV Intensity Alarm setpoint.
- A 5 character display that indicates elapsed time in hours. The Elapsed Time display will flash when the display reading is between 12,000 and 12,500 hours and it will also flash for each period of 12000 hours following the 12,000 hour mark; i.e. the display will flash from 12,000 – 12,500 hours, 24,000 – 24,500, 36,000 – 36,500..., until the display reaches 65535 hours, at which point the hour counter automatically resets to 0 hours. The flashing period indicates the lamps will need to be changed in the near future.
- 7 segment LEDs are used by both displays and are visible through the panel door.
- A dry contact is provided for Low UV intensity alarm.
- An isolated 4-20 ma signal is available for remote indication of UV intensity.
- The Monitoring System (12 x 10 x 6 inches) is enclosed in a Type 4X reinforced fibreglass wall mounted panel.



? HOW TO INFO

6.2 Maintenance

Cleaning

Like all products exposed to the outdoor environment, the enclosure's exterior should be washed monthly with a mild soap and water solution. Do not use a high-pressure hose.

A damp sponge or soft cloth should be used for regular cleaning. Do not use any corrosive cleansers on the System Monitor cabinet or operator interface.

Check the door seal each month to ensure no moisture is present in the panel.

Remove/Replace Monitor Board Fuse

An AC power supply fuse located beside the power termination strip, may require replacement if a power surge or short circuit occurs. To remove or replace the Monitor board fuse:

1. Disconnect AC supply to Monitor board.
2. Remove fuse with small screwdriver and test.
3. Replace fuse with an identical spare.

6.3 Operation

Monitoring System Configuration.

(Refer to Figure 1).

To set the Monitor to Read the UV Sensor

(Refer to Figure 2).

This is the normal mode of operation for the UV3000 PTP™ Monitoring System Display. The normal mode is set when dip switch #1 is in the ON position and switches #2, 3, and 4 are in the OFF position.

Clearing Elapsed Time Display

(Refer to Figure 2).

To clear the hour reading on the display, set dip switch #3 to the ON position, wait for 5 seconds, then return the switch to the OFF position. The display will flash and the elapsed time will display zero hours.

Setting the UV intensity Alarm

(Refer to Figure 2).

1. Disconnect AC power. Set dipswitch #1 to the OFF position and dip switches #2 and #4 to the ON position. Apply AC power and adjust R47 (using a small screwdriver), until the UV intensity display reads 1.6 w/cm2 (low UV intensity alarm set point).
2. Once the reading is set to the desired value, (1.6 mW/cm2 standard setting) disconnect AC power, turn dipswitch #4 OFF, then reconnect AC power. Ensure that the display reads 1.6 w/cm2 - if not, return to step 1.
3. Return dip switch #4 to the ON position and wait for 5 seconds, then turn dip switch #4 OFF (the ELAPSED TIME display must flicker when dip switch #4 is returned to the OFF position). This locks the UV intensity alarm.
4. Disconnect AC power. Set dipswitch #2 to the OFF position and dipswitch #1 to the ON position. This returns the monitor system to its operational mode.

CAUTION

Exposure to UV light causes burns to the eyes and skin. Keep illuminated UV lamps submerged in test tanks or system channel. Take precautions when working with UV light by wearing a face shield and covering exposed skin.

Power Up/Power Down

To power up the System Monitor, follow the procedure in the Start Up and Shut Down Chapter of this Operation and Maintenance Manual.

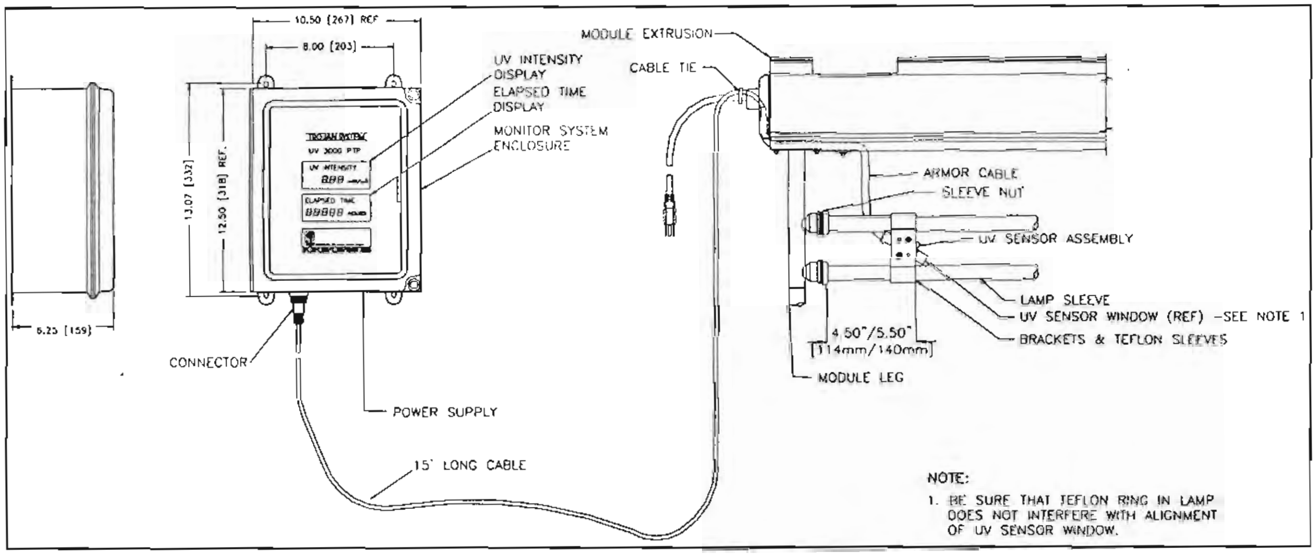


Figure 1

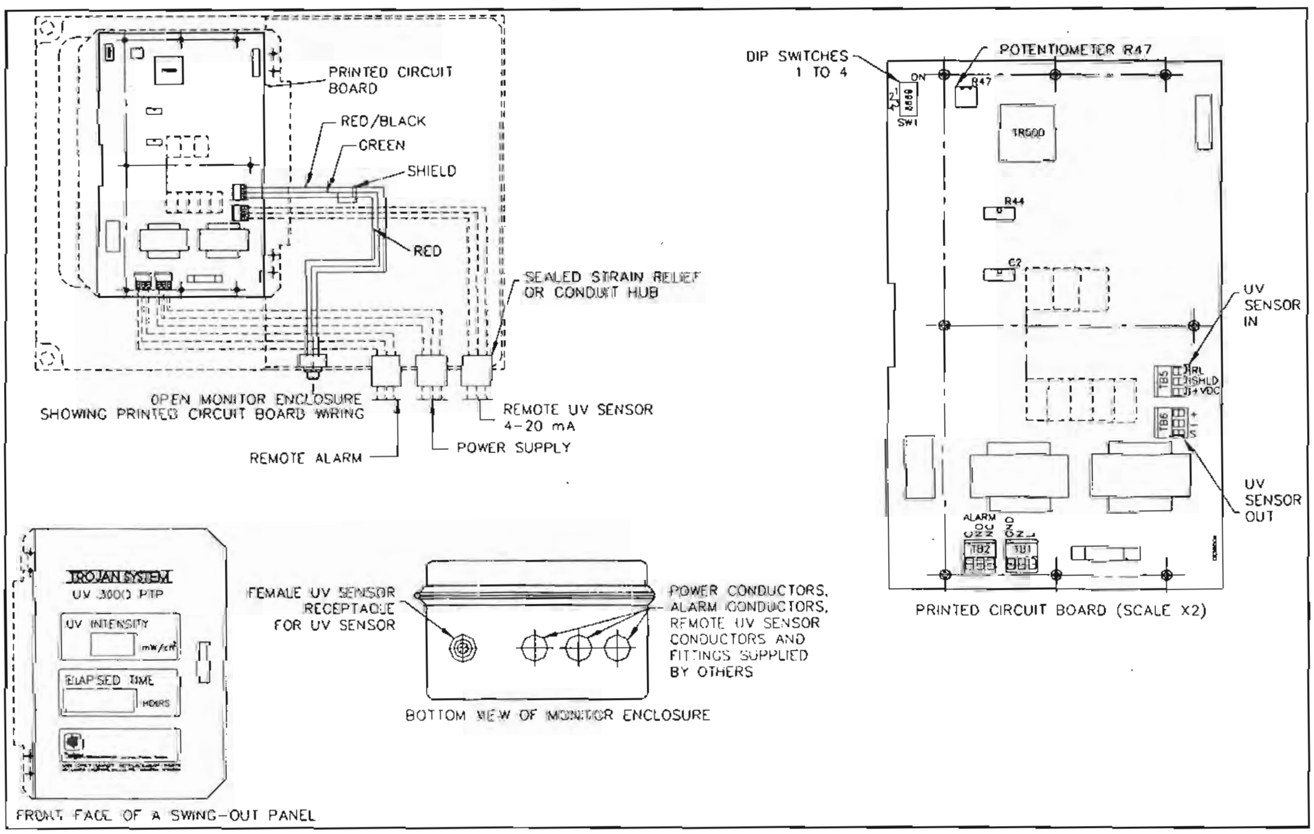
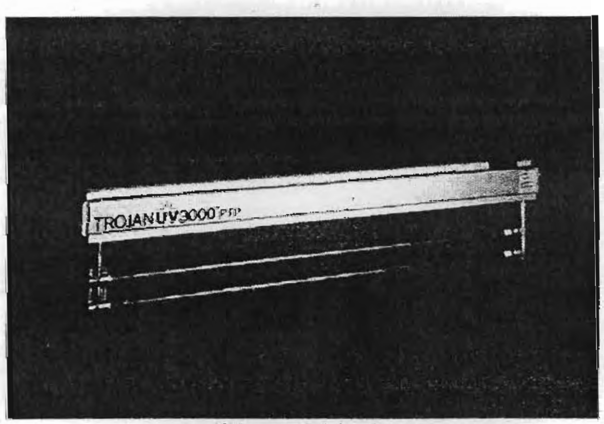


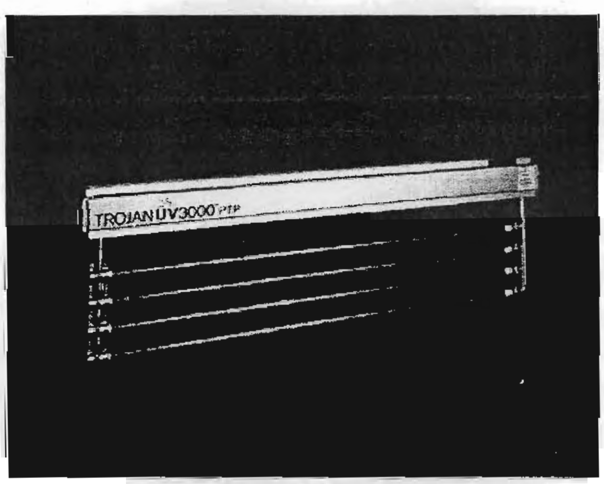
Figure 2

Chapter 7

UV MODULE



2 lamp 34-inch



4 lamp 64-inch

7 UV MODULE

7.1 UV Module Overview

Description

The UV module is the basic unit of the flow-through UV bank. A UV bank is made up of modules placed in parallel, 3 inches (76.2mm) between lamp centers. The module/bank configuration is determined at Trojan based on relevant information collected from the site.

There are two basic lengths of UV Modules, 34 (864mm) and 64 (1625mm) inches in length. The numbers of lamps are determined by the flow being treated and will vary from 2-4 per module depending on the size of the treatment plant. The module/bank configuration will be based on information from the plant process.

UV modules consist of a 316 stainless steel frame that holds the high-intensity UV lamps in position, and houses all connecting wires in a watertight enclosure.

Mounted on top is an anodized aluminum ballast enclosure that site personnel can easily hold while lifting the module out of the channel. This enclosure contains the electronic ballasts (one for every two lamps) and the UV module circuit board. UV modules are held in the support frame with the aluminum ballast enclosure above the water.

Modules are connected to the Power Distribution Receptacle (PDR) through the UV module power cable located at one end of the aluminum enclosure. UV lamps are enclosed in quartz sleeves and attached to the module at each end by means of a sleeve cup and the formed leg of the module.

Once positioned in the module support rack, the steel frame and the aluminum enclosure form a structure designed to support the weight of one operator walking on it for service purposes.

Note:	*Effluent level within the channel should never increase more than 1-inch above the top lamp.*

⚠	**CAUTION**
	Flooding the ballast enclosures or any other electrical equipment constitutes improper operation of the equipment and may cause extensive damage.

Specifications

Item	Value
Module leg	316 Stainless steel
Module enclosure	Anodized aluminum

? HOW TO INFO

Maintenance

Removing Modules

If the modules have to be removed, one person can easily lift the 4 and 2 lamp modules out of the channel. Trojan recommends that when there are more than 5 modules, the balance of modules should be removed from the opposite side of the channel.

Always unplug the unit while cleaning the modules and channel.

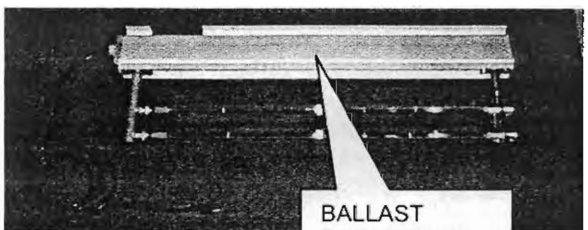
Disconnect Modules

To remove the module for cleaning or service, disconnect the plug from the PDR.

7.2 Electronic Ballast

Description

One (1) ballast powers two lamps. The ballasts are located within the module enclosure found on top of the module, which is positioned over the channel.



Specifications

Item	Value
Input	120V AC ± 10%, 1.6 A, 50 - 60 Hz; 175W
Output	2 x 78W

? HOW TO INFO

Maintenance

Remove and Replace Electronic Ballast

DANGER

Electrical Hazard!

LOCK OUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment.

Tools required:

- 1/4" Open wrench
- 7/16" Open wrench
- Wire Stripper
- Slot screwdriver
- A2 rubbing alcohol

1. Take note of the lamp(s) that are not energized.
2. Unplug and remove module from channel and replace with another module if possible (this is only required if module bank is required for disinfection).
3. Unscrew the 4 machine screws on each end cap of the module.

Note: *Do not remove the screws completely. Loosen the end cover only.*

4. Remove the end caps by pulling on the fins. It may be necessary to tap the end cap lightly to loosen it.
5. Loosen the ¼" pressure cone and the 7/16" nut at each end of the top *and* bottom extrusions.

Note: *The green wire does not have to be removed.*

6. Grasp the cable end with pliers (once pressure cones are loosened) and pull the ballast tray out toward the cable end to reveal the 9-terminal strip.
7. Observe the Blue wires passing through the current transformers.

   The Blue wires and the red return wire can be disconnected from the terminal strip and pulled through the current transformers. These are the wires from individual lamp sockets. Ensure that each wire is labeled before removing them from the current sensing coils.

8. Slide out ballast tray until the faulty ballast is visible.
9. Remove retaining rings from the wire channel that hold the ballast red and blue wires in place. Remove faulty ballast wires from terminal block.
10. Remove the ballast mounting nuts and lock washers.
11. Positions the new ballast on the mounting studs and reinstall the 2 ballast mounting nuts and lock washers on each end of ballast.
12. Trim and connect new ballast wires in corresponding terminal block(s). Return retaining rings to wire channel ensuring that the wires are held straight.
13. Slide the ballast tray back into the extrusion. Stop before the Printed Circuit Board enters the extrusion.

⚠	**CAUTION**
	Extreme caution must be taken when sliding ballast tray into extrusion in order to avoid damaging the ballast tray wiring.

14. Reconnect Blue wires making sure the appropriate wires pass through the proper current transformer.
15. Connect the Red return wire to the terminal.
16. Slide the ballast tray back into the extrusion.
17. Tighten each pressure cone to secure the ballast tray position.
18. Reinstall end caps by screwing the 4-machine screws snuggly.
    - The rectangular plastic ring must be aligned with the inner cap.
    - Insert the inner cap into the housing until the o-ring is against the end.
    - Next, apply alcohol to the o-ring.
    - Push on the end cap assembly while applying pressure with a slot screwdriver on the o-ring to set it in the groove. O-ring should enter extrusion at top first, then sides, and bottom last.
19. Tighten the 4-machine screws, keeping pressure against it while tightening. The end cap must be tight against the housing.
20. Return the module to service.

7.3 Lamp Assembly

Description

Trojan Technologies Inc. supplies 34 inch (864mm) and 64 inch (1625mm) long UV lamps. The germicidal lamp is a low pressure lamp. The lamps are designed to produce zero levels of ozone, withstand shock and vibration, and are constructed of materials resistant to UV.

UV lamp output after 12,000 hours of operation is approximately 80% of the output after the 100-hour burn-in period.

Lamp Holder Seal Assembly

The open end of the lamp sleeve is sealed by means of a Type 316 stainless steel sleeve nut which threads onto a sleeve cup and compresses the sleeve o-ring. The knurled surface of the sleeve nut allows a positive handgrip for tightening. It does not require any tools for removal.

The lamp is held in place by means of the molded lamp holder that incorporates a triple seal. The lampholder seals against the inside of the quartz sleeve to act as a second seal in series with the external o-ring seal. Another seal on the lampholder isolates and seals the lamp from the module frame and all other lamps in the module.

In the event of a quartz sleeve fracture, the seals of the lampholder prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

?	HOW TO INFO

Maintenance

The frequency of lamp replacement depends on factors such as:

- Temperature of effluent
- Power level of lamps
- Power Quality

Lamps are typically replaced every 12,000 hours of operation, although the actual time varies according to the above factors. To ensure lamps are replaces at the proper time, it is best to replace all lamps in a scheduled operation, and to maintain a record of lamp replacement dates and elapsed timing on all lamps.

To allow the system to remain operational, replace lamps in one module at a time.

Remove and Replace Lamp

DANGER

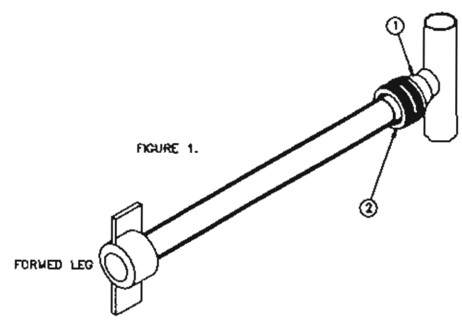
Electrical Hazard!

LOCK OUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment.

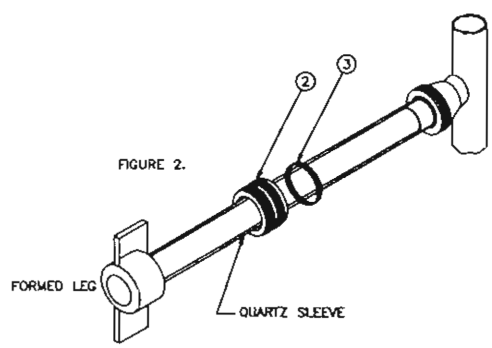
CAUTION

Wear cotton gloves when handling new lamps to protect lamps and sleeves.

1. Take affected UV module out of service by unplugging corresponding module from the power distribution receptacle.
2. Support the UV module on a flat surface.
3. It is recommended that quartz sleeves be cleaned at this time to facilitate lamp replacment and improve the performance of the UV module. See Remove and Replace Quartz Sleeve.
4. Unthread the sleeve nut (#2) by hand until it loosens from the sleeve cup (#1). See figure #1.

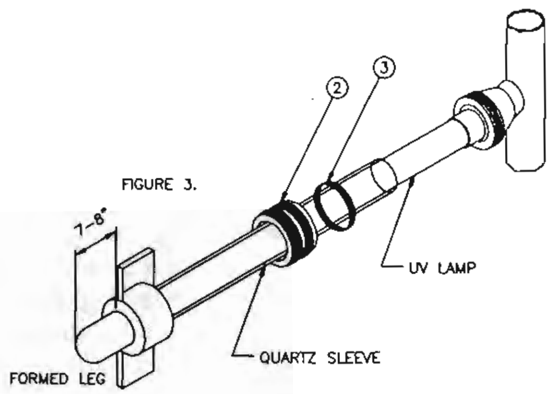


5. Carefully slide the sleeve nut (#2) and o-ring (#3) along the quartz sleeve 7 or 8 inches (15cm). See figure #2.



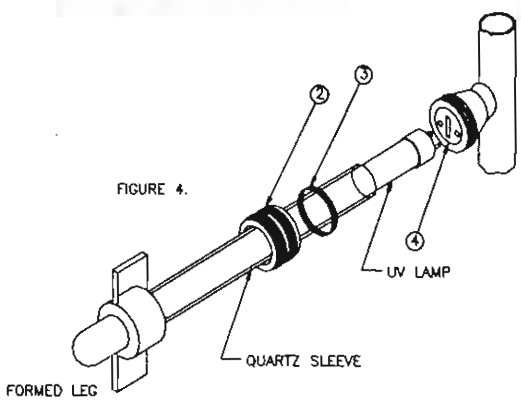
6. Carefully remove the quartz sleeve from the sleeve cup. (# 1) See figure #3.

   Do this by pulling and rotating the quartz sleeve at the same time. The quartz sleeve should be extended 7 to 8 inches (15cm) beyond the formed leg of the module.

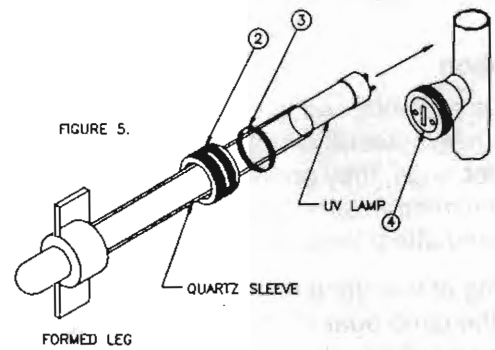


7. Remove the lamp from the lampholder (#4 below).

   Do this by gently pulling the lamp away from the lamp holder. (#4) See figure #4.

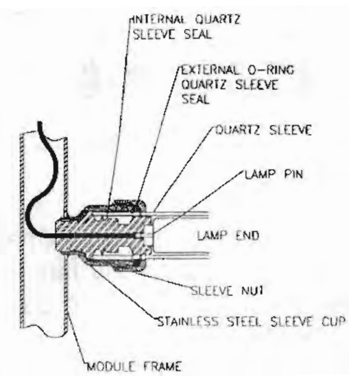


8. Support the quartz sleeve (when lamp is free from lampholder, (# 4) and remove the lamp. See figure #5.
9. Replace the o-ring (#3 below) at this time if any degradation or deterioration is evident.



10. Replace the lamp by repeating the above steps in reverse order.

When reassembling the UV module ensure the quartz sleeve is in full contact with the rubber sleeve stop and not just in contact with the internal quartz sleeve seal. Push the sleeve until it is past the internal sleeve seal and against the rubber sleeve stop.



It is also recommended that quartz sleeves be cleaned at this time to improve the performance of the UV module. See Remove and Replace Quartz Sleeve.

7.4 Quartz Sleeves

Description

UV lamps are enclosed in cylindrical quartz sleeves that protect the lamp. In conjunction with the spacer rings, they provide insulation assuring minimum lamp temperature variation, which could affect lamp performance.

The spring at the closed end of the sleeve pushes the lamp against the lamp holder (at the opposite end of the lamp) to provide a good electrical contact.

Specifications

Item	Value
Material	Type 214 clear fused quartz circular tubing
UV transmittance	No less than 89% UV light

? HOW TO INFO

Maintenance

To ensure maximum performance, it is essential that the quartz sleeves containing the UV lamps are kept clean. If coating is allowed to build up on the sleeves, the amount of UV light transmitted to water is reduced.

The cleaning interval for the UV modules depends on the effluent quality. Often, a hosing off of foreign matter clinging to the unit may be all that is required. Over a period of time, however, a coating will build up on the quartz sleeves and it will be necessary to clean them thoroughly.

Always clean quartz sleeves when intensity falls below 2.8 mW/cm^2.

CAUTION

Wear cotton gloves when handling quartz sleeves and lamps.

Cleaning Systems

The TrojanUV3000™PTP method of cleaning the sleeves is to manually hand wipe the quartz sleeves using a Trojan approved cleaning agent. The cleaning agent is applied using a cleaning cloth or sprayed on the quartz sleeves, then wiped off.

See Remove and Replace Quartz Sleeve.

WARNING

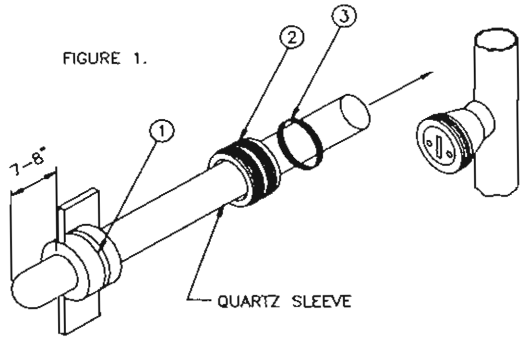
Corrosive! The Cleaning Agent contains phosphoric acid. Wear appropriate clothing and personal protective equipment.

Remove and Replace Quartz Sleeves

1. Follow steps 1 through 7 under the Remove and Replace Lamp.
2. Remove the sleeve nut (#2 below) and o-ring (#3 below) from the quartz sleeve.
3. Pull the sleeve out of the formed leg of the module once the lamp has been removed.

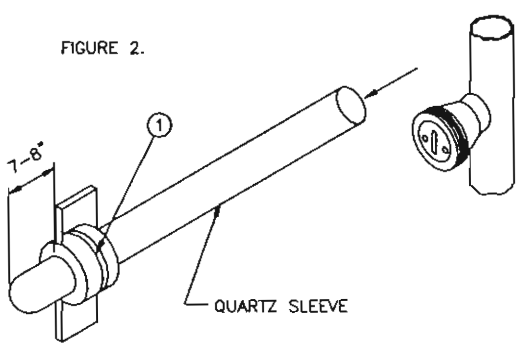
Note: *Do not hammer or pry the sleeve. If removal is difficult, lubricate the supporting o-ring (Fig. 1 below) with soapy water and rotate the sleeve back and forth while pulling.*

FIGURE 1.



4. Install new supporting o-ring if o-ring appears damaged or deteriorated.
5. Put the new sleeve (closed end) 7 to 8 inches (15cm) through the formed leg.

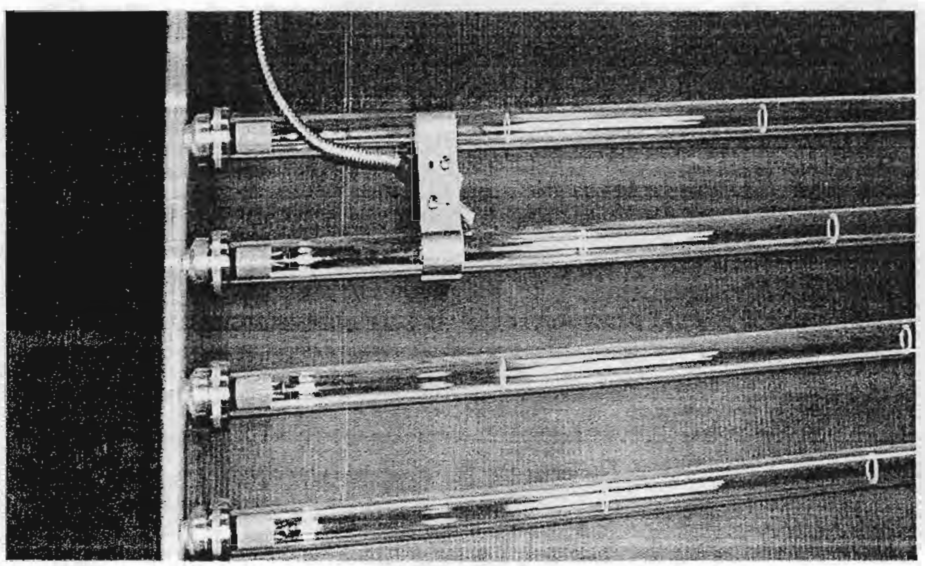
FIGURE 2.



6. Install sleeve nut and new o-ring (if replaced) on quartz sleeve. See figure 1.
7. Reassemble the UV lamp (see Remove and Replace UV Lamp).

Chapter 8

UV SENSOR



8 UV SENSOR

8.1 UV Sensor Overview

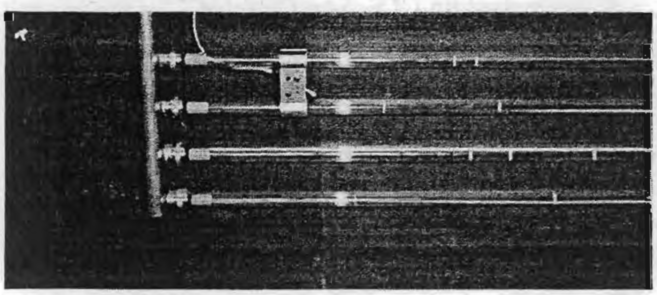
Description

Trojan Technologies Inc.'s UV Sensor continuously measures the UV intensity produced in each bank of modules. The submersible UV Sensor measures only the germicidal portion of the light emitted by the low-pressure UV lamps.

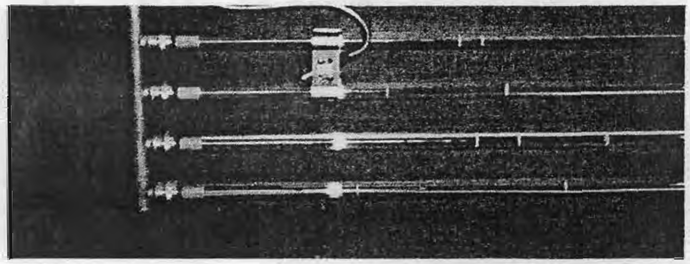
The UV Sensor incorporates a photodiode that gathers UV light from the lamp underneath the UV Sensor, which is converted into an analog signal and then displayed in mW/cm^2 at the operator interface in the System Monitor.

The UV Sensor is mounted on one (1) UV module per bank of modules, and its installation is typically located on the second lamp sleeve from the top of a module. The UV Sensor is mounted such that it faces away from the effluent flow.

Effluent flow



Effluent flow



Specifications

Item	Value
Input power	UV Sensor is designed to function with a supply voltage between 15 and 30 VDC
Cable	Twisted pair, shielded
Wavelength	UV Sensor responds only to ultraviolet energy
Storage temperature	-40°F to 176°F (-40°C to +80°C)
Operating temperature	33°F to 140°F (0.5°C to 60°C)

? HOW TO INFO

Maintenance

The UV Sensor system is calibrated in the factory and should not be altered, or its calibration changed, in any way.

UV Sensor Cleaning

UV Sensor cleaning frequency depends on the effluent quality. Fouling on the UV Sensor will lead to lower UV Sensor readings. The UV Sensor should be checked and cleaned at least as often as the quartz sleeves.

To clean the UV Sensor window and quartz sleeve:

1. Turn the system OFF. See Chapter 5 for Shut Down procedures.
2. Shut off the main power to the system.

> **DANGER**
>
> ***Electrical Hazard!***
>
> *LOCKOUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment.*

3. Lift and remove the module from the channel.
4. Apply a solution of 50% water and 50% Trojan approved cleaning agent (spray or wipe on using a cleaning cloth), then wipe the solution off.

> **WARNING**
>
> Corrosive! The Cleaning Agent contains phosphoric acid. Wear appropriate clothing and personal protective equipment.

5. Check the UV Sensor window and quartz sleeve for cleanliness and repeat step 4 if needed.
6. Place module back into the channel and return the system into service.

Remove/Replace the UV Sensor

> **DANGER**
>
> *Handle the UV Sensor with care. Avoid touching the end of the UV Sensor.*

Required tools:

- Philips screwdriver (#2)
- Small adjustable wrench
- Slot screwdriver (1/4")
- 3/32" hex key
- 7/16" Socket wrench

Remove Existing UV Sensor

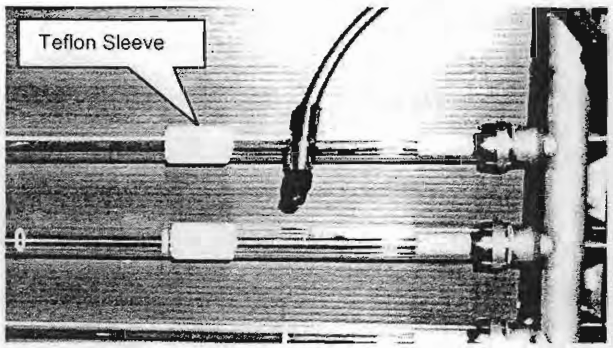
1. Turn the system OFF. See Chapter 5 for Shut Down procedures.
2. Shut off the main power to the system.

> **DANGER**
>
> ***Electrical Hazard!***
>
> *LOCKOUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment.*

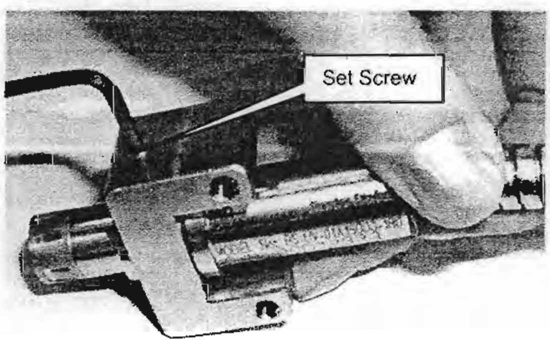
3. Lift and remove the module from the channel.
4. Remove the nylon cable ties and release UV Sensor cable from module leg and power cable.
5. Disassemble UV Sensor mounting bracket from Teflon sleeves (Teflon sleeves remain in place).

Install / Replace UV Sensor

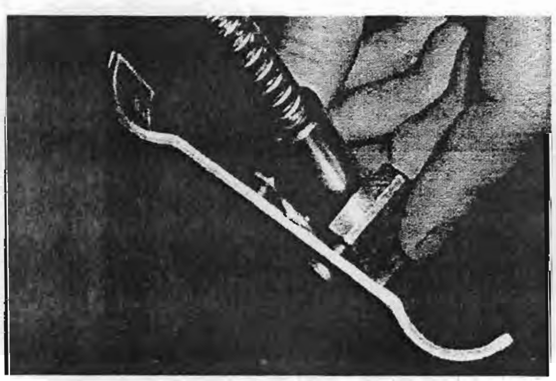
1. If necessary, remove UV Sensor body from new sensor assembly.



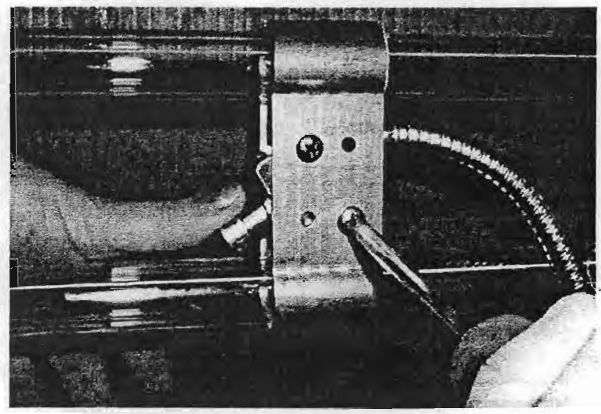
2. Insert body into sensor U-bracket until flush with bracket. Secure in place with #10 set screw.



3. Position one side of mounting bracket on U-shaped sensor bracket and attach loosely with screws and split lock washers.



4. Assemble sensor mounting bracket over Teflon® sleeves, leaving screws loose.
5. While sensor bracket is loosely connected to U-bracket, place pressure on the UV Sensor head to position UV Sensor as close to the lamp as the bracket will allow. Tighten all 4 screws.



Note:	*UV Sensor window is mounted such that it faces away from effluent flow.*

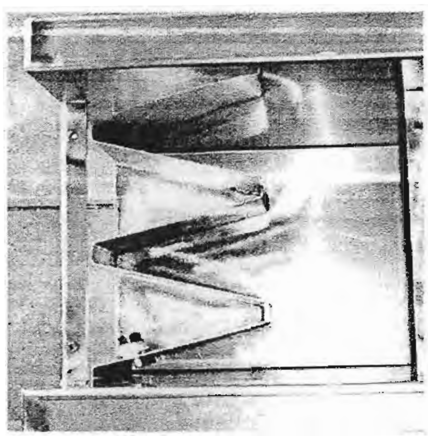
6. Use nylon ties to secure UV Sensor cable to module leg and power cable. Trim excess from cable ties.

8.2 References

Teflon® is a Registered Trade Mark of the DuPont Company.

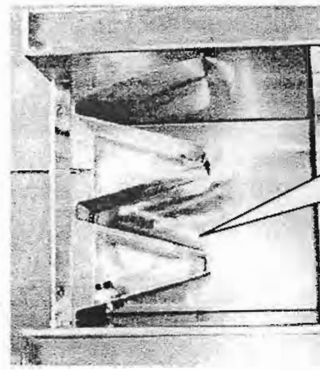
Chapter 9

LEVEL CONTROL WEIR



9 LEVEL CONTROL WEIR

9.1 Level Control Weir



Description

In the Trojan UV3000™PTP a weir is used to control the water level. Depending on system size and channel material weirs can differ slightly from those shown in this manual.

To achieve proper disinfection, the top of the weir is set at an elevation to control the depth of water above the top lamp. The weir height ensures the lamps will remain submerged in zero or low flow conditions.

The head associated with a fixed weir is dependent on the length of the weir. The shorter the weir, the greater the head, or depth of water over the weir for any given flow.

As effluent depth increases over the weir downstream of the UV system, effluent depth upstream of the Bank(s) increases a corresponding amount. Therefore, when using a fixed weir, the hydraulic capacity of the plant upstream of the Bank(s) must be considered under peak flow conditions.

Trojan Technologies Inc. typically uses a trapezoidal weir in both the Trojan UV3000™PTP stainless steel and concrete channels

Weirs can have many different shapes. The most common shape for a trapezoidal weir is a "finger" weir where the weir is lengthened into the channel in order to have a longer edge. This longer edge distributes the water over a longer perimeter and reduces the head.

Specifications

Item	Value
Weir	A drain is usually installed at the bottom of the weir to completely empty the channel if required. Material Stainless Steel.

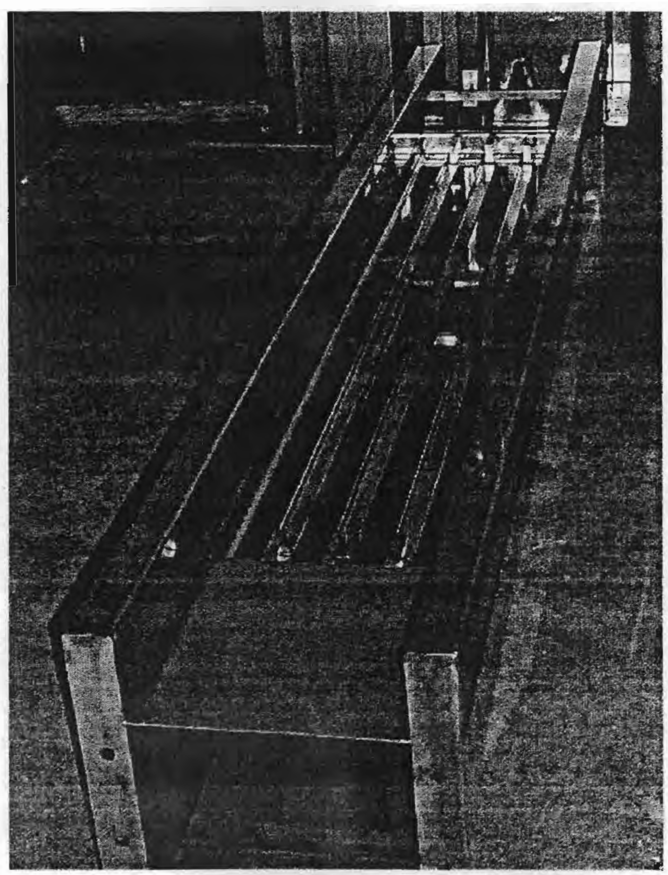
Maintenance

The crest of the weir should be inspected periodically.

If necessary, a high-pressure spray can be used to remove algae or other build-up on the weir.

Chapter 10

UV MODULE RACK



(Type K shown)

10 UV MODULE RACK

10.1 Introduction

Description

For Stainless Steel Channels (Type K Models)

The UV module support rack for K (stainless steel channel) systems is a stainless steel frame that supports the UV modules in the stainless steel channel.

Where a stainless steel channel is supplied, the rack comes welded in the channel. The UV module rack requires no further installation.

For Concrete Channels (Type K-1 Models)

The UV module support rack for –1 (concrete channel) systems is a stainless steel frame that supports the UV modules in the concrete channel.

The UV module support rack is fastened to four channel brackets attached to the concrete channel walls. The rack weldments are mounted to the side of the channel with angle brackets.

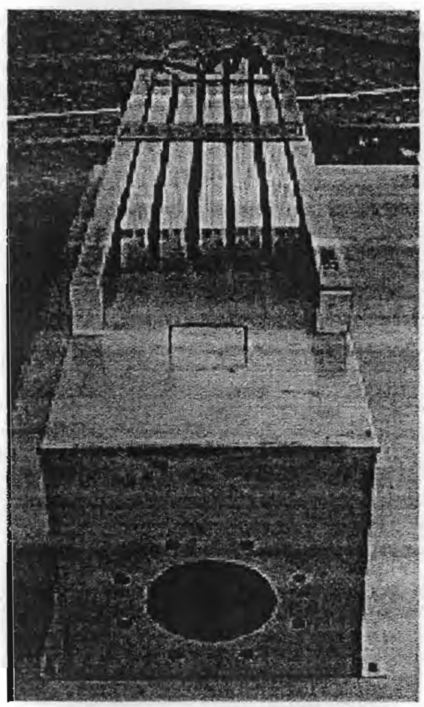
The support rack is adjusted to position the module's bottom lamp at a precise height in the bottom of the channel. No fastening of the individual UV lamp modules is necessary.

Specifications

Item	Value
Module rack	Stainless steel

Chapter 11

CHANNEL



(Type K shown)

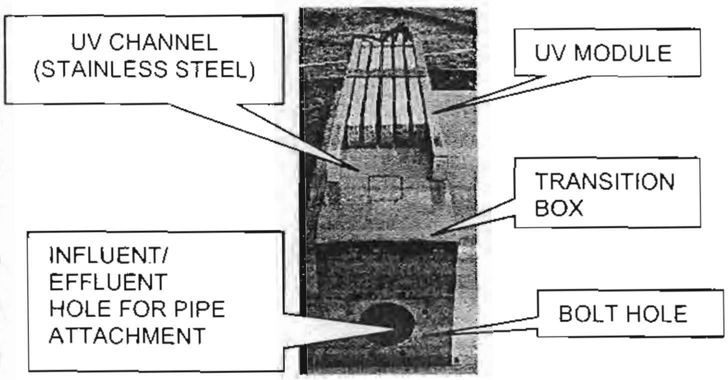
11 CHANNEL

11.1 Channel Overview

Description

Depending on the TrojanUV3000™PTP model provided, a stainless steel channel may have been provided. For systems where a stainless steel channel was not provided, a poured concrete channel by others may be required. Refer to the applicable channel type below:

Stainless Steel Channel (Type K option)



The stainless steel channel can be supplied with or without optional transition boxes and an optional turn box. Stainless steel channels with transition boxes and the turn box form a freestanding structure that connects to flanged pipes.

The stainless steel channel is typically constructed of 14 gauge stainless steel and comes complete with drain, UV module support rack and downstream serpentine weir.

Multiple channels may be connected in parallel, or series with a turn box, depending on the application requirements.

All interconnecting piping, associated material, such as gaskets, shall be supplied by others.

UV Modules are mounted in the stainless steel channel module support rack. The module support rack is shipped welded in the channel. Each channel shall support one bank of modules.

An overflow weir maintains correct water depth over a complete range of flow rates to be treated. Depending on the model and site requirements the weir may be located in the channel or in the most downstream transition box (if applicable).

Due to variations in effluent quality and flow characteristics, debris may settle at the bottom of the channel. A built-in drain helps facilitate channel cleaning.

The channel (and transition boxes, if provided) should always be thoroughly cleaned after any plant upset.

Concrete Channel (Type K-1 option)

For installations where a concrete UV channel will be used, stainless steel channel(s) and transition boxes will not be provided. UV module rack(s) and level control weir(s) will need to be installed by others. The poured concrete is also the responsibility of others.

Note:	*Poured concrete channels are required when a stainless steel channel is not provided. Trojan does not recommend that concrete be poured around a TrojanUV3000™PTP stainless steel channel, Transition or Turn Box.*

Refer to the following table for reference on models that are available for concrete channel installation.

See table on following page.

TrojanUV3000™PTP Model	Stainless Steel Channel & Transition Boxes provided (K Models)	Concrete channels provided by others (Stainless Steel Channel & Transition Boxes not provided) (K-1 Models)
3025 – 3300 & D3025 – D3300	✓	N/A
3400 to 3001 & D3400 to D3001	✓	✓

Chapter 12

WASTEWATER SAMPLING TECHNIQUES

12 WASTEWATER SAMPLING TECHNIQUES 12-1

12 WASTEWATER SAMPLING TECHNIQUES

Trojan Technologies Inc. recommends the use of *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, APHA, AWWA, and WEF for the collection, preservation and storage of samples. Refer to Part 9000 Microbiological Examination, and the subsections: 9010-Introduction, 9060-Collection and 9060B-Preservation and Storage for more detail.

G.1 General

Collection and testing of wastewater samples helps to determine the effectiveness of UV for disinfection. Measuring parameters such as % UV Transmittance (%UVT), Total Suspended Solids (TSS), and Particle Size Distribution (PSD) assist in the characterization of effluent quality. The presence of indicator organisms, such as coliforms, in a wastewater sample can suggest the presence of pathogens associated with fecal wastes. Measuring these indicator organisms following exposure to UV can provide an indication of the degree of disinfection. Disinfection limits vary depending on local regulations for a specific treatment plant or test protocol used.

CAUTION

Trojan relies on quality samples to prove disinfection efficiency, UV dose demand, and effluent quality variation. ***Proper sampling techniques are essential.***

The sampling location, time, container volume, preservation, storage and transit times are important factors to consider.

The sampling location varies depending on the test objectives. Predisinfected samples are collected for analysis of effluent quality parameters (%UVT, TSS, PSD) and influent bacteria counts (thousands-millions/100mL). Samples for a collimated beam test are also taken before disinfection to determine microbial response to varying UV dose. Disinfected samples are collected after UV to determine the performance of the equipment. Since UV dose can be altered by changing the flow rate or lamp intensity it is important to use a test protocol that clearly specifies the UV dose and test conditions. Bacterial counts are expected to decrease significantly as the UV dose increases (i.e., thousands to one/100 mL) and it is important to follow the sampling times exactly to allow sufficient time between samples. Trojan Technologies Inc. has developed a detailed test protocol for measuring the performance of equipment.

For microbial testing, grab samples taken at a specific time and location are preferred over other sampling methods such as composite or blended samples taken over a longer period of time.

Microbiological sample bottles are heat-sterilized using an autoclave and often contain preservatives such as sodium thiosulphate or EDTA. Sodium thiosulphate is a chlorine-neutralizing chemical that absorbs UV light and can significantly lower %UVT in samples. EDTA is used to neutralize the toxic effect of metals. It also absorbs UV light and can lead to inaccurate %UVT readings.

CAUTION

Trojan does not recommend the use of reducing agents (e.g. sodium thiosulphate or EDTA). Reducing agents in a sample will lead to false results and produce a low %UVT.

The size of sample bottle depends on the test method, the disinfection limit, and the number of tests required.

Sample bottles must be clearly labelled with permanent waterproof marker. Sample numbers should be recorded with the date, sample time, location and relative flow rate. Suggested sample volumes are provided below for each test procedure.

G.2 Sampling Procedure

WARNING

Fall Hazard*. Use care when working around open channels. Replace safety grating after taking sample.*

Grab Sample from a Channel for %UVT, TSS, PSD and Collimated Beam

a) UV Transmittance Test (%UVT)

UV Transmittance measures the ability of a solution to transmit UV light. It is a measure of the amount of UV energy that is not absorbed by chemicals or solids in wastewater. UV Transmittance is measured at a wavelength of 254 nm as a percentage relative to deionized water standardized at 100% Transmittance.

UV Transmittance decreases in the presence of UV-absorbing organic and inorganic substances and particles that either absorb or scatter UV light.

Wastewater UV Transmittance depends strongly on the type of treatment process and on the source and concentration of industrial wastewater relative to the total plant flow.

Sample Requirements for UV Transmittance (%UVT)	
Location:	Final Effluent, before disinfection
Sample Type:	Grab sample
Container:	Clean, plastic bottle
Preservation:	None
Sample Volume:	0.5 quart (500 mL)
Analysis Method	*Standard Methods for Examination of Water and Wastewater (Section: 5910)*

b) Total Suspended Solids (TSS)

Wastewater effluent contains suspended solids composed of bacteria-laden particles. The concentration of TSS and the size of the particles that protect the bacteria are limiting factors that help to determine the UV dose required to achieve disinfection.

Sample Requirements for Total Suspended Solids (TSS)	
Location:	Final Effluent
Sample Type:	Grab sample
Container:	Clean, plastic bottle
Preservation:	None
Sample Volume:	0.5 quart (500 mL) or 0.5 quart to 1 quart (1000 mL) for tertiary-treated effluent
Analysis Method	*Standard Methods for Examination of Water and Wastewater (Section: 2540)*

c) Particle Size Distribution (PSD)

A PSD test determines the average size as well as percentage of each size of particle in a sample. The PSD for wastewater samples depends on the upstream treatment process and type of effluent.

Sample Requirements for Particle Size Distribution (PSD)	
Location:	Final Effluent, **BEFORE** disinfection
Sample Type:	Grab sample
Container:	Clean, plastic bottle
Preservation:	1 teaspoon bleach per 0.5 quart (0.5 mL per 500mL)
Sample Volume:	0.5 quart (500 mL)
Analysis Method	Trojan Technologies Analytical Services
Shipping:	Overnight required

Primary solids generally have smaller particles with a mean size range of 13 to 25 microns.

Secondary effluents have particles that average between 20 to 35 microns or larger. Solids with a high percentage of large particles can pose a challenge to UV disinfection. PSD data combined with TSS data and process information is used to help establish the potential for disinfection.

d) Collimated Beam Test

The collimated beam test uses a bench scale UV apparatus to irradiate wastewater samples with varying UV doses. Accurate measurements of exposure time and the UV intensity provide a calculated UV dose. Indicator bacteria (i.e. fecal or total coliform) are enumerated before and after irradiation. The survivors are plotted against UV dose to produce a dose-response curve.

The collimated beam test may be used as a screening process to determine the UV dose response of a specific effluent and treatment process, and also to establish the range of UV dose required to reach a disinfection target. Effluent quality parameters that affect UV disinfection are also measured on the same grab sample.

Transit time and temperature are extremely important factors that affect sample quality. The samples should be delivered on ice to the laboratory within 24 hours of sampling for the collimated beam test.

Sample Requirements for Collimated Beam Test	
Location:	Final Effluent, **BEFORE** disinfection
Sample Type:	Grab sample
Container:	Clean, plastic bottle
Preservation:	None
Sample Volume:	3 x 1 quart (3 x 1L)
Analysis Method	Trojan Technologies Analytical Services
Packing & Delivery:	Ship overnight with ice

Grab Sample from a Channel for Post-Disinfection Microbial Analysis

Use aseptic techniques while sampling to prevent sample contamination.

Collect samples that are representative of the water being tested. Keep the bottle closed until it is time to sample.

1. Plunge capped plastic or "Nalgene" bottle under water well below surface scum and foam.
2. Remove cap from bottle and fill to approximately 1 inch (2.5 cm) from top. (The airspace allows for proper mixing before testing).
3. Replace cap immediately. Do not contaminate inner surface of cap or neck of bottle.
4. Store samples on ice in the dark to prevent photo repair or dark repair by the microorganisms.

Note:	*Properly label samples and take care to avoid possible contamination of bottles or samples. If any uncertainty exists while sampling, THROW THE SAMPLE AWAY AND RESAMPLE USING A NEW, STERILE BOTTLE.*

Transit time and temperature are extremely important factors that affect sample quality. The samples should be delivered on ice to the laboratory and be tested within 1 to 6 hours of sampling. If this is not possible samples should be refrigerated at 39.2°F (4°C) and cultured within 24 hours. Do not use dry ice to cool the sample.

Sample Requirements for Post-Disinfection Microbial Analysis	
Location:	Final Effluent, **AFTER** UV disinfection
Sample Type:	Grab sample
Container:	Sterile, plastic bottle
Preservation:	None
Sample Volume:	10 ounces (250 mL)
Analysis Method	*Membrane Filtration – Standard Methods for Examination of Water and*

	Wastewater (Section: 9222)
Shipping:	1 to 6 hours if using a local laboratory. Within 24 hours if shipping to Trojan Technologies.

Chapter 13

TROUBLESHOOTING GUIDE

13 TROUBLE SHOOTING GUIDE 13-1

13 TROUBLE SHOOTING GUIDE

Do not undertake operation, repairs or servicing of equipment unless you are familiar with the operation and servicing of technical equipment and are trained in electrical and mechanical safety.

If there is any doubt in your understanding of any of the information or procedures call your local Trojan Certified Service Representative or Trojan Technologies Inc. for assistance.

Your common sense and good judgment are crucial to safe and successful operation and maintenance of the equipment.

If you feel you are not competent in your level of training, skill or comprehension of this manual's instructions, have the work done by a qualified operator or a Trojan Certified Service Representative.

Read the Warnings and Precautions section and General Lock Out Procedures before operating or performing any maintenance on this equipment. Read procedures thoroughly before starting them. Review the warnings and cautions that accompany any procedure and review the warnings and precautions section each time you prepare to perform maintenance on the TrojanUV3000™PTP. For more information on the systems see the specific chapters in this manual.

Note: Ensure that the power has been disconnected prior to any work being performed on circuit boards.

Note: When reference is made to a certified technician or personnel, this means someone who has the skills to perform the procedures required. If there is any doubt about how to perform an operation do not attempt to do so without first consulting your local Trojan Certified Service Representative or Trojan Technologies.

DANGER

Electrical Hazard!

LOCKOUT and TAG all sources of power before performing any maintenance, cleaning or repairs on any piece of equipment. The power sources may include electrical or stored energy. Refer to the general lockout and tag procedures in the O&M Manual.

NOTE: A CERTIFIED ELECTRICIAN SHALL PERFORM ALL ELECTRICAL WORK.

Instructions:

1. Locate the condition in one of the tables below that best matches the condition onsite
2. Review the symptoms and possible causes corresponding to the given condition.
3. Review the corresponding solution(s) provided and follow correct procedures as outlined in this manual.

Note: If at any time you are unsure of the procedure, call your local Trojan Certified Service Representative or Trojan Technologies Inc. before proceeding. Injury or damage to the equipment due to improper testing, handling, or maintenance will not be covered under Trojan's warranty and is the responsibility of the individual performing the troubleshooting.

13.1 Basic System Troubleshooting

UV Module (UVM) Troubleshooting

Condition	*Symptom*	*Possible Cause*	*Solution*
1. One UV lamp status LED is off	Corresponding lamp is off	Lamp failure	Replace lamp
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
	Corresponding lamp is on	Module Board (MCB)	Replace module board
2. Two UV lamp status LEDs are off (lamps 1&2 or lamps 3&4)	Corresponding lamps are off	Lamp failure	Replace lamps
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
		Ballast failure	Replace ballast
	Both LEDs are off in a two-lamp module	No power to the module	Inspect module power cable – is it plugged-in or damaged? Reset ground fault of PDR or reset PDR supply breaker
	Corresponding lamps are on	Module Board (MCB)	Replace module board
3. All UV lamp status LEDs are off	All lamps are off	Lamp failure	Replace lamps
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
		Ballast failure	Replace ballast
	All lamps are on	Module Board (MCB)	Replace module board

IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL YOUR LOCAL TROJAN CERTIFIED SERVICE REPRESENTATIVE OR TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE.

Power Distribution Receptacle (PDR) Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. Ground Fault (GFI) trips	GFI trips for a specific module only	Cracked sleeve causing water intrusion	Replace sleeve
		Faulty o-ring causing water intrusion	Replace o-ring
		End-cap assembly causing water intrusion	Inspect and repair or replace end-cap assembly
		Faulty or cut wiring	Inspect and repair or replace faulty wiring
	GFI trips for any module	Faulty wiring at GFI	Inspect and repair or replace wiring as necessary
		Faulty GFI receptacle	Replace GFI receptacle
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL YOUR LOCAL TROJAN CERTIFIED SERVICE REPRESENTATIVE OR TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE.			

Monitoring System Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. Elapsed Time display flashing		Elapsed time displays 12000 -12,500, 24,000-24,500… hours	Replace lamps. Display will stop flashing after 12,000, 24,000… hours
2. UV intensity display is flashing and displaying 0.0mW/cm^2		Sensor cable is not connected to monitoring system	Reconnect UV sensor to monitoring system
		Fouled sleeve and/or sensor	Clean sleeve and sensor as required with Trojan approved cleaning agent.
		Loose or no connection at TB5 terminal in monitoring system enclosure	Tighten or reconnect wiring at terminal

3. UV intensity display is flashing and displaying value less than alarm set point (1.6 mW/cm^2)		Fouled sleeve and/or sensor	Clean sleeve and sensor as required with Trojan approved cleaning agent.
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL YOUR LOCAL TROJAN CERTIFIED SERVICE REPRESENTATIVE OR TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE.			

Disinfection Performance Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
Disinfection limit has been exceeded	Indicator organism is greater than legislated limit.	Lamps beyond 12,000 hours of operation.	Replace lamps. Refer to Chapter 7.
		Lamps out within system modules.	Replace defective lamps. Replace defective ballasts. Refer to chapter 7.
		Quarts sleeves are fouled.	Clean sleeves with Trojan approved cleaning agent. Refer to Chapter 7.
		Debris within UV Modules.	Remove debris from modules.
		Effluent level within channel is greater than 1 inch above top lamp.	Ensure channel flow is within system design parameters. Ensure weir is clean of debris. Ensure channel is clean.
		Contaminated sample, sample container.	Repeat sample following proper sampling techniques. Refer to Chapter 12.

Condition	***Symptom***	***Possible Cause***	***Solution***
Disinfection limit has been exceeded	Indicator organism is greater than legislated limit.	Channel has collected a build up of debris and solids.	Dewater channel and clean.
		Effluent Percent UV Transmittance (%UVT) is below system design parameter.	Review plant process to return % UVT within system design parameters. Refer to Chapter 1.
		Peak Flow greater than system design limits.	Ensure system peak flow is within system design limits.
		Effluent Total Suspended Solids (TSS) is greater than system design parameter.	Review plant process to return TSS within system design parameters. Refer to Chapter 1.
		Effluent Particle Size Distribution (PSD) is high.	Review plant process to address the size of effluent solids. Refer to Chapter 1.
		UV absorbent agents have entered plant process.	Review to changes to plant process. e.g.) Iron Review new local industries, which may be discharging to your plant. Refer to chapter 1.

IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL YOUR LOCAL TROJAN CERTIFIED SERVICE REPRESENTATIVE OR TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE. LABORATORY TESTING BY TROJAN TECHNOLOGIES INC. MAY BE REQUIRED FOR FURTHER INVESTAIGATION.

GF Piping Systems

Instruction manual

Metering ball valve type 523

1. Intended use

Metering ball valves of type 523 are exclusively intended to block or convey media within the allowed pressure and temperature limits or regulate the flow of fluid after installation into a piping system. The valve is intended to be used within the chemical stability of the entire valve and all its components.

2. Related Documents

You may obtain the Planning Fundamentals as further information from your Georg Fischer representative or from Georg Fischer Piping Systems Ltd.
CH-8201 Schaffhausen Switzerland
Info.ps@georgfischer.com or
www. piping.georgfischer.com

3. Safety and responsibility

- Only use metering ball valve as intended
- Only have installation, operation, maintenance, and repairs executed by qualified personnel
- Regularly train personnel regarding all applicable issues of the locally effective regulations for occupational health and safety, environmental protection, and most of all for pressure-retaining piping systems
- Make sure that personnel is familiar with the operating instructions and its contents, that they understand them and follow them.

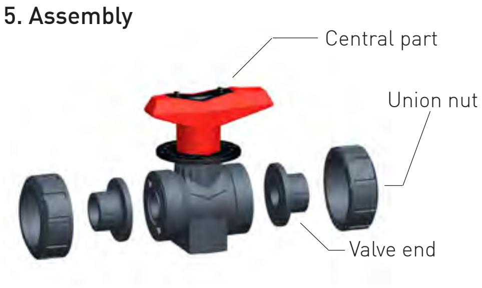
The same safety regulations apply to ball valves as to the piping system.
The maximum operating duration is 25 years.

> NOTICE
> **Observe operating instructions**
> The operating instructions are part of the product and an important part of the safety concept.
> Nonobservance may lead to severe injuries or death.
> - Read and follow operating instructions.
> - Always keep operating instructions available in proximity to the product.
> - Repeat operating instructions to all subsequent users of the product.

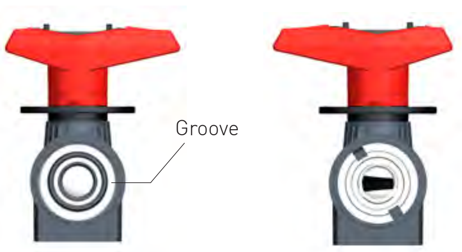
4. Transport and storage

- Transport and store metering ball valve in its original packaging with care
- Protect from damaging influences such as dust, dirt, moisture as well as thermal and UV radiation
- Prevent connecting parts from damage by either mechanical or other influences
- Store metering ball valve in open lever position.

5. Assembly



> WARNING
> **Confusion of fixed and loose side**
> Nonobservance may lead to severe injuries or death.
> - With housings one distinguishes between and fixed and a loose side. The fixed side is the side into which the ball cannot be inserted.
> - Carefully read operating instructions for assembly.



Fixed side: The fixed side has a deep groove, which separates the large outer diameter from a smaller diameter.

Please carefully and completely read these instructions prior to assembly and commissioning of the metering ball valve. They contain important information on how to avoid bodily injury and material damage.

Georg Fischer Piping Systems Ltd. CH-8201 Schaffhausen (Switzerland)
Phone +41(0)52 631 30 26 / info.ps@georgfischer.com / www.gfps.com

161.484.586 / GFDO 6260/1, 4 (04.12)

Loose side: The loose side shows the union bush, which is marked by two grooves at the outer edge. The grooves are the counterpart for the stems on the lever, which are intended for unscrewing the union bush.

6. Commissioning

Pressure test

> CAUTION
> **Overstraining due to exceeded maximum pressure**
> The test pressure of an assembly may not exceed 1.5 x PN (maximum of PN + 5 bar). The component with the lowest PN determines the maximum allowed test pressure in the performance section.
> - Prior to and during the pressure test, the assemblies and connectors must be checked for leak-tightness. Record result.

For the pressure test of ball valves, the same instructions apply as for the piping system.
For detailed information, please refer to the GF Planning Fundamentals, chapter Processing and Installation.
In addition, the following applies:

- Make sure that all assemblies are in the correct open and closed position.
- Fill the piping system and carefully de-aerate it.

7. Maintenance

Ball valves do not require maintenance with normal operation. However, the following provisions must be taken:

- Periodic inspection to make sure that there is no leakage of media to the outside.
- Operate ball valves that are always in the same position 1-2 x per year in order to check their functionality.

8. Mounting and dismounting

8.1 Dismount ball valve from pipe

> CAUTION
> **Central part as replacement part**
> Exchanging single components from the central part can have serious consequences.
> - When exchanging the ball valve type 523, only use the central part as a replacement.
> - When mounting / dismounting the ball valve, always follow the steps of these operating instructions.
> - Execute functional test prior to commissioning.

> NOTICE
> **Observe changes with variations**
> In comparison to type 323, type 523 has different installation dimensions, valve ends, and union nuts. Using different components and installation dimensions (than required for type 523) may damage the piping system.
> - Align installation dimensions and installation descriptions in the technical documentation with the available components.

> WARNING
> **Risk of injury due to uncontrolled evasion of the medium**
> If the pressure was not relieved completely, the medium can evade uncontrolled. Depending on the type of medium, risk of injury may exist.
> - Completely relieve pressure in the pipes prior to dismounting.
> - Completely empty and rinse pipe prior to dismounting in connection with harmful, flammable, or explosive media. Pay attention to potential residues.
> - Provide for safe collection of the medium by implementing appropriate actions (e.g. connection of a collection container). After dismounting, the ball valve should be stored or disassembled.
> - Partially open the dismounted ball valve (45° position) and let drain in vertical position. Collect the medium.

8.2 Mount ball valve to pipe

> CAUTION
> **Risk of injury due to false mounting of the ball valve to the pipe**
> Nonobservance may lead to severe injuries or death.
> - The ball valve must always be installed in open position.

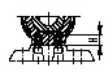
It is recommended to only remove the ball valve from its original packaging immediately prior to installation.

Ball valve and pipe must be aligned so that the assembly is unobstructed by mechanical demands. To mount to the pipe, specific connection regulations for cemented, welded, or screw joints must be followed. Please find further information in the "Georg Fischer Planning Fundamentals".

> WARNING
> **Material damage due to nonobservance of the insertion depth**
> Not observing the thread reaches can cause damage of the ball valve.
> The pressure load of a damaged housing can cause breakage.
> - When using the integrated fastening in the foot of the ball valve, always observe the requirements regarding the maximum insertion depth of the screws.

Maximum insertion depth of the screws into the ball valve

DN	15/10
Screw	M6
Thread reach H (mm)	15



> WARNING
> **Damage due to usage of pliers or similar tools**
> Pliers or similar tools may damage the material of the union nuts. If other tools such as pliers are used, the union nuts could be damaged. There is also the danger of damaging the thread if they are tightened too strongly.
> - Thighten the union nuts of the ball valves only handtight without the use of additional tools.

> NOTICE
> **Longitudinal or lateral forces**
> Due to temperature changes, longitudinal or lateral forces may occur if thermal expansion is constrained. Operation of a valve causes reactive forces which could damage the valve.
> - Mount the ball valve as a fixed point with the designated fastener or reinforce the piping directly before and after the ball valve with suitable supporters.

> WARNING
> **Incorrect mounting of the ball valve**
> Incorrect mounting can cause death or severe injuries upon contact in connection with harmful, aggressive, flammable, or explosive materials. Further commissioning is prohibited.
> - Following the mounting, the torque must be checked
> - A functional test – manually closing and opening the ball valve – must be executed
> - Ball valves with identifiable functional disorder may not be installed.

8.3 Mounting of scale and lever

1. Insert the scale into the housing.
   The round notch on the crown must point into the direction of the marking.

> CAUTION
> **Pay attention to arrows on scale**
> Rotating the scale will impair the functionality. This can cause incorrect setting of the ball position.
> - Pay attention to the arrows on the scale. These must always point into the direction of the fixed side.

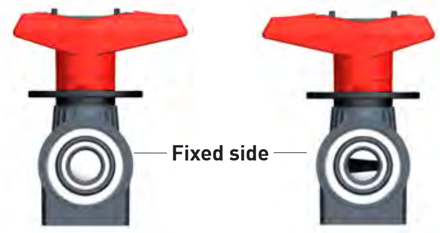
2. Mount the display element to the lever.

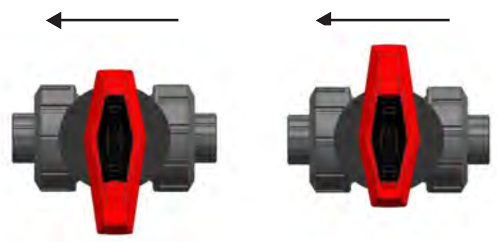
3. Attach the standard lever with the stem to the crown of the housing. The ball valve is now ready for use. The display must read zero on both sides.

9. Functional test

Step 1:
Turn the lever clockwise as far as it will go.
To check whether the ball is closed, take a quick look into the fixed side.

Step 2:
Turn the lever counter-clockwise (approx. 180°) as far as it will go. To check whether the ball is open, take a look into the fixed side.





10. Troubleshooting

To troubleshoot, please refer to chapter "Troubleshooting" in the Planning Fundamentals as well as to the warnings contained in this document. You may obtain the Planning Fundamentals on the Internet or request them from your Georg Fischer representative.

11. EC declaration of conformity

The manufacturer Georg Fischer Piping Systems Ltd., 8201 Schaffhausen (Switzerland) declares that ball valves of type 523 comply with the harmonized design norm EN-ISO 16135

1. pressure-retaining armatures in terms of the EG pressurizer regulation 97/23/EG and correspond with such requirements of this regulation regarding the assemblies,
2. and comply with the requirements of the building product regulation 89/106/EG pertaining to the assemblies.

The commissioning of this ball valve is prohibited until the conformity of the entire system, which the ball valve is integrated into, has been declared in accordance with one of the mentioned EG regulations. Modifications to the ball valve, which impact the specified technical data and the intended use, void the manufacturer's declaration. Additional information may be found in the "Georg Fischer Planning Fundamentals".

Schaffhausen, 28.02.2012

Dirk Petry
R&D Manager
Georg Fischer Piping Systems

The technical data are not binding. They neither constitute expressly warranted characteristics nor guaranteed properties nor a guaranteed durability. They are subject to modification. Our General Terms of Sale apply.

Wallace & Tiernan® Liquid Feed Systems Encore® 100 Diaphragm Metering Pump

The Encore® 100 Diaphragm Metering Pump combines the robustness of hydraulic diaphragm drives with the unparalleled economy, simplicity, and serviceability of mechanical diaphragm liquid ends.

The pump is ideal for metering chemicals commonly used in the treatment of water and wastewater as well as industrial processes. It handles capacities up to 197 l/h (52 USGPH) at back pressure to 10 bar (150 psi). Precision engineered liquid ends suitable for mild solutions, aggressive chemicals, high viscosity polymers and slurries are available. Clear cartridge valves provide fast, service and built in visual indication of operation.

The Encore® 100 Diaphragm Metering Pump provides high metering accuracy even at varying pressure. Its rugged industrial construction, yet compact and light-weight design provides long lasting service.

Key Benefits

- Ideal for metering most chemicals used in water and wastewater or industrial applications
- Capacities to 197 l/h (52 USGPH), back pressures to 10 bar (150 psi)
- Built-in indication or operating status with clear PVC cartridge valves
- High metering accuracy even with varying discharge pressures
- Efficient metering through precision engineered liquid ends
- Single or double liquid end configuration

Product Sheet

Water Technologies

SIEMENS

Features

Manual Control

A five-turn micrometer gives continuous feed-rate adjustment over a 10:1 range. A percent scale and vernier indicate stroke length setting to 1 part in 100. Stroke length is infinitely adjustable from 0 to 100%.

Start-Stop Control

Encore® 100 pumps are easily wired into the circuit of a transfer pump, switch, timer, or controller.

Variable Speed Control or Variable Frequency Control

Precise and accurate feed rate control via stroke speed control using a DC motor or a variable frequency drive for inverter duty motor is available. Stroke frequency can be regulated manually by a potentiometer setting, or automatically via a 4-20 mA process variable input signal (optional). Closed loop speed regulation provides feed rate control accurate to 1% of full scale. Flow proportional control dosing or scaling of a process variable can be accomplished by means of a SCU used in conjunction with a variable speed or variable frequency drive.

For more compound loop control, a PCU can be used to provide set point control in response to two variables, such as flow and chlorine residual.

Advantages

Available with standard induction or optional variable speed / inverter duty motors for wider operating ranges and automatic process control.

This robust mechanical assembly includes an epoxy-painted cast iron gearbox for superior corrosion resistance, heavy duty ball bearings, robust gears, and a hardened steel cam and spring drive for incomparable simplicity and economy.

Double simplex capability: If your process changes or grows, a second drive with independent capacity control can be added quickly, easily, and economically. The corrosion resistant PVC liquid end adapter completely separates and seats the pump head from the drive unit. This isolating design eliminates the risk of cross-contaminating gearbox lubricant and process fluid.

Obtain precise and highly repeatable feed rate settings with a five-turn micrometer type stroke length adjuster. A percent scale and vernier indicate stroke length in 1% increments. Feedrate is infinitely adjustable from 0 to 100%.

High precision guided ball-and-seat clear PVC cartridge valves provide built-in sight flow indication and fast service. The design includes wide flow paths and four-point guides to control ball rise and assure proper seating. The valve housing is compression sealed to the pump head and pipe connectors by o-rings, and removes easily for service or replacement.

Short suction and discharge porting minimizes friction losses and cavitation, improving hydraulic characteristics and providing far more efficient fluid metering than conventional liquid end designs.

Our premium composite diaphragm is manufactured to a stringent specification to ensure long life even under the most demanding applications. The design incorporates Teflon® coated facing, for the highest degree of chemical resistance, and nylon reinforcements, all bonded to a pre-formed elastomeric support. We've added convolutions for unconstrained rolling action, a steel backing plate to assure volumetric accuracy even at varying discharge pressures and an o-ring groove in the head's diaphragm cavity for complete sealing.

An optional diaphragm leak detection system senses the early stages of diaphragm failure. The system consists of a solid-state, electro-optic sensor that mounts on the liquid end, and a control box. This box, which can be mounted at the pump, or up to 100 feet away, can monitor two liquid ends. LED's and a relay provide both local and remote indication of failure.

Single and double ball valves are available to handle mild solutions, aggressive chemicals, high-viscosity polymers, and slurries. Kynar® head and valve arrangements are also offered for high temperature applications. Traditional grey PVC threaded valves can also be supplied.

Chemical Metering Integrated Systems

Low cost packaged systems can be custom configured from standard stock components including tanks, mixers, instrumentation and a wide range of controls. For example, combine an Encore® 100 metering pump with variable speed control, a Wallace & Tiernan® Residual Analyzer and a PCU Process Control Unit for an economical hypochlorite disinfection control system. All systems are shipped assembled, prewired and ready to install.

Accessories

Our comprehensive range of coordinated accessories provide the ability to produce the best possible installation. Choose from Backpressure Valves, Pressure Relief Valves, Anti-syphon Valves, Multifunction Valves, DeGas Valves, Main Connections, Strainers, Pulsation Dampeners, Calibration Chambers, Solution Tanks, Mixers, Liquid Level Switches, Slurry Flushing Systems and numerous mounting accessories, just to name a few.

Replacement Parts

Genuine Wallace & Tiernan® replacement parts not only protect your investment in Wallace & Tiernan® equipment, they also offer assurance against failure in critical health related applications. Avoid the hazard and hidden costs of cheap imitations. Siemens Water Technologies offers fast delivery of original quality replacement parts from a large parts inventory.

PM Kit® Package

PM Kit preventive maintenance packages contain original Wallace & Tiernan® replacements for those parts most susceptible to wear. They facilitate scheduled maintenance and help maintain equipment in good working order, eliminating equipment breakdowns and costly downtime.

Side View

Technical Information

Accuracy
Repeatable metering accuracy is $\pm$2% of full scale, at constant hydraulic conditions, over a 10:1 operating range.

Stroke Length
4.8mm (0.18 inches)

Feed Rate Adjustment
Feed rate is infinitely adjustable from 0 through 100%. A percent scale and vernier indicate stroke length settings in 1% increments. Each revolution of the knob changes stroke length by 20%.

Operating Range
Stroke length is adjustable over a 10:1 range; stroke frequency is adjustable over a 20:1 range (using an optional variable speed DC motor), and 10:1 (using an optional variable frequency drive and invertor duty motor). Total combined maximum operating turndown can be as high as 200:1. Above 100:1 continous turndown, total available operating range should be evaluated against specific chemicals being metered. Minimum recommended stroke length and frequency adjustment is 10%.

Suction Lift
The pump will self-prime with 3m (10 ft) of water suction lift (wetted valves, zero back pressure, full stroke and speed, water like solutions). Once primed, the pump will operate with a 3m (10 ft) of water suction lift. Flooded suction is recommended.

Temperature Limits
With PVC liquid end: Ambient temperatures from 2 to 52° C (35 to 125°F), process fluid temperatures up to 52°C (125°F). With Kynar® liquid end: Process fluid temperatures up to 62°C(144°F).

Control Modes
Manual, remote-manual, start-stop, variable speed, flow proportional, direct residual and compound loop.

Electrical Requirements
Standard induction motor arrangement is 1450 or 1725 rpm, 115/230 Volt, 50/6OHz single phase, TEFC, UL listed, CSA approved. Motors with other electrical characteristics are available as an option. Diaphragm leak detector requires 115/230 Volts. Relay rating 5 Amps @ 250 Volts, 30 VDC. Variable speed drive control unit requires 115/230 Volt, 50/60 Hz single phase, 2.5 to 10 Amps.

Materials of Construction
Gear box: epoxy-painted cast iron
Liquid end adapter: PVC
Pump head: PVC and Kynar® standard; stainless steel optional
Suction and discharge valve housings: clear PVC, grey PVC, Kynar®
Valve balls: 316 stainless, TFE, ceramic, glass and polyurethane (for slurry service)
Valve seals: Hypalon® and Viton®
Diaphragm: TFE-faced, fabric reinforced, elastomer backed, with a steel backing plate
Mounting base: ABS

Polymer and Slurry Handling Capabilities
Polymer solutions up to 5000 centipose (Brookfield Viscometer with No. 2 spindle @12 rpm) under any condition. Higher viscosities with decreased capacitiy. Hydrated lime slurries up to 0.45 kg/l (3.8 lb/gal) of water; activated carbon slurries up to 0.13 kg/l (1.1 lb/gal); Diatomaceous earth slurries up to 0.20 kg/l (1.7 lb/gal) of water.

Weight and Shipping Weight
Single simplex: 20 kg; 24 kg (44 lb; 53 lb)
Double simplex: 25 kg; 29 kg (55 lb; 64 lb)

Dimensions
See WT.440.050.100.UA.CN and WT.440.050.102.UA.CN

Top View

Capacity Chart

Diaphragm Size (inches)	50 Hz 1450 RPM Stroke Frequency Strokes / min	50 Hz Simplex Capacity [1] l/h	50 Hz Simplex Capacity [1] usgph	60 Hz 1725 RPM Stroke Frequency strokes / min	60 Hz Simplex Capacity [1] l/h	60 Hz Simplex Capacity [1] usgph	Maximum Discharge Pressure bar	Maximum Discharge Pressure psi	Motor Induction (Variable Speed) kw	Motor Induction (Variable Speed) hp	Connections NPT (BSP) [tubing]
35 mm (1-1/2")	36	4.9	1.3	43	5.7	1.5	10	150	.18 (.37)	1/4 (1/2)	R1/2" (1/2") [3/8" ID x 1/2" OD]
	72	10.6	2.8	86	11.3	3.0					
	120	15.9	4.2	144	18.9	5.0					
	144	18.9	5.0	---	---	---					
50 mm (2")	36	24.6	6.5	43	29.3	7.7	10	150	.18 (.37)	1/4 (1/2)	R1/2" (1/2") [3/8" ID x 1/2" OD]
	72	49.2	13.0	86	58.8	15.5					
	120	82	21.7	144	98.4	26					
	144	98.4	26.0	---	---	---					
*100 mm (4")	36	35	9.2	43	41.8	11.4	4	60	.18 (.37)	1/4 (1/2)	R3/4 (3/4")
	72	70	18.5	86	83.6	22.1					
	120	116	30.6	144	140	37					
	144	140	37	---	---						

* Note: 100mm (4") head is an application special. Available as simplex arrangement only.

[1] The capacity table reflects simplex capacities. Double simplex arrangements must be configured with the same stroke frequency on both liquid ends.

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Literature No.: WT.440.050.000.IE.PS.0308
Subject to change without prior notice.

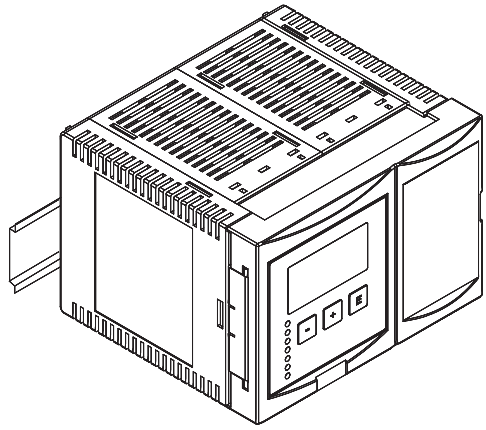
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

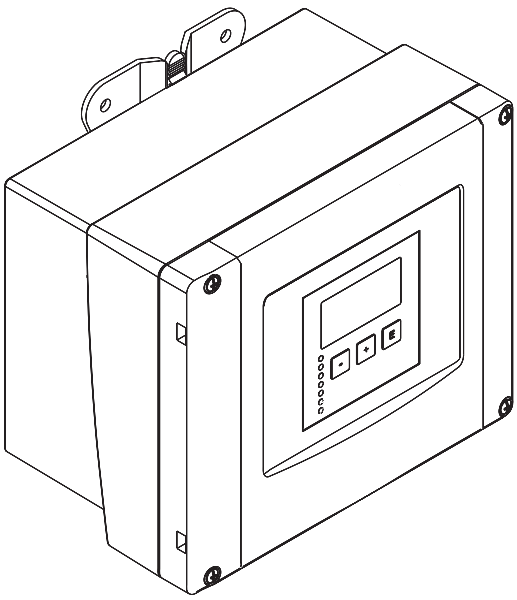
Operating Instructions

Prosonic S FMU90

Flow Measurement
Backwater and Dirt Detection
Totalizers and Counters

COMMUNICATION PROTOCOL





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V 02.01.00

Endress+Hauser

People for Process Automation

Table of Contents

1 Safety Instructions

1.1 Designated use

The Prosonic S FMU90 is a transmitter for the ultrasonic sensors FDU90, FDU91, FDU91F, FDU92, FDU93, FDU95 and FDU96. The sensors of the class FDU8x can be connected as well.
The transmitter version for level measurements (→ 🗎 9, "Product structure":
FMU90 - *1**********) can be applied for different measuring tasks, e.g.:

- level measurement in tanks and silos
- conveyor belt measurement
- level limit detection
- (alternating) pump control, screen and rake control

The version for level and flow measurements (→ 🗎 9, "Product structure":
FMU90 - *2**********) is usable for further measuring tasks, e.g.:

- flow measurement at open flumes and weirs
- (non-resettable) totalizers and (resettable) counters
- control of samplers by time or counting pulses
- backwater and dirt detection in flumes
- simultaneous measurement of level and flow in a stormwater overflow basin with only one sensor

1.2 Installation, commissioning, operation

The Prosonic S FMU90 is fail-safe and constructed to the state-of-the-art. It meets the appropriate standards and EC directives. However, if you use it improperly or other than for its designated use, it may pose application-specific hazards, e.g. product overflow due to incorrect installation or configuration. Installation, electrical connection, start-up, operation and maintenance of the measuring device must therefore be carried out exclusively by trained specialists authorised by the system operator. Technical personnel must have read and understood these operating instructions and must adhere to them. You may only undertake modifications or repair work to the device when it is expressly permitted by the operating instructions.

1.3 Operational safety and process safety

Alternative monitoring measures must be taken to ensure operational safety and process safety during configuration, testing and maintenance work on the device.

Hazardous areas

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this Additional documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local regulations.

The transmitter may only be installed in suitable areas.
Sensors with a certificate for hazardous areas may be connected to a transmitter without a certificate.

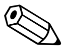
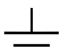
⚠ Warning!
The sensors FDU83, FDU84, FDU85 and FDU86 with an ATEX, FM or CSA certificate are not certified for connection to the FMU90 transmitter.

For installations in the USA:
Installation should be in accordance with the National Electrical Code NFPA 70 (NEC)

For installations in Canada:
Installation should be in accordance with the Canadian Electrical Code (CEC)

1.4 Notes on safety conventions and symbols

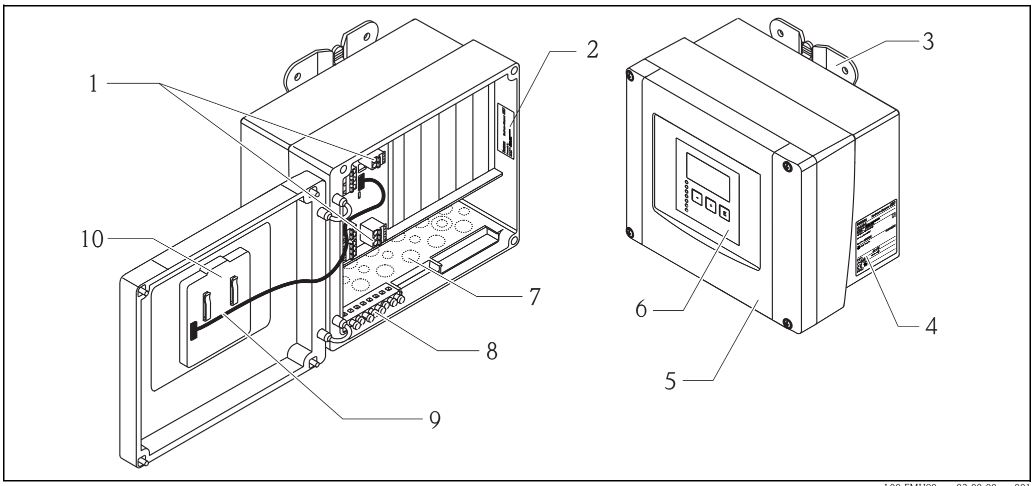
In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.

Safety conventions	
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned
Explosion protection	
	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its name plate it can be installed in an explosion hazardous area
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. Devices located in and wiring entering areas with the designation "explosion hazardous areas" must conform with the stated type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas
Electrical symbols	
⎓	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied
~	**Alternating voltage** A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice
	**Temperature resistance of the connection cables** States, that the connection cables must be resistant to a temperature of at least 85 °C (185 °F).

2 Identification

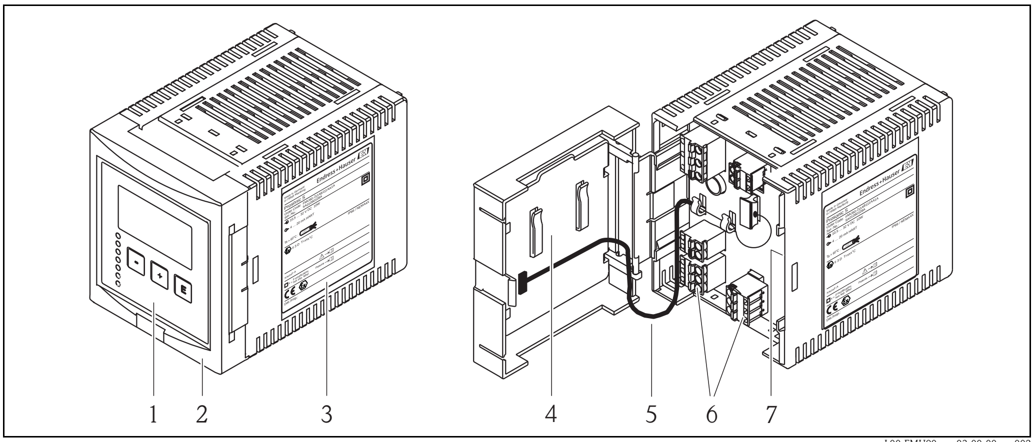
2.1 Parts of the Prosonic S FMU90

2.1.1 FMU90 in the field housing



1 Terminals
2 Instrument designation and identification
3 Mounting help
4 Nameplate
5 Cover of the terminal compartment
6 Display and operating module
7 Prestamped openings for cable entries
8 Grounding terminals
9 Display cable
10 Short instructions

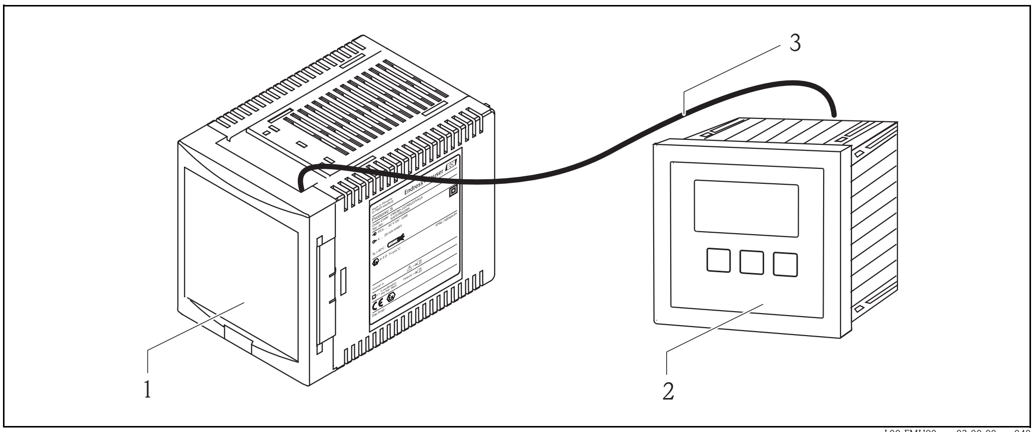
2.1.2 FMU90 in the DIN-rail housing



1 Display and operating module
2 Cover of the terminal compartment
3 Nameplate
4 Short instructions
5 Display cable
6 Terminals
7 Instrument designation and identification

Note!
The picture shows the smallest possible version of the DIN-rail housing. Depending on the version of the Prosonic S, the width of the housing may be larger.

2.1.3 FMU90 with remote display and operating module for cabinet door and switchboard mounting (96 x 96 mm (3.78 x 3.78 in))

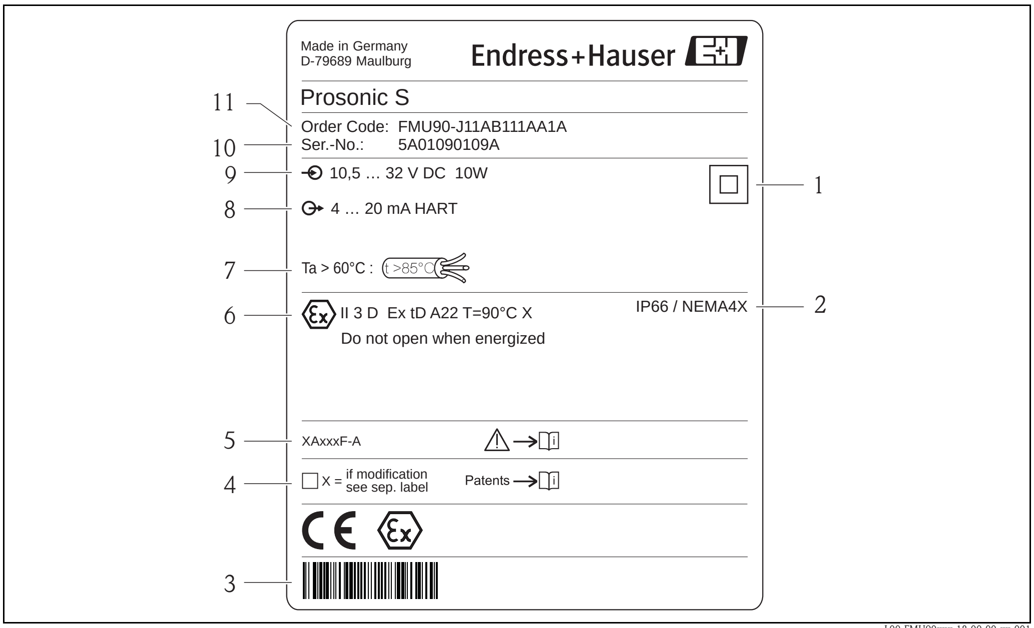


L00-FMU90xxx-03-00-00-xx-040

1 DIN-rail housing without display
2 Remote display and operating module for cabinet mounting
3 The cable (3 m (9.8 ft)) is supplied

Note!
The picture shows the smallest possible version of the DIN-rail housing. Depending on the version of the Prosonic S, the width of the housing may be larger.

2.2 Nameplate (Example)



L00-FMU90xxx-18-00-00-xx-001

1 Specification of the electrical protection class (protective insulation)
2 Ingress protection
3 Barcode
4 Marked if a modification nameplate is present
5 Reference to additional safety-relevant documentation
6 Certificate-related data
7 Specification of required temperature resistance of the connection cables
8 Output signal
9 Power supply
10 Serial number
11 Order code (as defined by the product structure)

2.3 Product structure

10	**Approval**	
	R	Non-hazarous area
	J	ATEX II 3D
	N	CSA General Purpose
20	**Application**	
	1	Level + pump control, alternating
	2	Flow + totalizer + level + sample control + preprogrammed OCM flow curves
	3	Level + additional pump control
	4	Universal instrument (Level + Flow + Additional pump control)
30	**Housing, material**	
	1	Field mounting PC, IP66 NEMA 4x
	2	DIN rail mounting PBT, IP20
40	**Operation**	
	C	Illuminated display + keypad
	E	Illuminated display + keypad, 96x96, panel mounting, front IP65
	K	w/o display, via communication
50	**Power supply**	
	A	90-253 VAC
	B	10,5-32 VDC
60	**Level input**	
	1	1x sensor FDU9x/8x
	2	2x sensor FDU9x/8x
70	**Switch output**	
	1	1x relay, SPDT
	3	3x relay, SPDT
	6	6x relay, SPDT
80	**Output**	
	1	1x 0/4-20mA HART
	2	2x 0/4-20mA HART
	3	PROFIBUS DP
90	**Additional input**	
	A	w/o additional input
	B	4x limit switch + 1x temperature PT100/FMT131
100	**Datalog function**	
	A	Basic version
110	**Languages**	
	1	de, en, nl, fr, es, it, pt
	2	de, en, ru, pl, cs
	3	en, zh, ja, ko, th, id
120	**Additional option**	
	A	Basic version
	L	5-point linearity protocol only to order with FDU9x sensor + 5-point linearity protocol
995	**Marking**	
	1	Tagging (TAG)
	2	Bus address
FMU90 -		complete product designation

(*): meaning of the language code:
cs: Czech; de: German; en: English; es: Spanish; fr: French; id: Bahasa (Indonesia, Malaysia); it: Italian; ja: Japanese; ko: korean; nl: Dutch; pl: Polish; pt: Portuguese; ru: Russian; th: Thai; zh: Chinese

2.4 Scope of delivery

- Instrument according to the version ordered
- Endress+Hauser operating program on the enclosed CD-ROM
- For FMU90-***E********: remote display and operating module; retainers; connection cable (3 m (9.8 ft))
- For FMU90-*21********* FMU and for FMU90-*41*********: 2 slotted capstan screws (can be used to seal the housing)
- Accessories → 113
- Approval documentation: if this is not included in the operating manual (Refer to the nameplate for the names of the safety instructions that apply to your device version.)
- CD-ROM with further documentation, e.g.
  – Technical Information
  – Operating Instructions
  – Description of Instrument Functions
  – Slot/Index tables
- Brief operating instructions for quick commissioning, see the following table:

Brief operating instructions	Output	Application	Instrument version
KA01065F	HART	▪ level measurement ▪ alternating pump control ▪ screen and rake control	FMU90 – *******1**** FMU90 – *******2****
KA01066F		▪ flow measurement ▪ backwater and dirt detection ▪ totalizers and counters	FMU90 – *2*****1**** FMU90 – *4*****1**** FMU90 – *2*****2**** FMU90 – *4*****2****
KA01067F	PROFIBUS DP	▪ level measurement ▪ alternating pump control ▪ screen and rake control	FMU90 – *******3****
KA01068F		▪ flow measurement ▪ backwater and dirt detection ▪ totalizers and counters	FMU90 – *2*****3**** FMU90 – *4*****3****

2.5 Certificates of approvals

CE mark, declaration of conformity
The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EC directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

2.6 Registered trademarks

HART®
Registered trademark of HART Communication Foundation, Austin, USA

ToF®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

FieldCare®
Trademark of Endress+Hauser Process Solutions AG

3 Installation

3.1 Incoming acceptance, transport, storage

3.1.1 Incoming acceptance

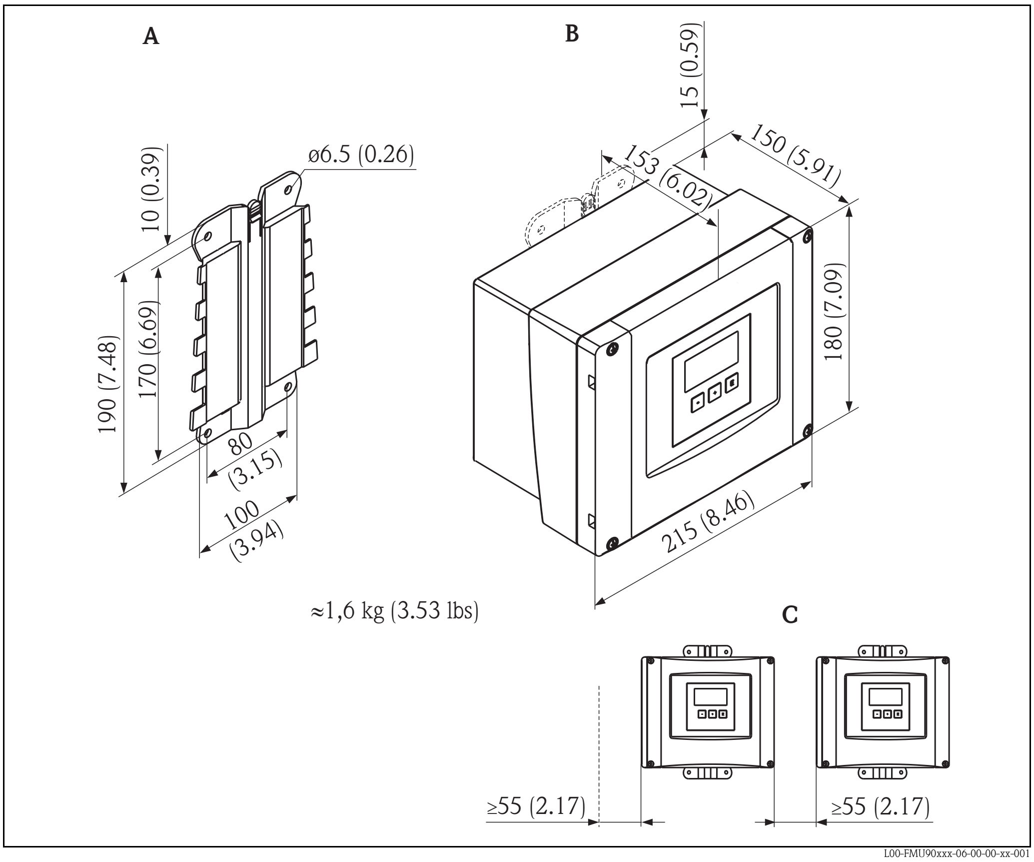
Check the packing and contents for any signs of damage.
Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Transport, storage

Pack the measuring instrument so that it is protected against impacts for storage and transport. The original packing material provides the optimum protection for this.
Permissible storage temperature: -40 to +60 °C (-40 to +140 °F)

3.2 Mounting the field housing

3.2.1 Dimensions of the field housing



Dimensions in mm (in)
A Mounting help (supplied); can also be used as drilling template
B Field housing
C Minimum mounting distance

The dimensions of the field housing are the same for all instrument versions.
To open the housing, a minimum mounting distance of 55 mm (2.17 in) is required on the left.

3.2.2 Installation conditions

Weather protection

In order to avoid excessive sunlight exposure, the instrument should be mounted in a position which is protected against direct sunlight or a protection cover should be applied (→ 113, "Accessories").

Overvoltage protection

In order to protect the Prosonic against overvoltages (especially if mounted outdoors), connection of an overvoltage protection is recommended (→ 113, "Accessories").

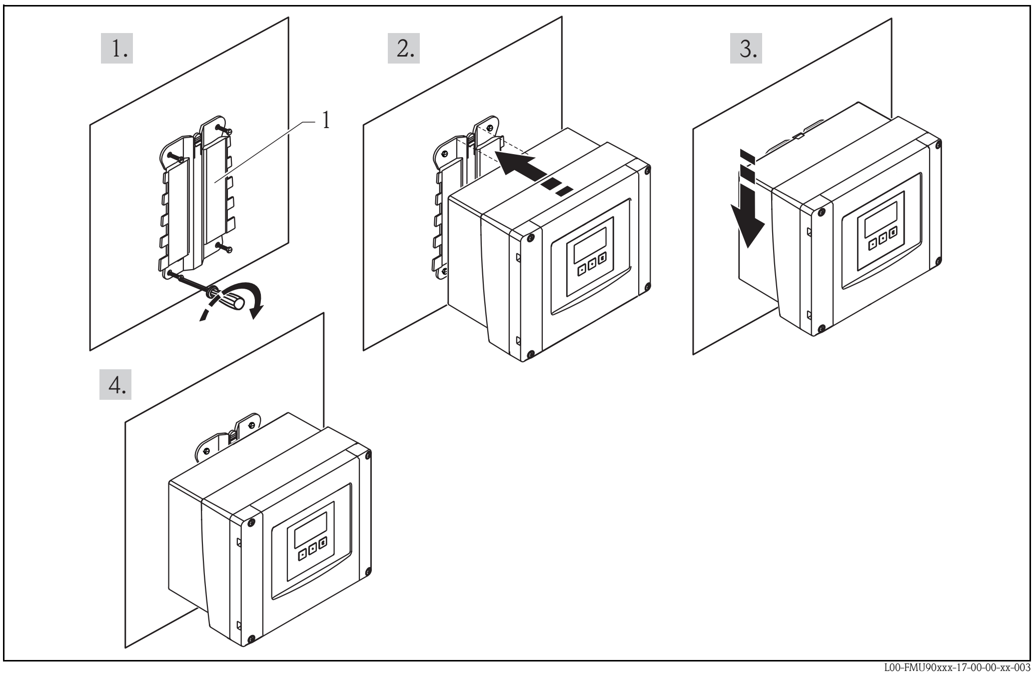
Wall mounting

A mounting help for wall mounting is supplied. It also serves as drilling template. The mounting help should be mounted on a flat surface and may not become distorted.

Pipe mounting

A mounting plate is available for mounting of the field housing to 1" to 2" pipes (→ 113, "Accessories").

3.2.3 Installation



1 Wall mounting with mounting help

3.3 Mounting the DIN-rail housing

3.3.1 Dimensions of the DIN-rail housing

The dimensions of the DIN-rail housing depend on the instrument version. The version determines, which terminal areas the Prosonic S contains. The dimensions are influenced by the following features of the product structure (→ 🗎 9):

- 60: Level Input
- 70: Switch Output
- 80: Output

In order to determine the dimensions of a specific version, perform the following steps (see the example → 🗎 14):

1. Using the product structure, determine the options of the features 60, 70 and 80 of the instrument version in question.

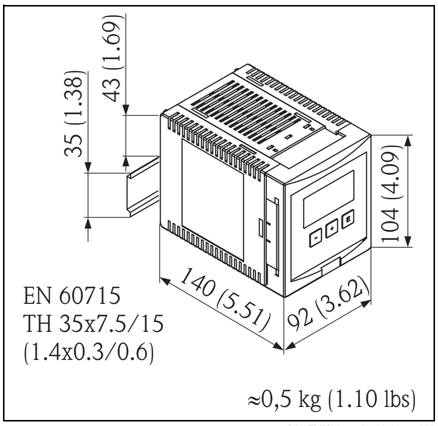
	10	20	30	40	50	**60**	**70**	**80**	**90**	100	110	120
FMU90 -												

2. Using the following table, determine how many optional terminal areas this instrument version contains.

Feature and option of the product structure	**corresponds to the following terminal area**	**present?** **yes = 1** **no = 0**
feature 60; option 2 and/or feature 80, option 2	2 sensor inputs and/or 2 analogue outputs	
feature 70, option 3 or 6	3 o 6 relays	
feature 80, option 3	PROFIBUS DP interface	
feature 90, option B	inputs for external switches and external temperature sensor	
	Sum =	

3. The appropriate dimensions are given in the following diagram:

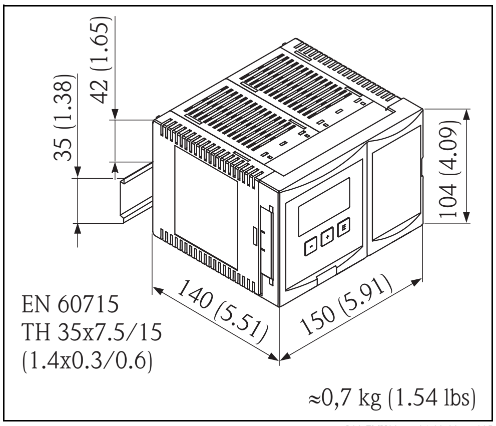
Sum = 0
(only basic terminal area)



L00-FMU90xxx-06-00-00-xx-002

Dimensions in mm (in)

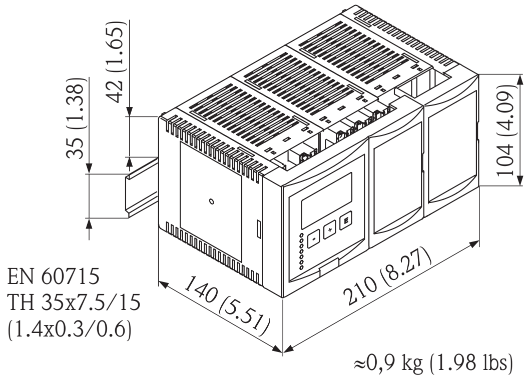
Sum = 1, 2 or 3
(1-3 optional terminal areas)



L00-FMU90xxx-06-00-00-xx-005

Dimensions in mm (in)

Sum = 4
(4 optional terminal areas)



Dimensions in mm (in)

Example

	10	20	30	40	50	**60**	**70**	**80**	**90**	100	110	120
FMU90 -	R	1	2	A	A	2	3	2	A	A	1	A

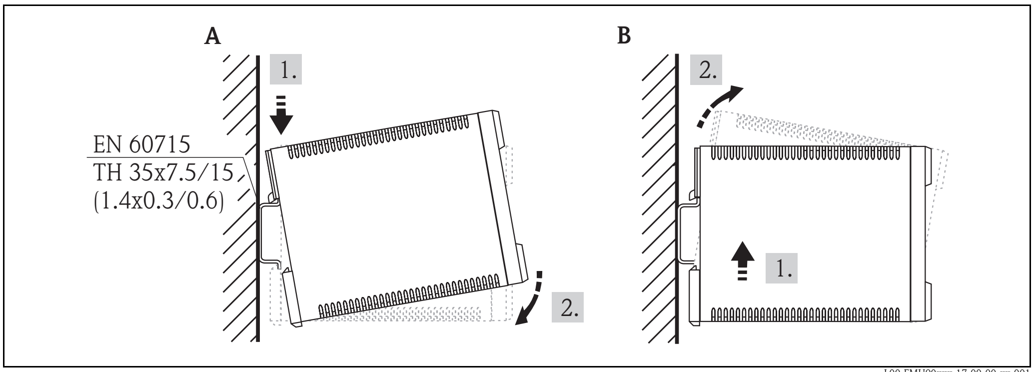
feature and option of the product structure	**corresponds to the following terminal area**	**present?**
feature 60; option 2 and/or feature 80, option 2	2 sensor inputs and/or 2 analogue outputs	1 (yes)
feature 70, option 3 or 6	3 or 6 relays	1 (yes)
feature 80, option 3	PROFIBUS DP interface	0 (no)
feature 90, option B	inputs for external switches and external temperature sensorr	0 (no)
	Sum =	2

Sum = 2
=> 104 x 150 x 140 mm (4.09 x 5.91 x 5.51 in)

3.3.2 Installation conditions

- The DIN-rail housing must be mounted outside hazardous areas in a cabinet.
- The housing is mounted on a DIN rail EN 60715 TH 35x7,5 or TH 37x15.
- Do not install the instrument in the vicinity of high-voltage lines, motor lines, contactors or frequency converters. The installation regulations for high-voltage lines, motor lines, contactors or frequency converters must be observed.
- To ensure easy mounting and opening of the housing, a distance of approx. 10 mm (0.39 in) should be kept between the instruments.
- In order to avoid interference signals, the sensor cables must not be laid parallel to high voltage or electric power lines.
- The cables may not be laid in the proximity to frequnecy converters.

3.3.3 Mounting



L00-FMU90xxx-17-00-00-xx-001

A Attaching the instrument to the rail
B Detaching the instrument from the rail

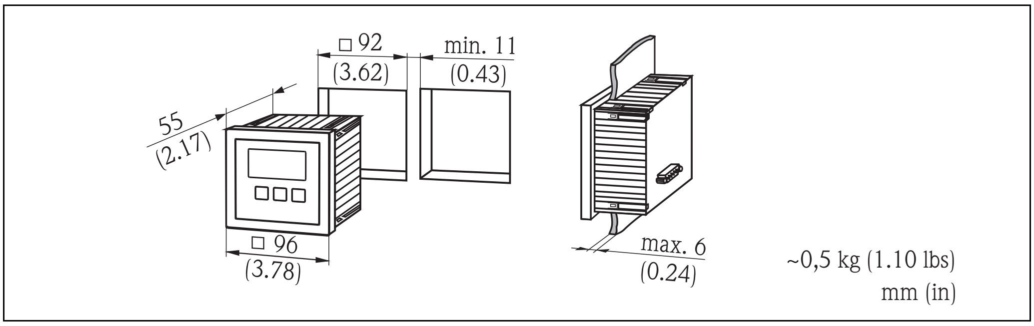
3.4 Mounting the remote display and operating module

3.4.1 Scope of delivery

If the Prosonic S is ordered with the display for cabinet door mounting, the following is contained in the scope of delivery:

- Display and operating module, 96 x 96 mm (3.78 x 3.78 in)
- 4 retainers (with nuts and screws)
- Connection cable (3 m (9.8 ft)) for connection to the transmitter (preassembled with suitable plugs).

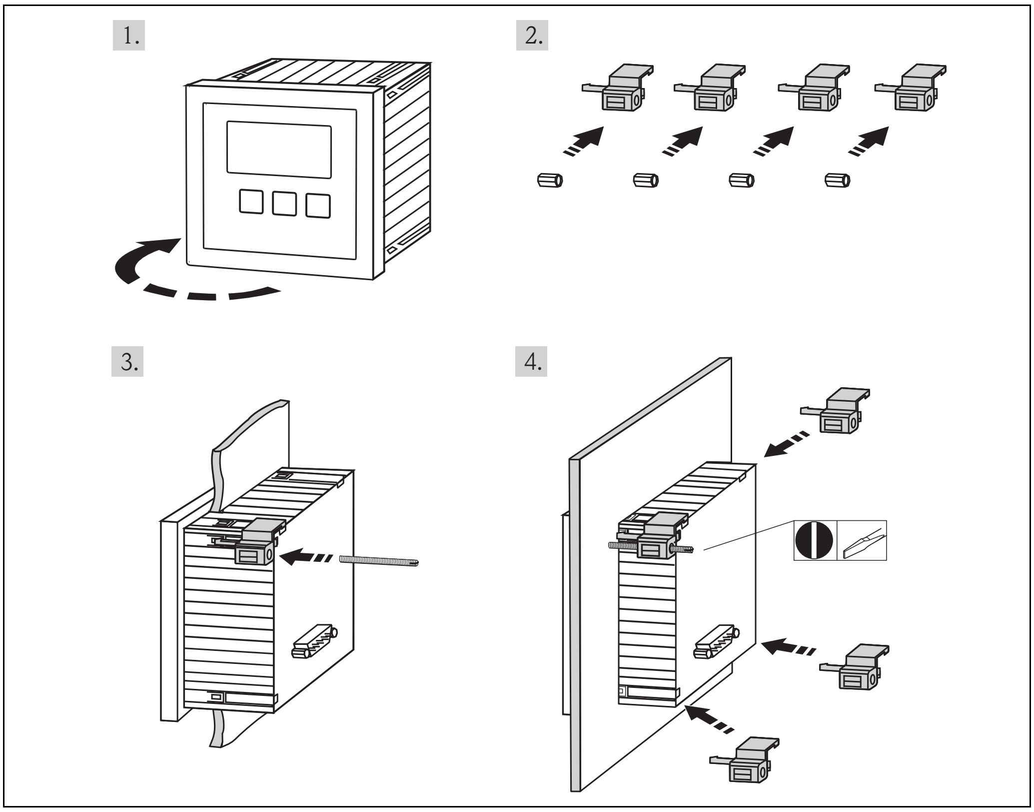
3.4.2 Dimensions of the separate display and operating module



L00-FMU90xxx-06-00-00-xx-004

3.4.3 Mounting

1. Cut an opening of 92 x 92 mm (3.62 x 3.62 in) into the intended mounting position (e.g. cabinet door).
2. Insert the remote display module into the opening and fix the retainers as shown in the following figure:

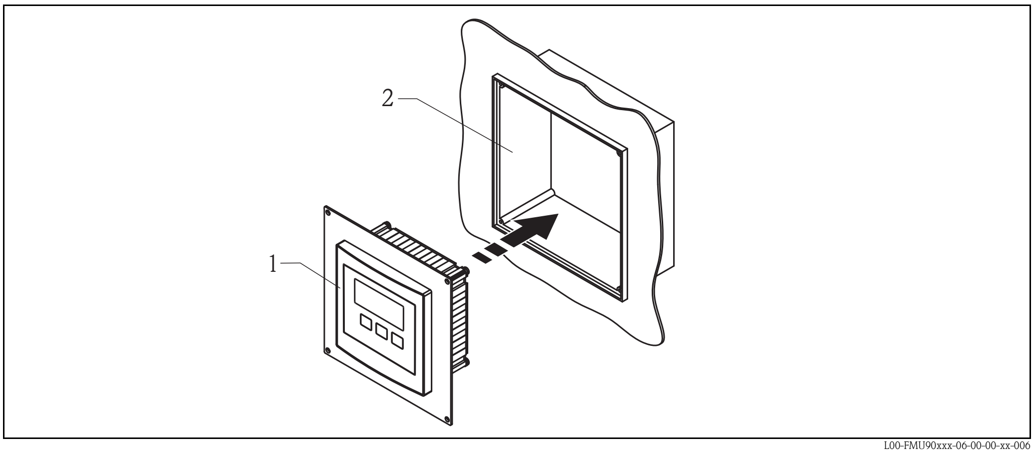


L00-FMU90xxx-17-00-00-xx-002

3.4.4 Adaption plate

If an opening of 138 x 138 mm (5.43 x 5.43 in) and the remote display of the Prosonic FMU860/861/862 are already present, you can use the adaption plate (Order Code: 52027441, → 🗎 113, "Accessories"). It is inserted into the remote display of the FMU860/861/862.

Note!
The adapter plate is mounted directly in the housing of the old remote display of the FMU86x series. The housing of the remote display of the FMU86x is the holder for the adapter plate and the new remote display of the FMU90/FMU95 in the format 96 x 96 mm (3.78 x 3.78 in).



1 Remote display of the FMU90 with adaption plate
2 Opening of the remote display of the FMU860/861/862

3.5 Mounting of the sensors

Information on the mounting of the sensors can be found in the following documents:

- Technical Information TI00189F/00 (for FDU8x)
- Technical Information TI00396F/00 (for FDU9x)

These documents are supplied with the sensors.

Caution!
Observe the mounting distances of the sensors as specified → 🗎 137, "Pre-programmed flow curves".

3.6 Installation check

After installing the device, carry out the following checks:

- Is the device damaged (visual inspection)?
- Does the device correspond to the meausring point specifications such as process temperature, process pressure, ambient temperature, measuring range etc?
- If available: Are the measuring point number and labelling correct?
- Is the instrument sufficiently protected against rainfall and direct sunlight?
- For the field housing: Are the cable glands tightened correctly?
- Is the instrument securely mounted to the DIN rail or the mounting help (visual inspection)?
- For the field housing: Are the screws of the terminal compartment cover securely tightened (visual inspection)?

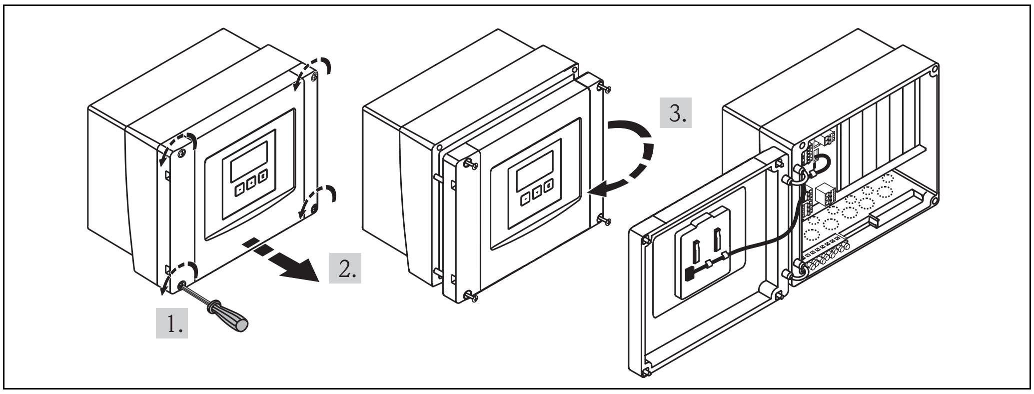
4 Wiring

Warning!
The instrument may only be installed if the supply voltage is switched off.

4.1 Terminal compartment

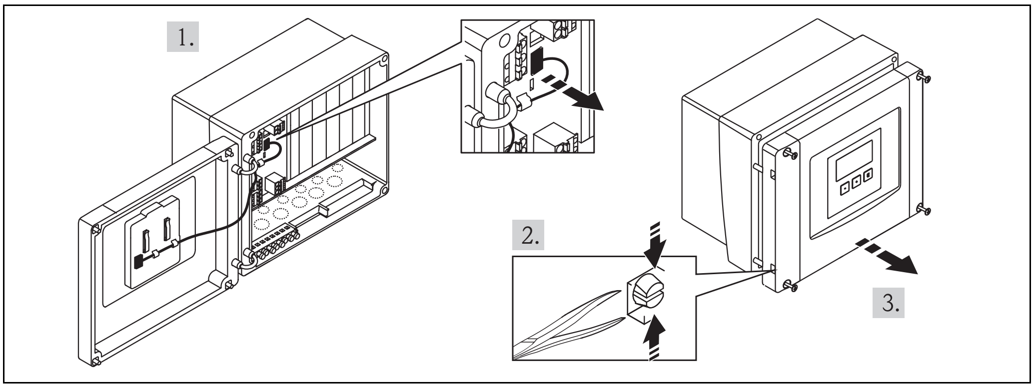
4.1.1 Terminal compartment of the field housing

The field housing has a separate terminal compartment. It can be opened after loosening the four screws of the lid.



L00-FMU90xxx-04-00-00-xx-002

For easier wiring, the lid can be completely removed by unplugging the display plug and loosening the hinges:



L00-FMU90xxx-04-00-00-xx-009

4.1.2 Cable entries of the field housing

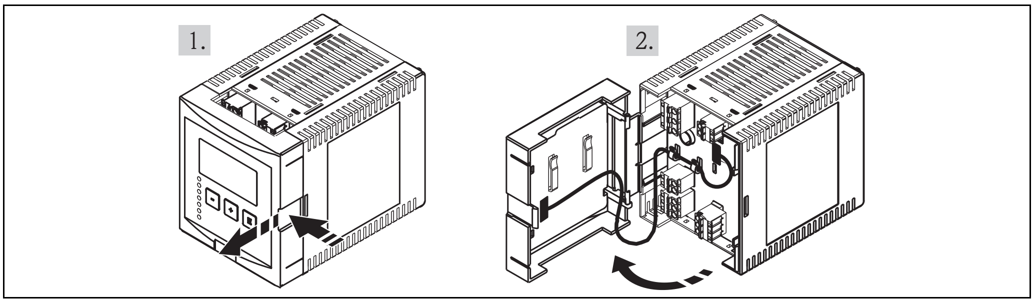
The following openings for cable entries are prestamped on the bottom of the housing :

- M20x1.5 (10 openings)
- M16x1.5 (5 openings)
- M25x1.5 (1 opening)

The required number and types of cable entries depend on the application at hand.
The prestamped openings can be removed by a suitable tool (e.g. knife or boring bit) or by punching them out cautiously.

4.1.3 Terminal compartment of the DIN-rail housing

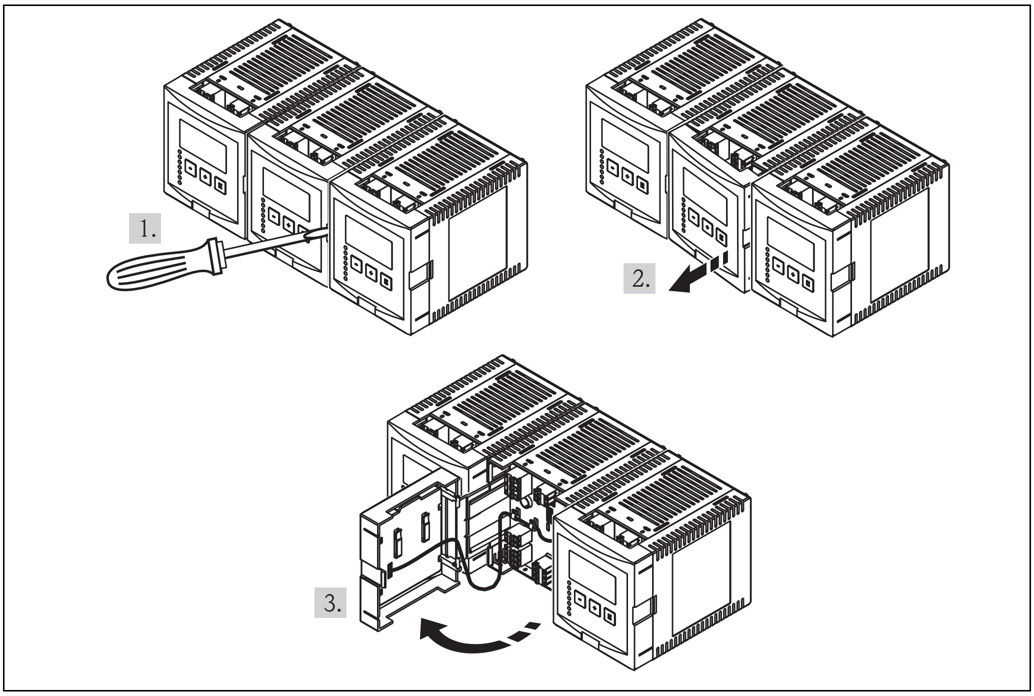
Single instrument



L00-FMU90xxx-04-00-00-xx-003

The catch can be unlocked by slightly pressing onto the clip. Then, the cover of the terminal compartment can be opened.

Several instruments mounted side by side



L00-FMU90xxx-04-00-00-xx-012

1. Open the catch of the cover (e.g. by a screwdriver).
2. Pull the cover out by approx. 20 mm (0.79 in) .
3. The cover can now be opened.

Note!
- The cables can be inserted into the housing from above or from below.
- The pictures show the smallest housing version but are valid for the larger versions as well.
- If the instruments are mounted next to each other and if the sensor cables run in parallel, the synchronization terminals (39 and 40) must be interconnected (→ 🗎 20 "Terminal assignment" and → 🗎 30 "Synchronization line").

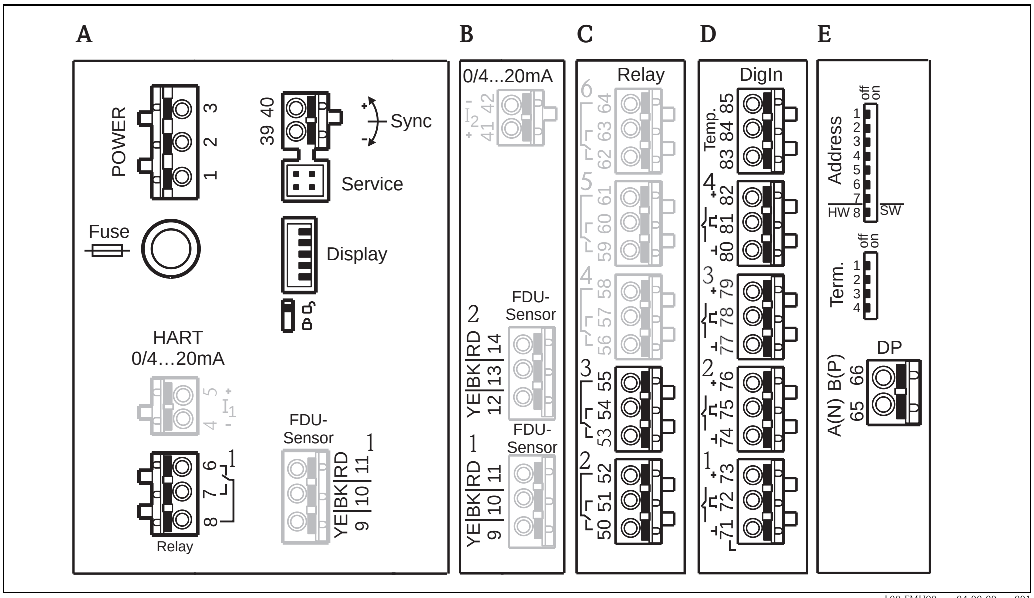
4.2 Terminal assignment

Pluggable spring-force terminals for connection of the cables are supplied in the terminal compartment. Rigid conductors or flexible conductors with cable sleeve can directly be inserted and are contacted automatically.

Conductor cross section	0.2 mm² to 2.5 mm² (26 to 14 AWG)
Cable and sleeve cross section	0.25 mm² to 2.5 mm² (24 to 14 AWG)
min. stripping length	10 mm (0.39 in)

The terminal configuration depends on the instrument version ordered. There is a basic terminal area, which is present in every instrument version. Additonal optional terminal areas are only present if the respective option has been selected in the product structure.

Terminal area		**present for the following instrument versions**
Basic area	A	for all versions
Optional areas	B	for instrument versions with 2 sensor inputs and/or 2 analogue outputs (FMU90 - *****2****** and/or FMU90 - *******2****)
	C	for instrument versions with 3 or 6 relays (FMU90 - ******3***** oder FMU90 - ******6*****)
	D	for instruments with external switch inputs and external temperature input (FMU90 - ********B***)
	E	for instrument versions with PROFIBUS DP interface (FMU90 - *******3****)



L00-FMU90xxx-04-00-00-xx-001

Terminals of the Prosonic S (the terminals depicted in grey are not present in every instrument version)
A *Basic terminal area*
B–E *Optional terminal areas (present if the respective option has been selected in the product structure)*

Note!
The depicted switching states of the relays refer to the de-energized state.

Terminals	Meaning	Terminal area	Remarks
Auxiliary energy			
1, 2	▪ L (für AC version) ▪ L+ (for DC version)	A	depending on instrument version: ▪ 90 ... 253 V_{AC} ▪ 10,5 ... 32 V_{DC}
2	▪ N (for AC version) ▪ L- (for DC version)	A	
3	Potential equalization	A	
Fuse		A	depending on instrument version: ▪ 400 mA T (for AC) ▪ 2 A T (for DC)
Analog outputs (not available for PROFIBUS DP instruments)			
4, 5	Analog output 1; 4 ... 20 mA with HART/ 0 ... 20 mA w/o HART	A	**not** present for the PROFIBUS DP version
41, 42	Analog output 2 (optional); 4 ... 20 mA/ 0 ... 20 mA	B	only for the version with two analog outputs; no HART signal at this output
Relay outputs			
6, 7, 8	Relay 1	A	
50, 51, 52	Relay 2 (optional)	C	only for the versions with 3 or 6 relays
53, 54, 55	Relay 3 (optional)	C	only for the versions with 3 or 6 relays
56, 57, 58	Relay 4 (optional)	C	only for the version with 6 relays
59, 60, 61	Relay 5 (optional)	C	only for the version with 6 relays
62, 63, 64	Relay 6 (optional)	C	only for the version with 6 relays
Bus communication (only available for PROFIBUS DP instruments)			
65	PROFIBUS A (RxT/TxD - N)	D	only for the PROFIBUS DP version
66	PROFIBUS B (RxT/TxD - P)	D	
Synchronization			
39, 40	Synchronization	A	→ 30, "Synchronization line"
Level inputs			
9 (YE), 10 (BK), 11 (RD)	Sensor 1 (FDU8x/9x) YE: yellow strand BK: black strand RD: red strand	▪ A: for versions with 1 sensor input ▪ B: for versions with 2 sensor inputs[1]	
12 (YE), 13 (BK), 14 (RD)	Sensor 2 (FDU8x/9x) (optional) YE: yellow strand BK: black strand RD: red strand	B	only for the version with 2 sensor inputs
external switch inputs			
71, 72, 73	external switch input 1	D	0: < 8 V or 72 and 73 interconnected 1: > 16 V or 72 and 73 not interconnected
74, 75, 76	external switch input 2	D	0: < 8 V or 75 and 76 interconnected 1: > 16 V or 75 and 76 not interconnected
77, 78, 79	external switch input 3	D	0: < 8 V or 78 and 79 interconnected 1: > 16 V or 78 and 79 not interconnected
80, 81, 82	external switch input 4	D	0: < 8 V or 81 and 82 interconnected 1: > 16 V or 81 and 82 not interconnected
temperature input			
83, 84, 85	temperature input: ▪ PT100 ▪ FMT131 (Endress+Hauser)	D	→ 27, "Connection of a temperature sensor"

1) In this case, terminals 9/10/11 are not present on terminal area A.

Warning!
When using the public supply mains, an easily accesible power switch must be installed in the proximity of the device. The power switch must be marked as a disconnector for the device (IEC/EN 61010)

Note!
- In order to avoid interference signals, the sensor cables should not be laid parallel to high voltage or electric power lines.
- The cables may not be laid in the proximity to frequnecy converters.

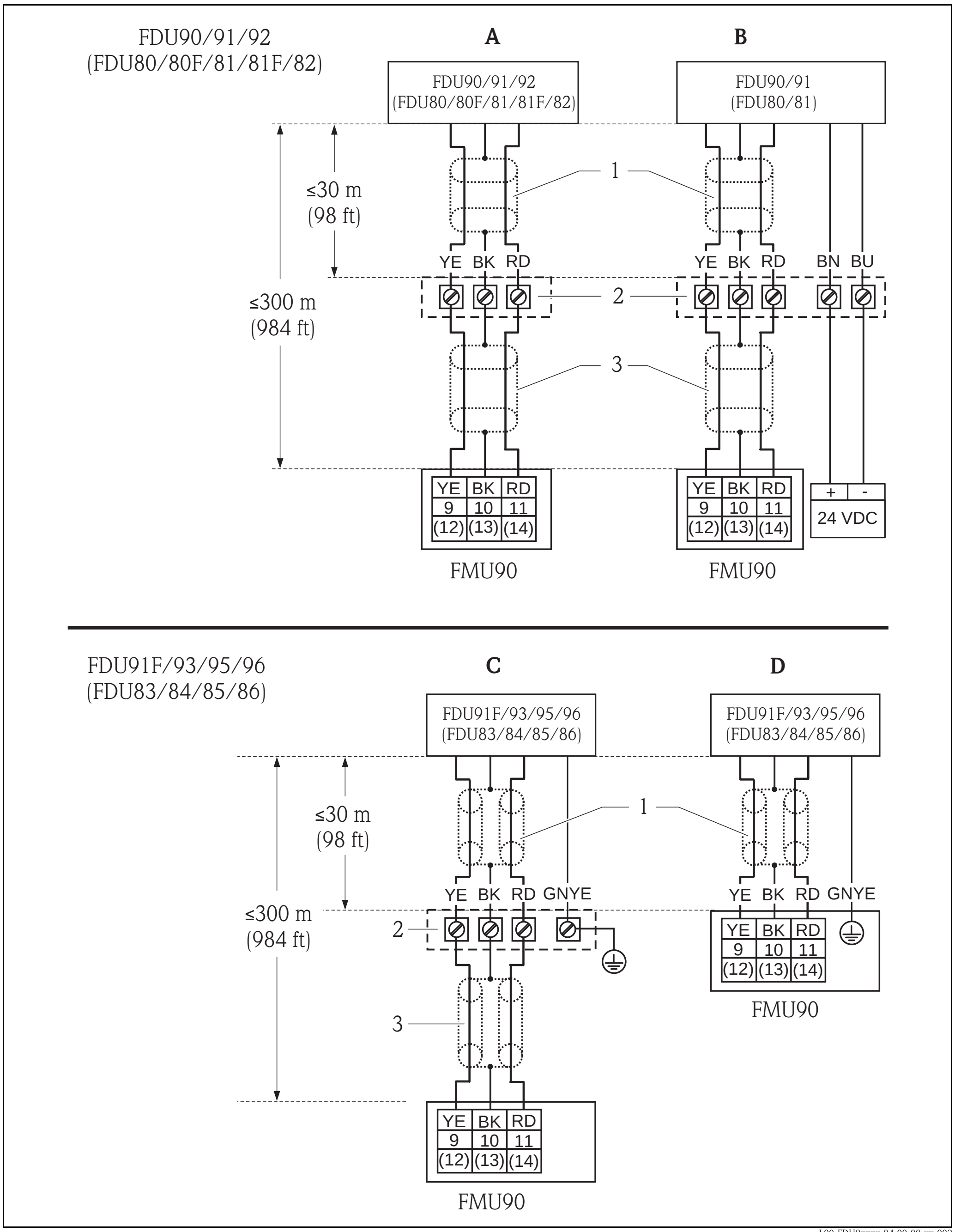
Additional elements on the terminal areas

Designation	Meaning/Remarks
Fuse	Fuse: 2 A T /DC or 400 mA T/AC
Display	Connection of the display or the remote display and operating module
Service	Service interface for connection of a PC/Notebook via Commubox FXA291
	Locking switch
Term.	Bus termination (only applicable for instruments with PROFIBUS interface)
Address	Bus address (only applicable for instruments with PROFIBUS interface)

Warning!
On wiring, the supply voltage must be switched off.

4.3 Sensor connection

4.3.1 Connection diagram



L00-FDU9xxxx-04-00-00-xx-002

A Without sensor heater
B With sensor heater
C Grounding at the terminal box
D Grounding at the transmitter FMU90
1 Screen of the sensor cable
2 Terminal box
3 Screen of the extension cable
Colours of the strands: YE = yellow; BK = black; RD = red; BU = blue; BN = brown; GNYE = green-yellow

4.3.2 Connection hints

Caution!
- In order to avoid interference signals, the sensor cables should not be laid parallel to high voltage electric power lines. The cables may not be laid in the proximity to frequency converters.
- The cable screen serves as a return cable and must be connected to the transmitter without any electrical break. With the pre-assembled cables, the screen ends in a black strand (BK). With the extension cable, the screen must be twisted together and connected to the "BK" terminal.

Warning!
- The sensors FDU83, FDU84, FDU85 and FDU86 with an ATEX, FM or CSA certificate are not certified for connection to the FMU90 transmitter.
- For the sensors FDU91F/93/95/96 and FDU83/84/85/86:
  The ground lead (GNYE) must be connected to the local potential equalization **after a maximum distance of 30 m (98 ft).** This can be done
  – either at the terminal box
  – or at the transmitter FMU90 or in the cabinet (if the distance to the sensor does not exceed 30 m (98 ft)).

Note!
For easier mounting it is advisable to use the sensors FDU90/91/92 and FDU80/80F/81/81F/82 with a maximum cable length of 30 m (98 ft) as well. For longer distances an extension cable with a terminal box should be used.

4.3.3 Extenxion cables for the sensors

For distances up to 30 m (98 ft) the sensor can be directly connected by the sensor cable. For longer distances, it is recommended to use an extension cable. The extension cable is connected via a terminal box. The total length (sensor cable + extension cable) may be up to 300 m (984 ft).

Caution!
If the terminal box is installed in explosion hazardous areas, all applicable national guidelines must be observed.

Suitable extension cables can be obtained from Endress+Hauser (→ 113, "Accessories")
Alternatively, cables with the following properties can be used:

- Number of cores according to the connection diagram (see above)
- Braided wire screen for the yellow (YE) and red (RD) core (no foil screen)
- Length: up to 300 m (984 ft), (sensor cable + extension cable)
- Cross section: 0.75 mm^2 to 2.5 mm^2 (18 to 14 AWG)
- Up to 8 Ω per core
- Max. 60 nF (between core and screen)
- For FDU91F/93/95/96 and FDU 83/84/85/86:
  The earth lead must not be within the screening.

4.4 Connection of the sensor heater (for FDU90/FDU91)

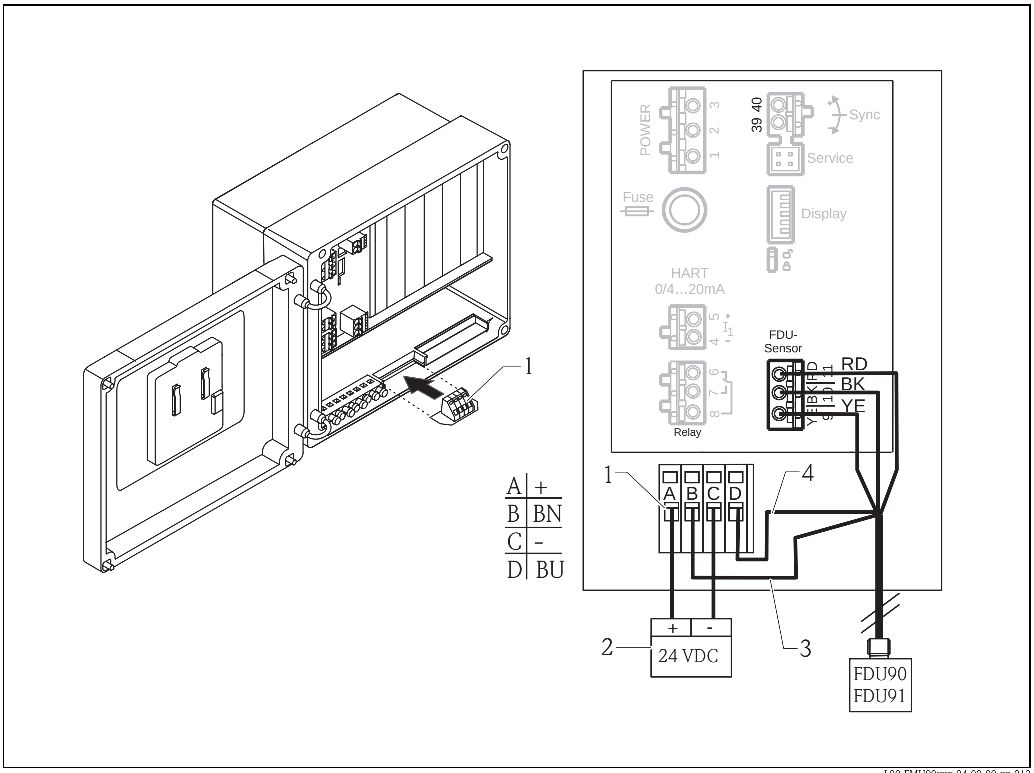
The FDU90 and FDU91 sensors are available in a version with heater. The power for this heater must be provided by an external power supply unit. The supply voltage is connected to the brown (BN) and blue (BU) strands of the sensor cable.

Technical Data

- 24 VDC ± 10%; residual ripple < 100 mV
- 250 mA per sensor

4.4.1 Connection in the field housing

For the sensor with heater, a special terminal module is supplied for the connection of the supply voltage. This terminal module can be inserted into the field housing:

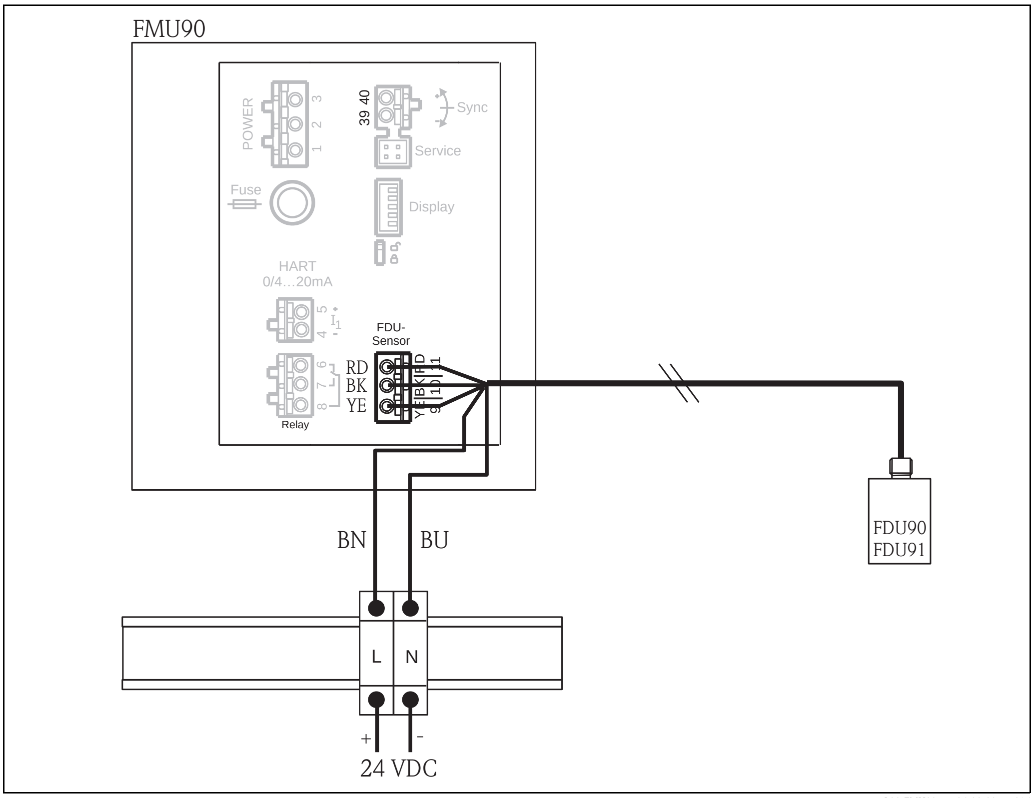


L00-FMU90xxx-04-00-00-xx-013

1 Terminal module for the sensor heater
2 External power supply unit
3 Brown strand (BN)
4 Blue strand (BU)

4.4.2 Connection in the DIN-rail housing

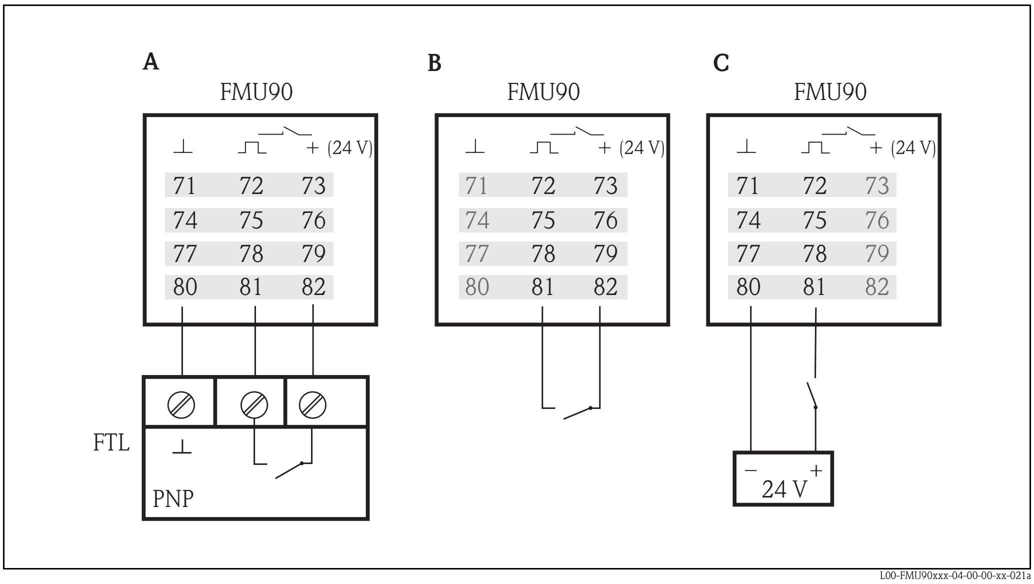
The supply voltage must be provided in the cabinet, e.g. by a terminal on the DIN-rail:



L00-FMU90xxx-04-00-00-xx-014

✎ Note!
The terminal module supplied with the sensor can also be used for connection of the supply voltage. For the terminal assignment on this module → 🗎 25.

4.5 Connection of external switches (for FMU90-********B***)



A Liquiphant
B External switch
C External switch with external supply voltage

The maximum short-circuit current at 24 V is 20 mA.

4.6 Connection of a temperature sensor

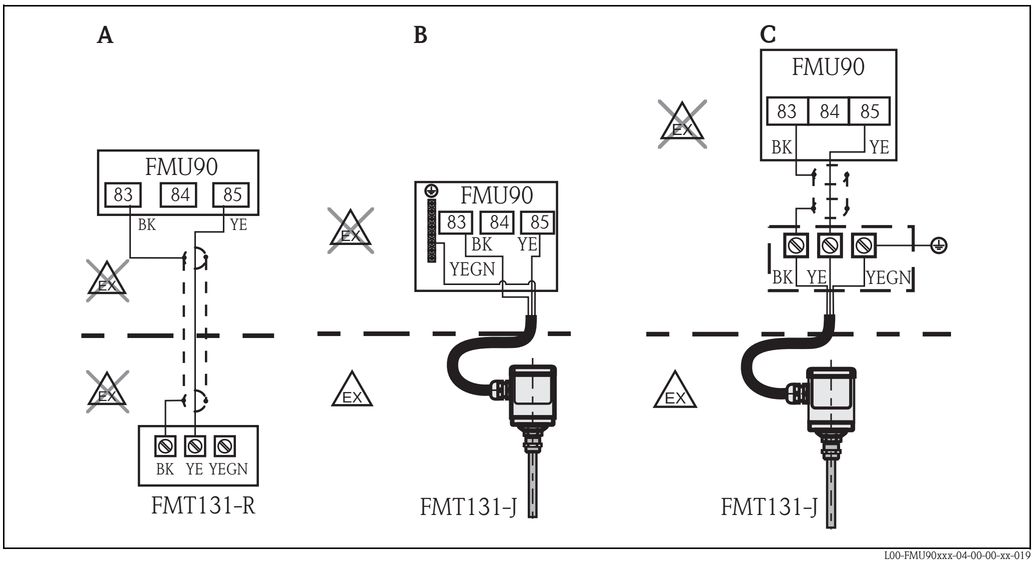
The Prosonic S FMU90 transmitter has an optional input for an external temperature probe (in the product structure: feature 90 "Additional input", option B). The following probes can be connected:

- a FMT131 temperature probe from Endress+Hauser
- a Pt100 temperature probe

Note!

- After connecting an external temperature sensor, the following is required:
  1. The type of the connected sensor (Pt100 or FMT131) must be selected in "sensor management/ext. temp. sensor" in the "sensor type" parameter.
  2. The external temperature sensor must be assigned to an ultrasonic sensor in "sensor management/FDU sensor/US sensor N" in the "temp. measurement" parameter.
- If the option "alarm" has been selected for the case of an error in external temperature sensor, this alarm is indicated by the alarm relay.

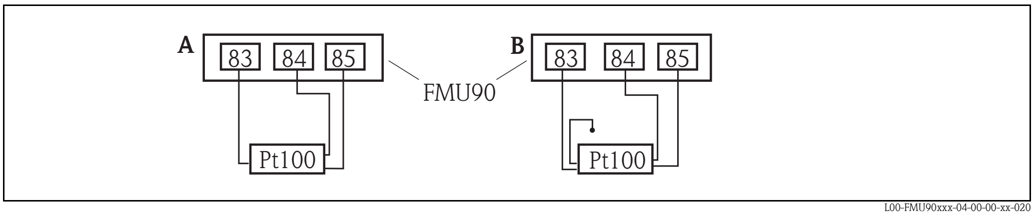
4.6.1 FMT131 (Endress+Hauser) (connectable to FMU90-********B***)



A	*Non-Ex area (FMT131-R)*	*BK*	*black*
B	*Ex area (FMT131-J) with grounding in the FMU90*	*YE*	*yellow*
C	*Ex area (FMT131-J) with grounding at a terminal box*	*YEGN*	*yellow-green*

Note!
For details refer to the Operating Instructions KA00019F/00.

4.6.2 Pt100 (connectable to FMU90-********B***)



A Pt100 with 3-wire connection
B Pt100 with 4-wire connection (one connector remains unused)

Note!
A Pt100 with 2-wire connection may not be used due to its insufficient measuring accuracy.

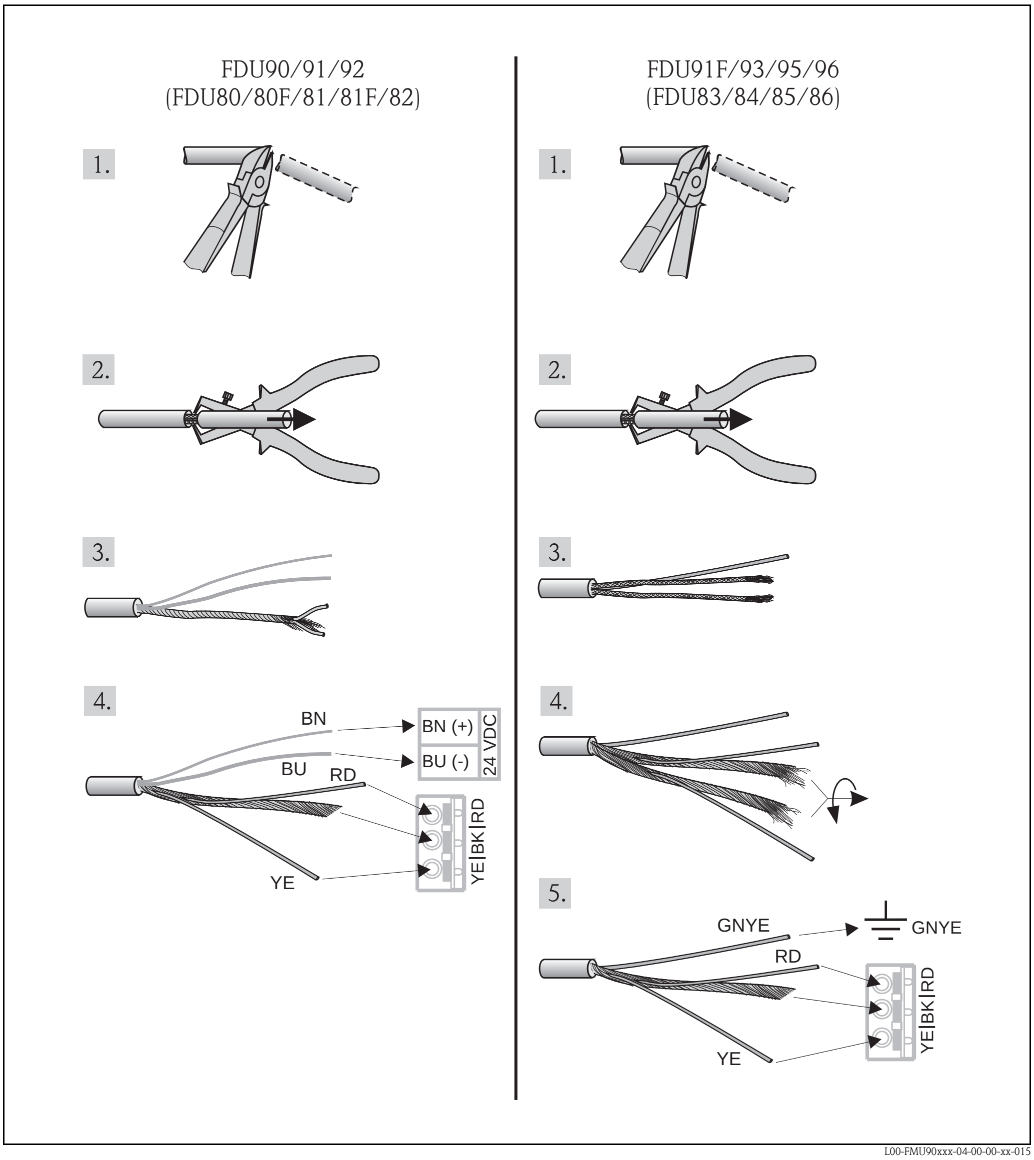
Warning!
A Pt100 may not be connected in explosion hazardous areas. A FMT131 must be used instead.

4.7 Shortening the sensor cable

If required, the sensor cable can be shortened. Please note:

- Do not damage the cores when removing the insulation.
- The cable is shielded by a metallic braiding. This shielding serves as a return cable and corresponds to the black (BK) strand of the unshortened cable. After shortening the cable, loosen the metallic braiding, twist it together securely and connect it to the "BK" terminal.

Caution!
The protective earth conductor (GNYE), which is present in some of the sensor cables, may not be electrically connected to the cable shield.

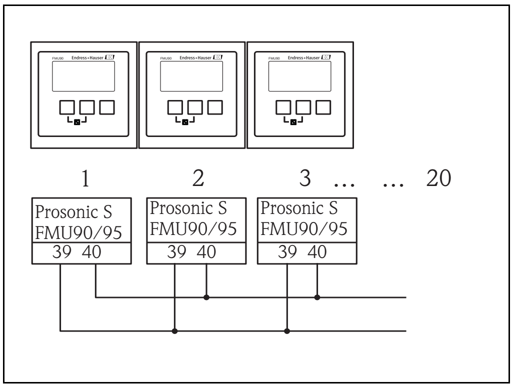


Colours of the strands: YE = yellow; BK = black; RD = red; BU = blue; BN = brown; GNYE = green-yellow

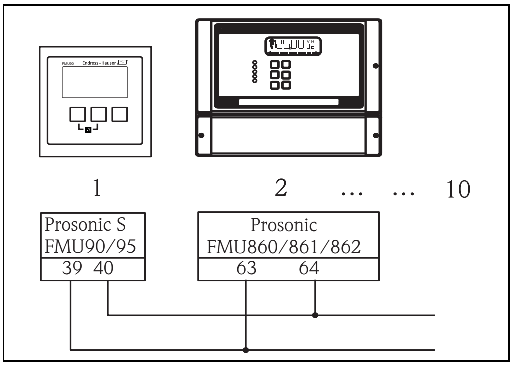
Note!
The blue (BU) and brown (BN) strands are only present for sensors with heater.

4.8 Synchronization line

- If wiring several Prosonic S (FMU90/FMU95) which are mounted in a common cabinet and if the sensor cables run in parallel, the synchronization terminals (39 and 40) must be interconnected.
- Up to 20 instruments can be synchronized in this way.
- The synchronization causes the evaluation units FMU9x to send the pulses simultaneously. Only after all sensors have received their signal, new simultaneous pulses are sent. This prevents pulses in the sensor cable of one sensor from influencing the received signal on the cable of a different sensor.
- If there are more than 20 instruments, groups must be formed, each containing a maximum of 20 instruments. For the instruments within each group, the sensor cables may run in parallel. The sensor cables of different groups must be seperated from each other.
- Usual commercial screened cable can be used for synchronization
  - Max. length: 10 m (33 ft) between the individual instruments
  - Cross section: 2 x (0.75 to 2.5 mm^2 (18 to 14 AWG))
  - For lengths up to 1 m (3.3 ft), an unscreened cable can be used; for lenghts exceeding 1 m (3.3 ft), screening is required. The screen must be connected to ground
- Instruments of the Prosonic FMU86x family can be connected to the synchronization line as well. In this case a maximum of 10 instruments can be connected to each synchronisation line.

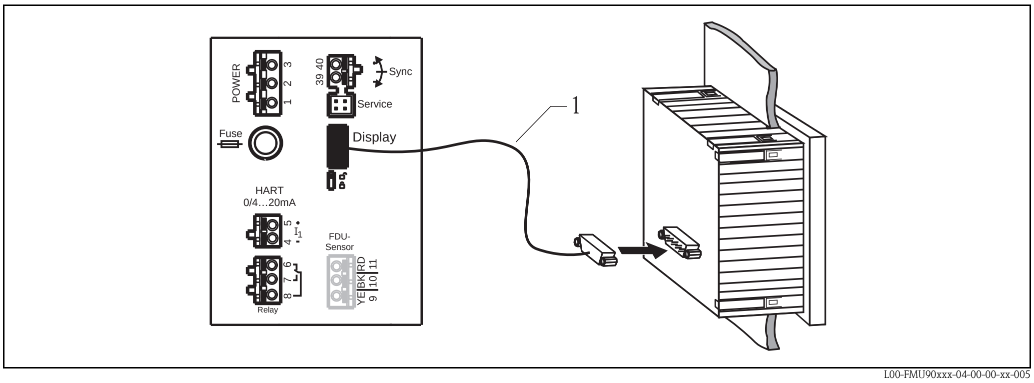


L00-FMU90xxx-04-00-00-xx-004



L00-FMU90xxx-04-00-00-xx-017

4.9 Connection of the separate display and operating module



1 Connection of the display plug with the cable (3 m (9.8 ft))

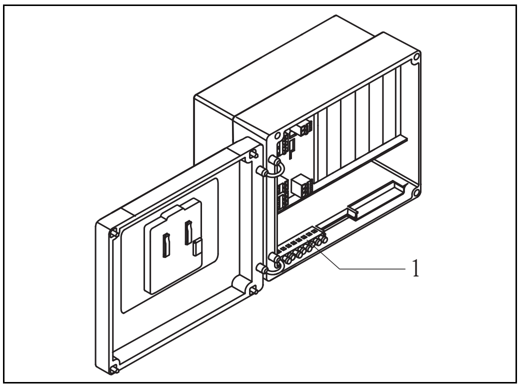
For the version of the Prosonic S with a separate display for panel mounting, a pre-assembled connecting cable (3 m (9.8 ft)) is supplied. The cable must be connected to the display plug of the Prosonic S.

✎ Note!
Minimum diameter for cable bushing: 20 mm (0.79 in).

4.10 Potential equalization

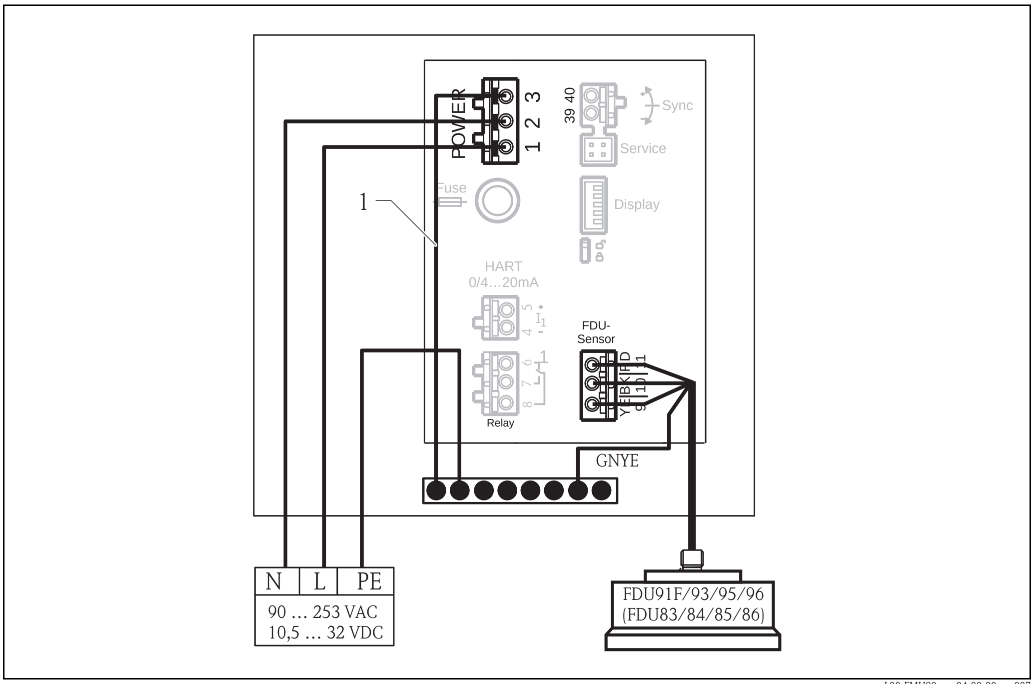
4.10.1 Potential equalization in the field housing

⚠ Warning!
The grounding line of the sensors FDU91F/93/95/96 and FDU83/84/85/86 must be connected to the local potential equalization system **after a maximum of 30 m (98 ft)** → 🗎 23. The metallic terminal block (1) in the field housing can be used for this.



L00-FMU90xxx-04-00-00-xx-006

Example



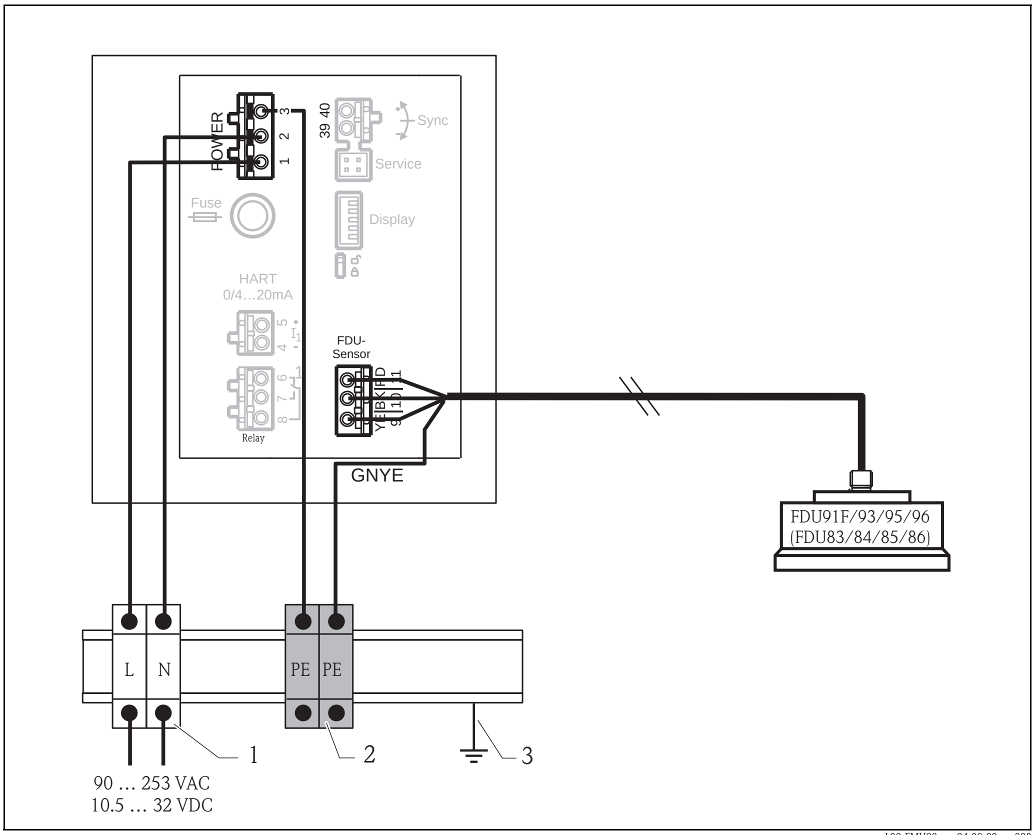
L00-FMU90xxx-04-00-00-xx-007

1 The wire is already connected on delivery

4.10.2 Potential equalization for the DIN-rail housing

If the DIN-rail housing is used, the potential equalization must be connected in the cabinet, e.g. at a metallic DIN rail:

Warning!
The grounding line of the sensors FDU91F/93/95/96 and FDU83/84/85/86 must be connected to the local potential equalization system **after a maximum of 30 m (98 ft)** (→ 23).



L00-FMU90xxx-04-00-00-xx-008

1 Terminal (isolated from the DIN rail)
2 Protective earth terminal (with contact to the DIN rail)
3 Protective ground via DIN rail

Caution!
The signal evaluation electronics and its direct connections (display interface, service interface etc.) are galvanically isolated from the supply voltage and the communication signals. Their electric potential is identiacal to the potential of the sensor electronics.
Pay attention to the potential difference if the sensors are connected to ground!

Note!
- The longest required distance has to be taken into account when removing the jacket of the sensor cable (GNYE in the above example).
- When shortening the sensor cable, comply to the notes → 29, "Shortening the sensor cable".

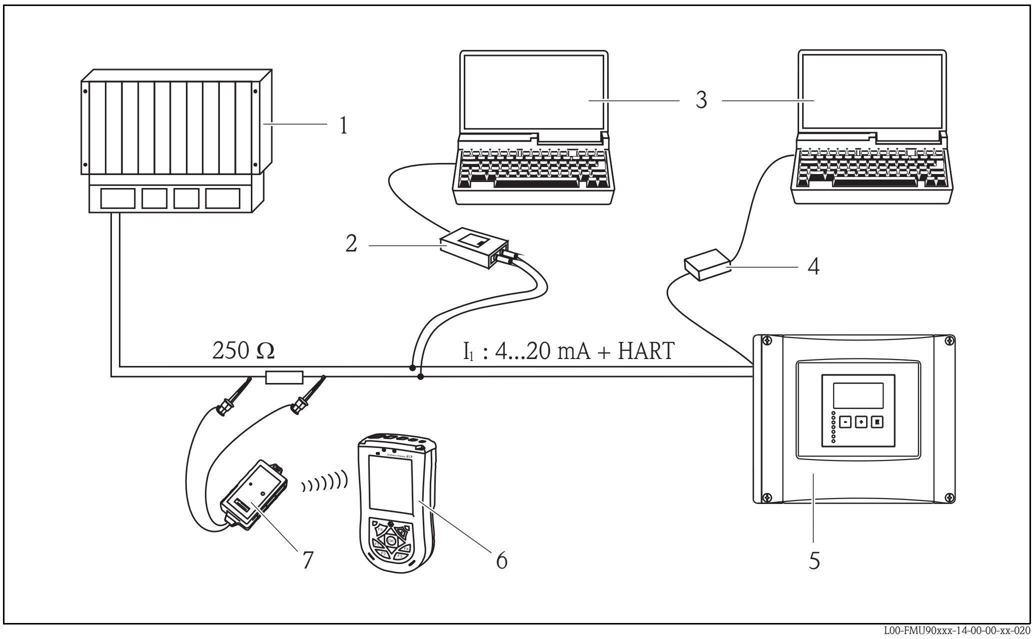
4.11 Post-connection check

After wiring the transmitter, carry out the following checks:

- Is the terminal assignment correct?
- For the field housing: Are the cable glands tight and is the cover of the terminal compartment securely closed?
- If auxiliary energy is switched on: Does a display appear on the display module (if available) and does the green LED light up?

5 Operation

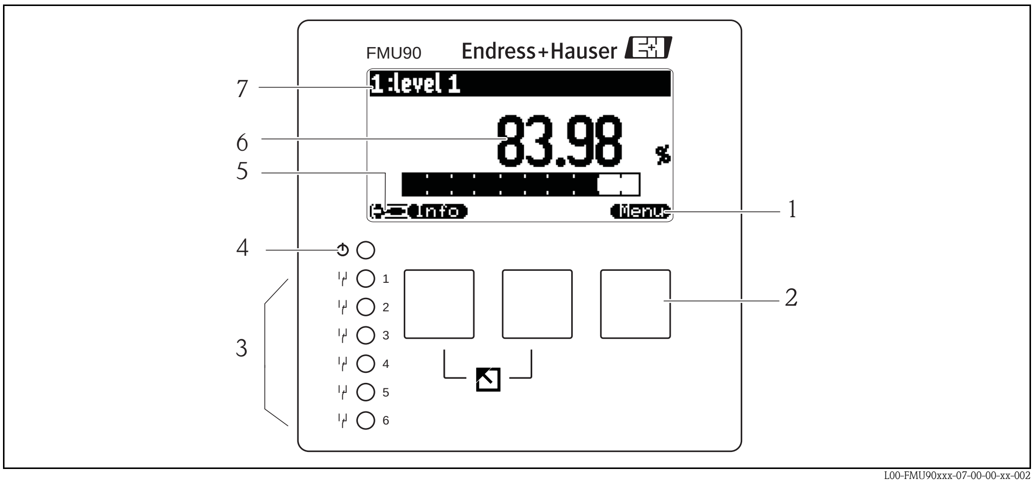
5.1 Operating options



1 SPS, PLC, API
2 Commubox FXA195 (USB), HART-Protocol
3 FieldCare
4 Commubox FXA291 (service interface)
5 Operating and display module at the Prosonic S (if present)
6 Field Xpert SFX100
7 VIATOR Bluetooth-Modem with connection cable

5.2 Operation via the display and operating module

5.2.1 Display and operating elements



1 Softkey symbol
2 Key
3 LEDs indicating the switching states of the relays
4 LED indicating the operating state
5 Display symbols
6 Value of the parameter, including unit
7 Name of the parameter

Display symbols

Symbol	Meaning
Operating mode of the instrument	
	**User** User parameters can be edited. Service parameters are locked.
	**Diagnosis** The service interface is connected.
	**Service** User and service parameters can be edited.
	**Locked** All parameters are locked.
Locking state of the currently displayed parameter	
	**Display parameter** The parameter can **not** be edited in the current operating mode of the instrument.
	**Editable parameter** The parameter can be edited.
Scroll symbols	
 	**Scroll list available** Indicates that the list contains more parameters than can be represented on the display. By pressing ↑ or ↓ repeatedly, all parameters of the list can be accessed.
Navigation in the envelope curve display	
	**Move left**
	**Move right**
	**Zoom in**
	**Zoom out**

LEDs

LED indicating the operating state (pos. 4 in the figure)	
green	normal measuring mode; no error detected
red (flashing)	Warning: An error is detected but the measurement continues. Reliability of the measured value is no longer ensured.
red	Alarm: An error is detected. The measurement is interrupted. The measured value assumes the value specified by the user (parameter "output on alarm").
off	supply voltage missing

LEDs for the relays (pos. 3 in the figure)	
yellow	The relay is activated.
off	The relay is de-activated (idle state).

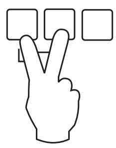
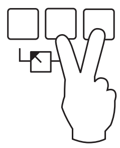
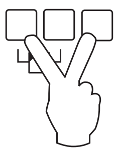
Keys (softkey operation)

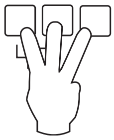
The function of the keys depends on the current position within the operating menu (softkey functionality). The key functions are indicated by softkey symbols in the bottom line of the display.

Symbol	Meaning
	**Move downwards** Moves the marking bar downwards within a selection list.
	**Move upwards** Moves the marking bar upwards within a selection list.
	**Enter** ■ Opens the marked submenu, the marked parameter set or the marked parameter ■ Confirms the edited parameter value
	**Previous parameter set** Reopens the previous parameter set within the submenu.
	**Next parameter set** Opens the next parameter set within the submenu.
	**Confirm selection** Selects the option of a selection list which is currently marked by the bar.
	**Increase value** Increases the active digit of an alphanumeric parameter.
	**Decrease value** Decreases the active digit of an alphanumeric parameter
	**Error list** Opens the list of all errors which are currently detected. If a warning is present, this symbol flashes. If an alarm is present, the symbol is displayed continuously.
	**Change Display** Change to the next page of measured values (only available if more than one pages of measured values have been defined; see "display" menu)
	**Info** Opens the Shortcut Menu, which contains the most important information about the current state of the instrument
	**Menu** Opens the Main Menu, which contains **all** parameters of the Prosonic S

General key combinations

The following key combinations do not depend on the menu position:

Key combination	Meaning
	**Escape** ■ While editing a parameter: Exit the editing mode without accepting the changes. ■ Within the navigation: Move upwards to the previous layer of the menu.
	**Increase contrast** Increases the contrast of the display module.
	**Decrease contrast** Decreases the contrast of the display module.

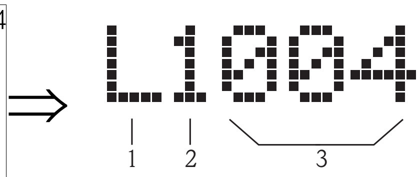
Key combination	Meaning
	**Locking** Locks the instrument against parameter changes. The instrument can only be unlocked again by the keys.

5.2.2 The operating menu

Structure of the menu

The parameters of the Prosonic S are organized in an operating menu (consisting of a main menu and several submenus). Parameters which are related to each other are comprised in a common parameter set. To simplify the navigation within the menu, a five-digit position code is displayed with each parameter set.

```
LVL 1 appl.para              L1004
 tank shape :dome ceiling
 medium property:liquid
 process cond:standard liq.
```



Identification of the parameter sets:
1 Submenu
2 Number of the associated input or output
3 Number of the parameter set within the submenus

- The **first digit (1)** specifies the submenu[1]:
  – **L:** "level"
  – **F:** "flow"
  – **A:** "safety settings"
  – **R:** "relay/controls"
  – **O:** "output/calculations"
  – **D:** "device properties", "calibr. display" and "sensor management"
  – **I:** "system information"
  – **S:** "service" (only available if the service password has been entered)

  Diagrams of the submenus can be found in the chapter "Operating menu".

- The **second digit (2)** is used if the parameter set occurs several times within the Prosonic S (e.g. for different inputs or outputs).

  Example:
  – O1201: "allocation current" for output 1
  – O2201: "allocation current" for output 2

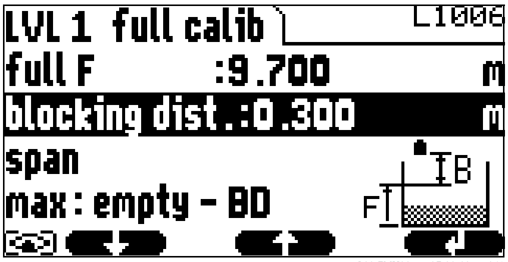
  If the parameter set occurs only once wihtin the Prosonic S, "X" is indicated at this position.

- The **last three digits (3)** specify the individual parameter sets within the submenu.

1) Depending on the instrument version, the installation environment and the selected operating mode, some of the submenus may not be present.

Parameter types

Display parameters



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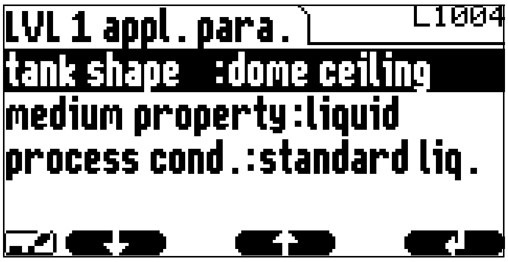
Parameters for which the symbol is displayed in the left bottom corner of the display module, are either locked or display-only parameters.

Editable parameters



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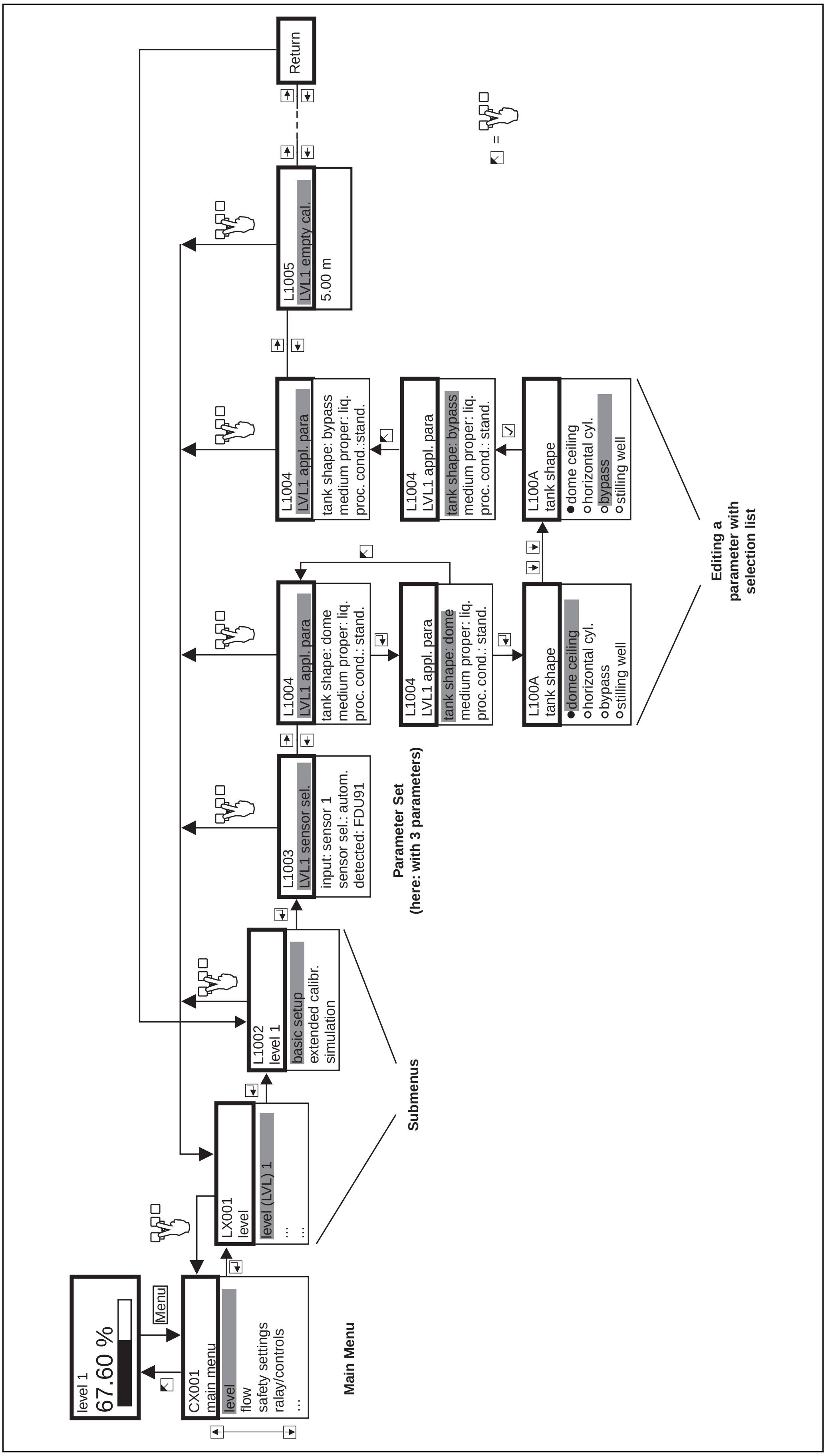
Parameters, for which the symbol is displayed in the left bottom corner of the display module, can be entered for editing by pressing .

The editing procedure depends on the type of parameter:

- when entering a **selection parameter**, the associated selection list appears (see below: "Editing a parameter with selection list").
- when entering a **numerical or alphanumerical parameter**, the text and number editor appears (see below: "Entering numbers and characters").

Navigation within the menu (Example)



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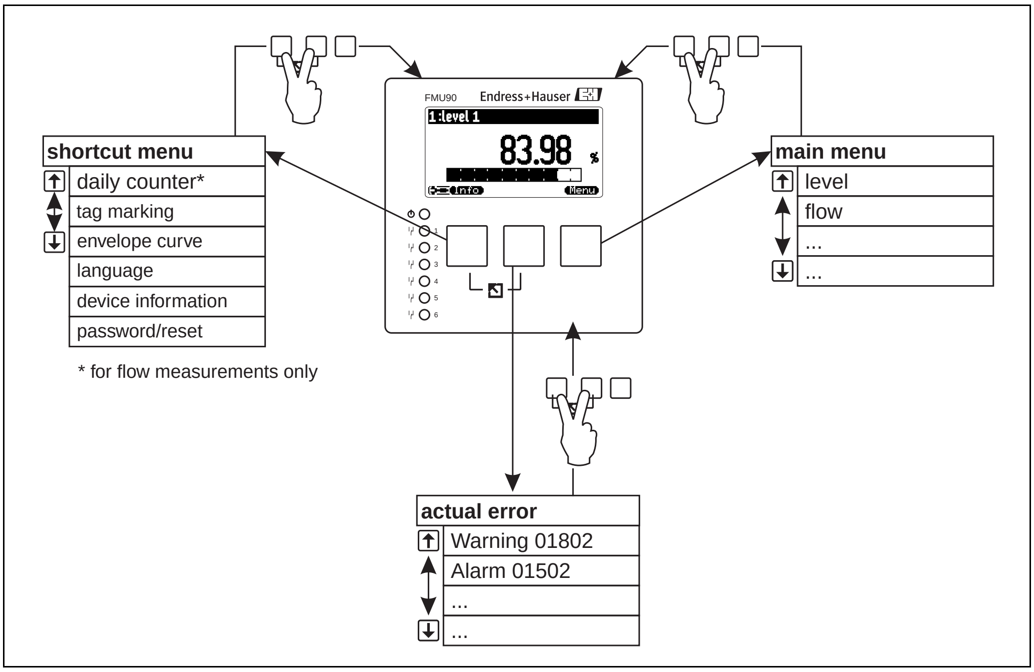
Entering the menu

The navigation always starts from the main screen (measured value display[2]). From there, the following menus can be opened by the keys:



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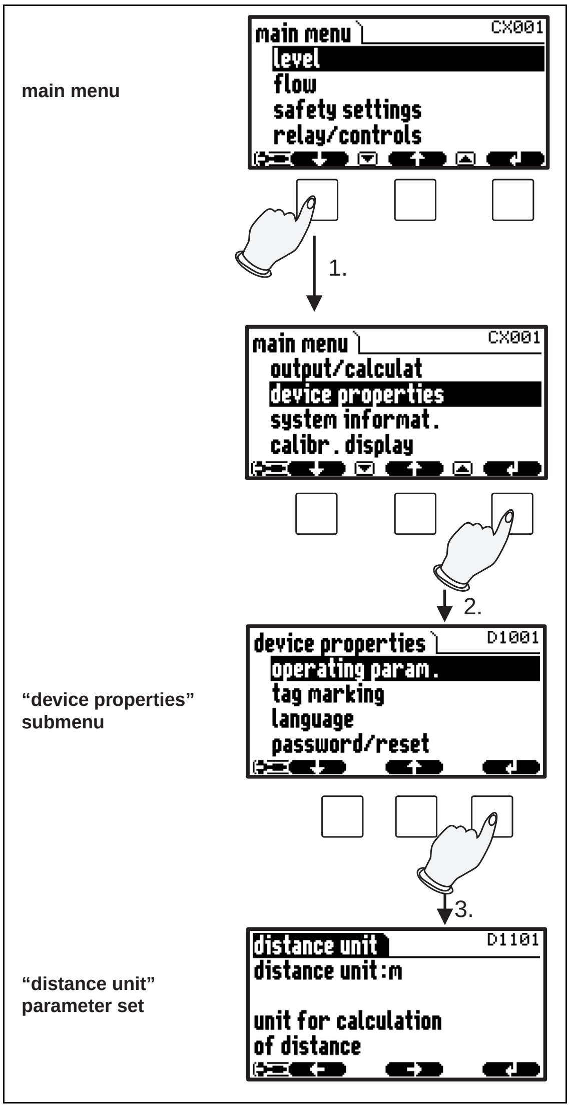
- **shortcut menu**
  The shortcut menu is accessed via the **"Info"** key. It allows quick access to device information:
  – daily counter (for flow measurements)
  – tag marking
  – envelope curve: used to check the signal quality
  – language: sets the display language
  – device information: serial number, versions of software and hardware
  – password/reset: used to enter the password or reset code
  All parameters of the shortcut menu are contained in the main menu as well.
- **main menu**
  The main menu is accessed via the **"Menu"** key. It contains all parameters of the Prosonic S. It is divided into submenus. Some of the submenus consist of further submenus. Which submenus are actually present, depends on the instrument version and the installation environment.
  An overview of all submenus and parameters is given in the chapter "Operating menu".
- **actual error**
  If the self-monitoring of the Prosonic S detects an error, the softkey symbol appears above the middle key.
  If the softkey symbol flashes, only "warnings"[3] are present.
  If the softkey symbol is displayed permanently, at least one "alarm"[3] is present.
  After pressing the key, a list of all currently present errors appears.

2) Note: Depending on the configuration, the appearance of the measured value display may be differemt from the example in the figure.
3) The difference between"Warning" and "Alarm" → Chap. 10.1

Selecting a submenu



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1. In the main menu, press ↓ or ↑ until the required submenu is marked by the bar.

   ✎ Note!
   The symbols ▼ ▲ indicate that the selection list contains more items than can be displayed on the module. Press ↓ or ↑ several times, to mark one of the hidden items.

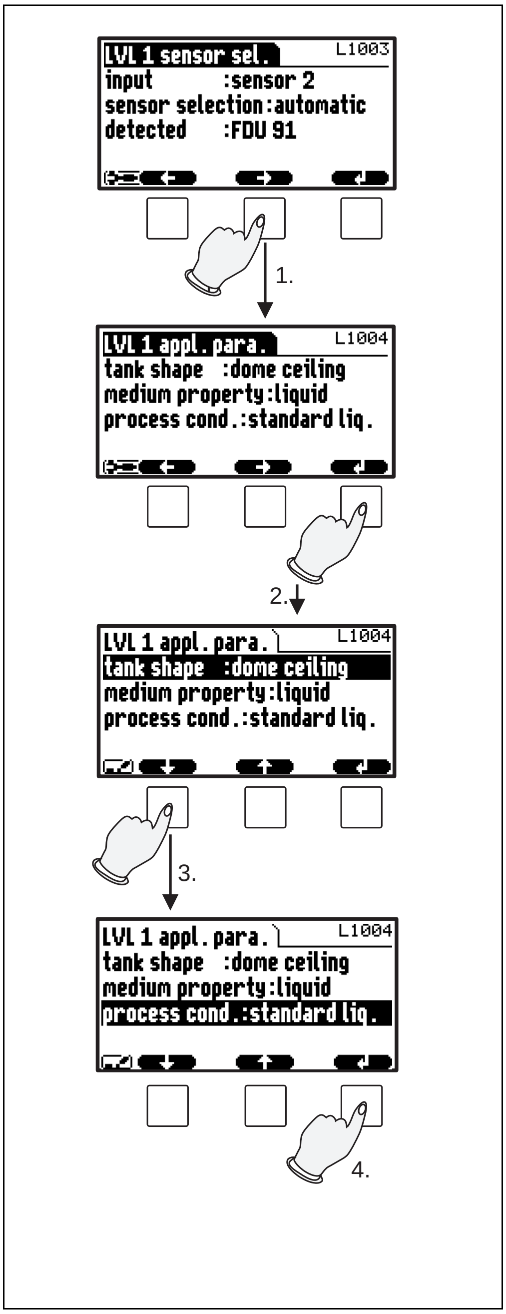
2. Press ↵, in order to enter the marked submenu.

3. If the submenu contains further submenus, continue until you reach the level of the parameter sets. This level is reached if the softkey symbols ← and → appear.

✎ Note!
If necessary, you can return to the previous level of the menu by pressing .

Selecting a parameter

By pressing ← or → you can switch between the parameter sets of the current submenu. For each parameter set the values of all its parameters are displayed. In order to change one of the values, proceed as follows:



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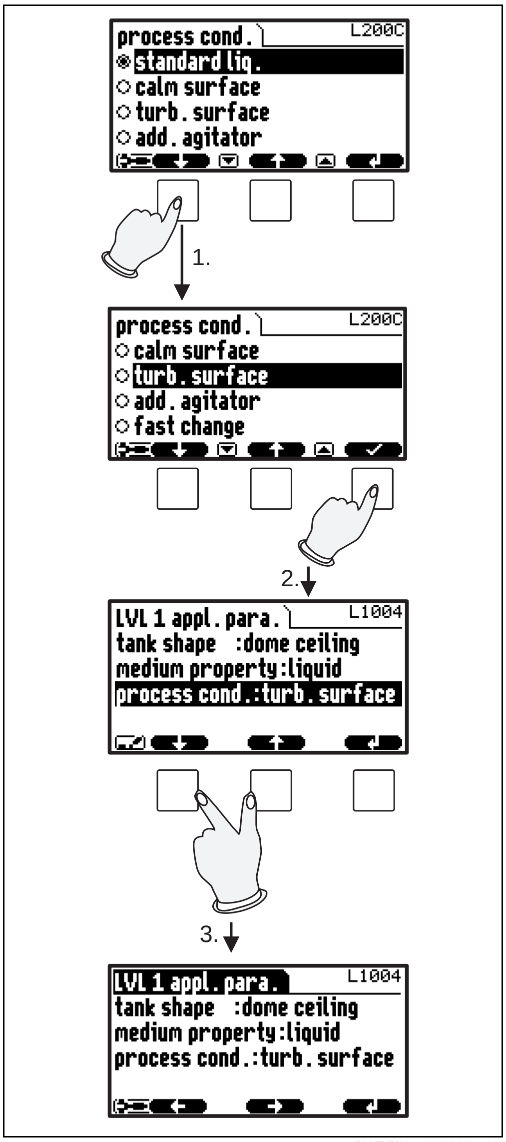
1. Press ← or →, until you have reached the required parameter set.
2. Press ↵, in order to enter the parameter set.
3. Select the required parameter by pressing ↓ or ↑.
   (This step is not required if the set contains only one parameter.)
4. Press ↵, in order to enter the editing mode of the parameter.
   The editing method depends on the type of parameter (selection list, numeric or alphanumeric parameter). For details refer to the following sections.

Note!
If necessary, you can exit the parameter and parameter set by pressing .

Editing a parameter with selection list



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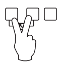
1. Press ↓ or ↑, until the required option is marked by the bar (in the example: "turb. surface").

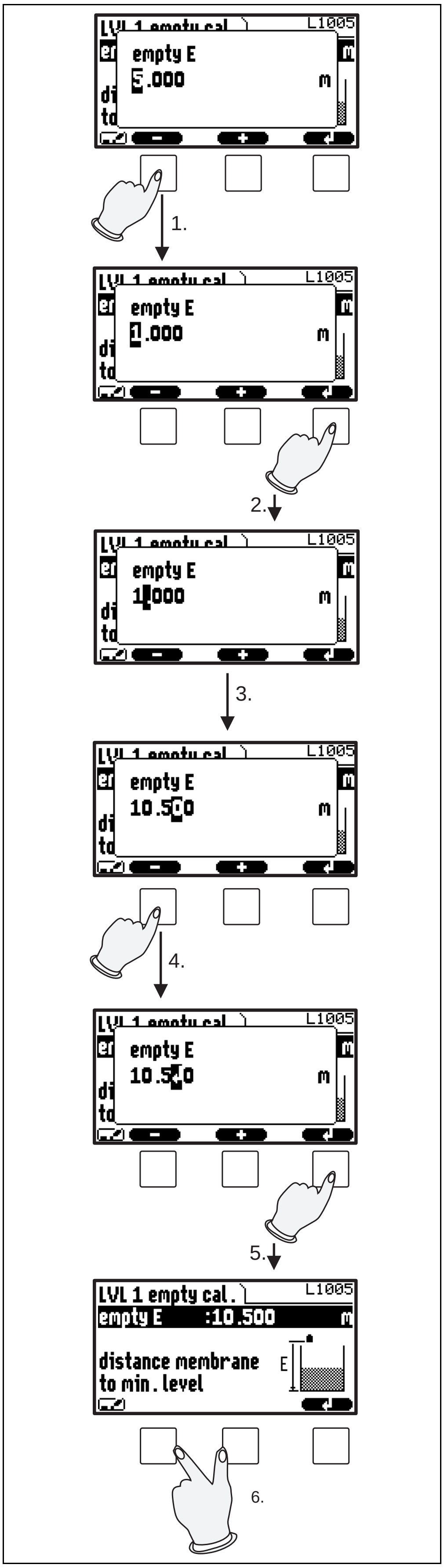
   ✎ Note!
   The symbols ▼ ▲ indicate that the selection list contains more items than can be displayed on the module. Press ↓ or ↑ several times, to mark one of the hidden items.

2. Press ✓, in order to select the marked option. It is then stored in the instrument.

3. Press the left and middle keys simultaneously in order to quit the parameter.
   The software key symbols ← and → reappear and you can switch to the next parameter set.

✎ Note!
By pressing  before ✓ you can quit the parameter without accepting your changes.

Entering numbers and characters



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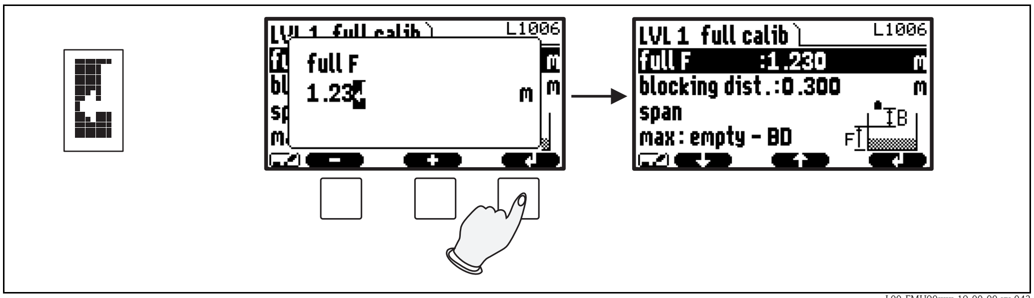
When you select a numeric parameter ("empty calibration", "full calibration" etc.) or an alphanumeric parameter ("device marking" etc.), the editor for numbers and text strings appears. Enter the desired value in the following way:

1. The cursor is at the first digit. Press − or + until this digit has the required value.
2. Press ↵ in order to confirm the value and to jump to the next digit.
3. Repeat the procedure for all relevant digits.
4. If all relevant digits have been entered: Press − or +, until ↵ appears at the cursor.
5. Press ↵ to store the complete value in the device.
6. Press the left and middle keys simultaneously in order to quit the parameter.

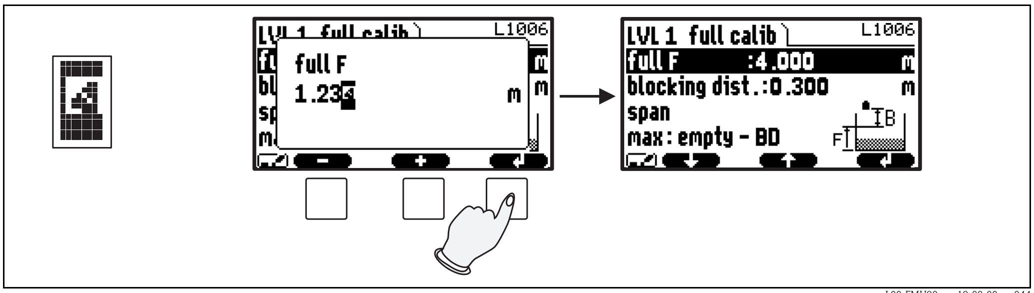
Special editing functions

Within the editor for alphanumeric characters, pressing – or + does not only lead to numbers and characters but also to the following symbols for special editing functions. They simplify the editing procedure.



L00-FMU90xxx-19-00-00-yy-043

Enter: *The number left of the cursor is transferred to the instrument.*



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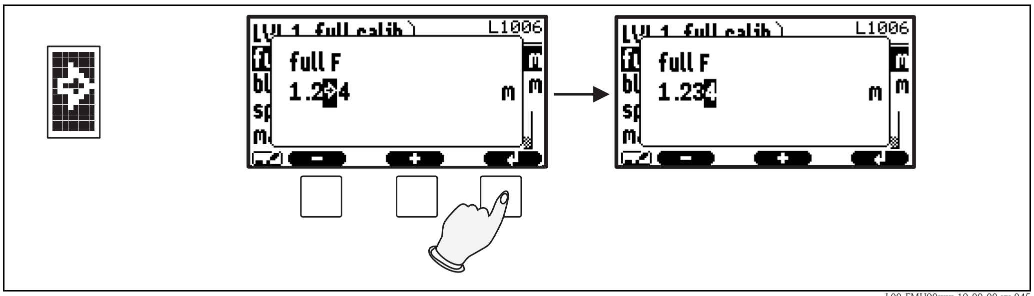
Escape: *The editor is closed. The parameter maintains its former value. The same behavior can be achieved by pressing the left and the middle key simultaneously ( ).*



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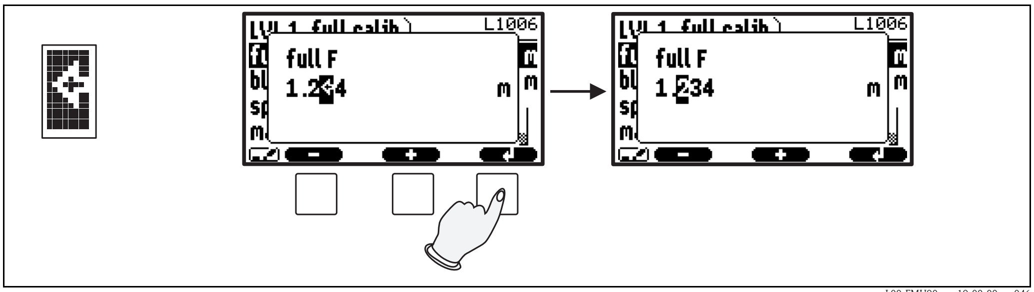
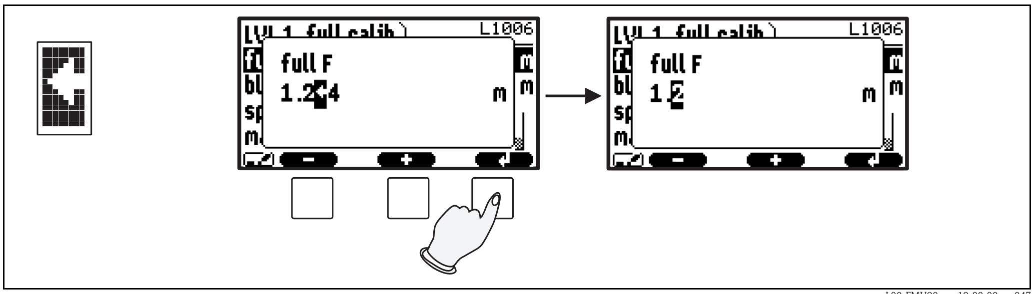
Next digit: *The cursor moves on to the next digit.*



L00-FMU90xxx-19-00-00-yy-046

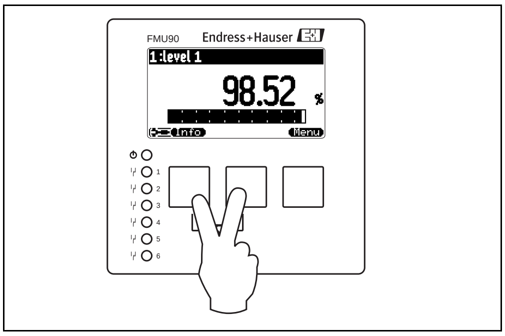
Previous digit: *The cursor moves back to the previous digit.*



L00-FMU90xxx-19-00-00-yy-047

Delete: *The current digit and all digits to its right are deleted.*

Return to the measured value display



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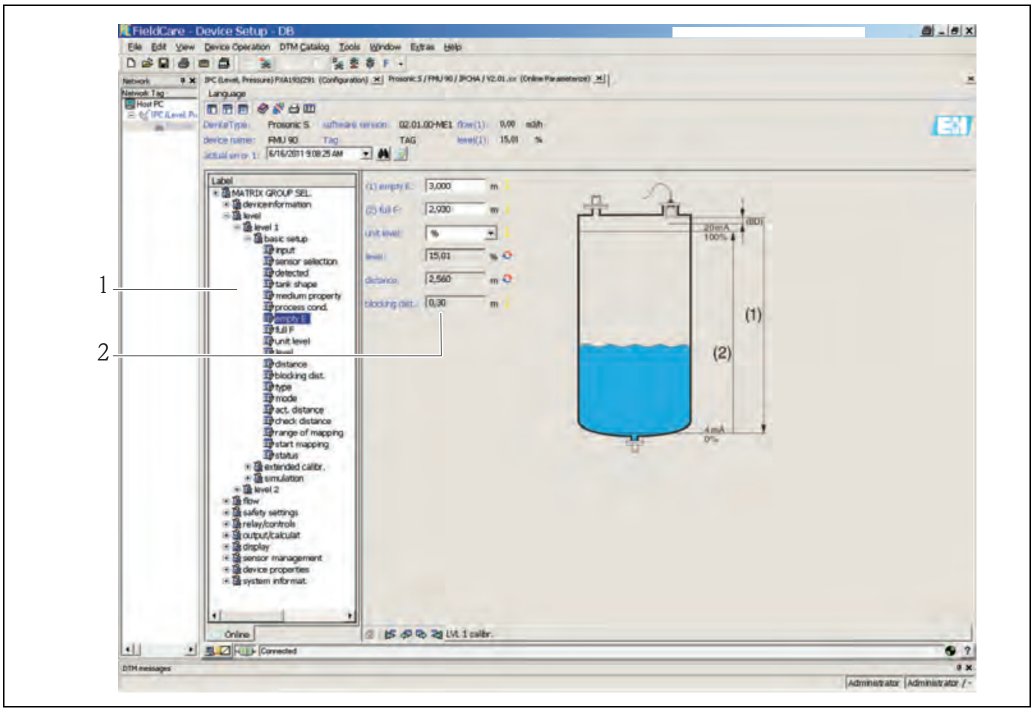
By pressing the left and middle keys simultaneously you can return

- from a parameter to the parameter set
- from the parameter set to the submenu
- from the submenu to the main menu
- from the main menu to the measured value display

5.3 Operation via Endress+Hauser operating tool "FieldCare"



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Operation via the FieldCare is similar to the operation via the display module.

- The operating menu can be found in the **navigation bar (1)**.
- Input fields for the parameters can be found in the **parameter editor (2)**.
- When you click on a parameter name, the **help pages** appear. They contain a detailed description of the respective parameter.

5.4 Operation via Field Xpert SFX100

Compact, flexible and robust industry handheld terminal for remote parametrization and measured value inspection via the HART current output or FOUNDATION Fieldbus. For details refer to Operating Instructions BA00060S/04/EN.

5.5 Lock/unlock configuration

5.5.1 Software locking

Locking

Go to the parameter "device properties/passoword-reset/code" and enter a value ≠100. The instrument is locked against parameter changes.
The  symbol appears on the display.

Unlocking

If you try to change a parameter, the "password-reset" parameter set appears. Select the "code" parameter and enter "100". Parameters can be changed again.

5.5.2 Locking by key combination

Locking

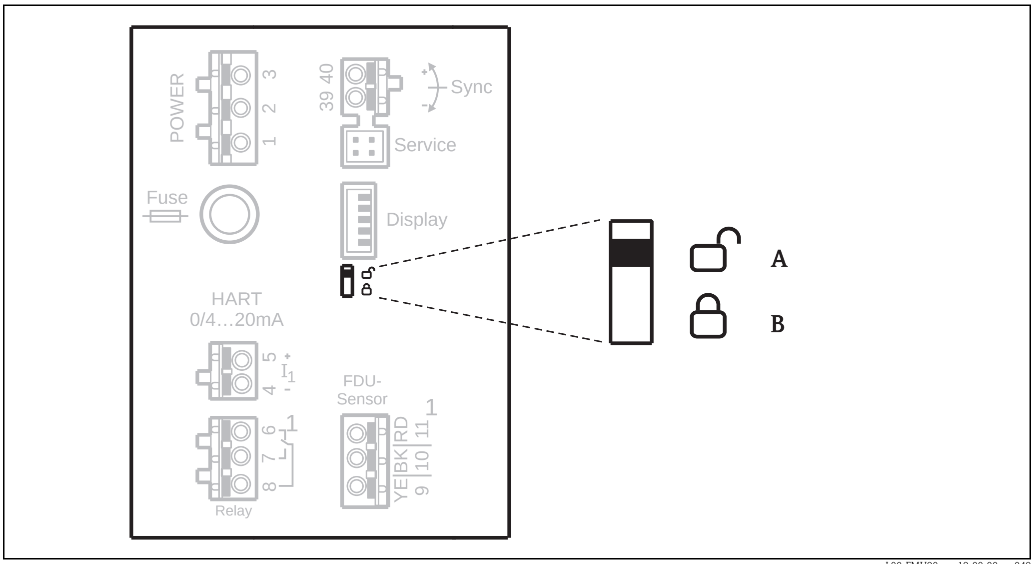
Press all three keys simultaneously. The instrument is locked against parameter changes.
The symbol appears on the display.

Unlocking

If you try to change a parameter, the "password/reset" parameter set appears. "key locked" is displayed in the "status" parameter. Press all three keys simultaneously. Parameters can be changed again.

5.5.3 Hardware locking

The instrument can be locked against parameter changes by the locking switch in the terminal compartment of the Prosonic S.



*Switch position **A**: unlocked; parameters can be changed*
*Switch position **B**: locked; parameters can not be changed.*

If the switch is in position B, appears on the display and parameters can not be changed. The instrument can only be unlocked by the switch.

5.5.4 Indication of the locking state

The current locking state of the instrument is displayed in the parameter "device properties/ password-reset/status". The following states may occur:

- **unlocked**
  All parameters (except of service parameters) can be changed.
- **code locked**
  The instrument has been locked via the operating menu. It can be unlocked by entering the unlocking code into the "code" parameter.
- **key locked**
  The key has been locked by a key combination. It can only be unlocked by pressing all three keys simultaneously.
- **switch locked**
  The instrument has been locked by the switch in the terminal compartment. It can only be unlocked by this switch.

5.6 Reset to the default configuration

Caution!
A reset may lead to impairment of the measurement. As a rule, a basic calibration is required after a reset.

Application of the Reset
It is advisable to reset the customer parameters if you want to use a device with an unknown history.

Effects of the Reset
- All parameters are reset to their default values.
- The linearisation type is switched to "none". If a linearisation table is present, it is not deleted. If required, it can be reactivated at a later point of time.
- An interference echo curve is set "inactive". However, the curve is not deleted and can be reactivated at a later point of time.

Note!
In the menu diagrams (→ 126, "Operating menu") the default values of the parameters are printed in bold.

Performing a Reset
In order to perform a reset, enter "333" into the parameter "device properties/password-reset/reset".

5-point linearity protocol

Note!
The specified measuring accuracy is a typical value → 122, "Performance characteristics".
With the production of the 5-point linearity protocol the measuring system (FDU9x sensor and FMU9x transmitter electronic) is adjusted exactly to one another and the measuring accuracy is optimized for the specified range.
To realize this, the parameter "zero distance" is fine adjusted. After a reset the value for the zero distance has to be re-parameterized in the service menu according to the data on the associated 5-point linearity protocol for the FDU9x sensor. Please contact the Endress+Hauser service.

Note!
- To **delete a linearisation table**, use the parameter "basic setup/linearisation" → Chap. 6.4.3
- To **delete an interference echo mapping**, use the parameter "extended calibration/distance mapping/state" → Chap. 6.4.9

6 Commissioning

Warning!
For the version with field housing: The instrument may only be operated if the field housing is closed.

6.1 Structure and Functions of the Prosonic S

6.1.1 Function blocks

The Prosonic S contains various function blocks. During the commissioning procedure the blocks are linked to each other in order to perform the desired measuring task. Depending on the instrument version and installation environment, the following function blocks may occur:

Signal inputs
- Sensor 1
- Sensor 2 (if selected in the product structure)

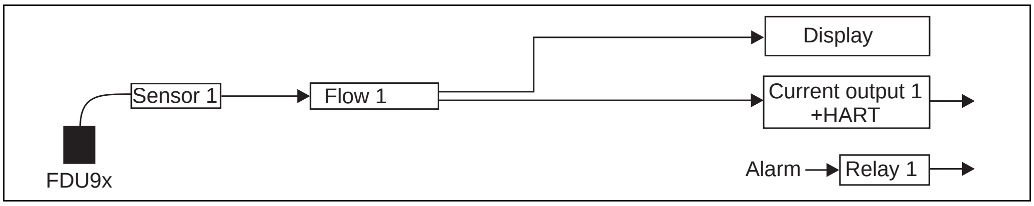
Signal evaluation (calculation of the measured value)
- Level 1
- Level 2 (for instruments with 2 current outputs)
- Flow 1 (for flow instruments)
- Flow 2 (for flow instruments)

Controls
- Pump control
- Rake control
- Backwater detection

Signal output
- Display
- Current output 1 with HART
- Current output 2 (if selected in the product structure)
- Relay 1
- Relay 2 (for instruments with 3 or 6 relays)
- Relay 3 (for instruments with 3 or 6 relays)
- Relay 4 (for instruments with 6 relays)
- Relay 5 (for instruments with 6 relays)
- Relay 6 (for instruments with 6 relays)

6.1.2 Typical block configurations

1-channel flow measurement



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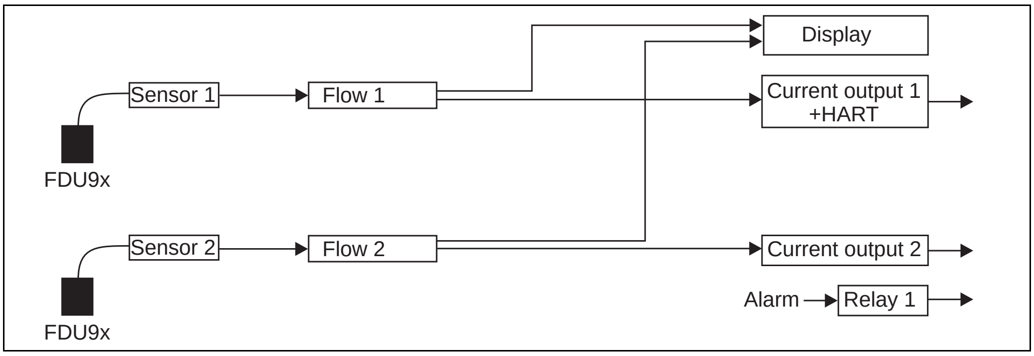
2-channel flow measurement



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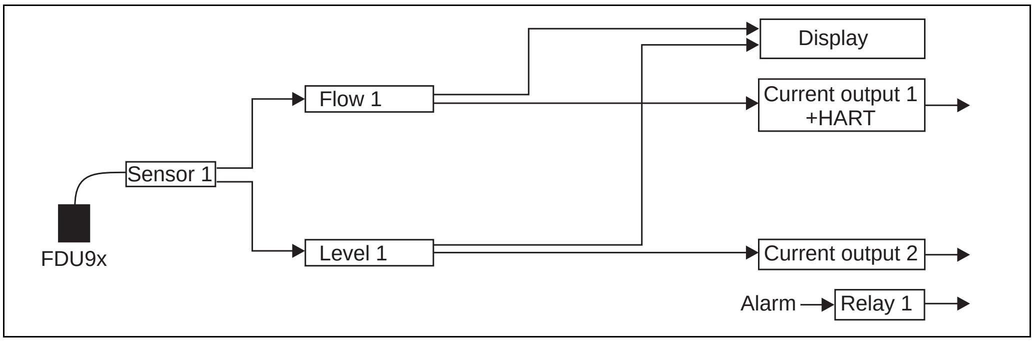
Level and flow measurement with 1 sensor



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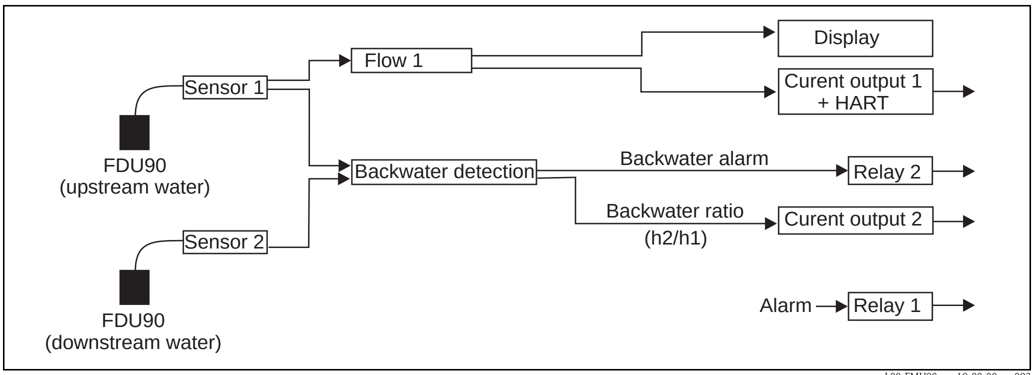
Backwater detection



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Note: The backwater alarm relay must be configured by the user. It is not part of the default configuration.

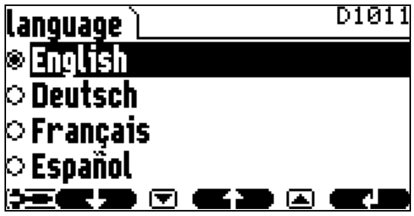
Note!
By default, relay 1 is always configured to be the alarm relay.

6.2 First setup

Note!
This chapter describes the commissioning of the Prosonic S via the display and operating module. Commissioning via FieldCare or the Field Xpert SFX100 is similar. For further instructions refer to the FieldCare Online Help or the Operating Instructions supplied with the Field Xpert SFX100.

After switching on the power supply for the first time, you are requested to define the basic operating parameters:

1. Select the display language.
   a. Press ↓ or ↑ to move the marking bar above the desired language.
   b. Press ↵ to confirm your selection.



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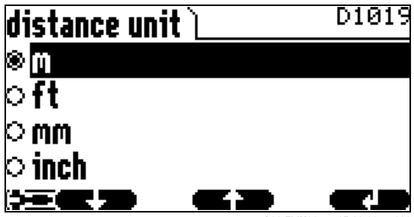
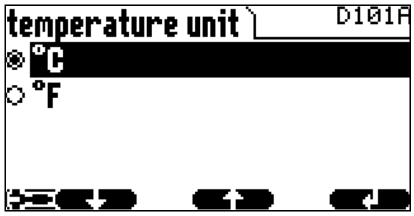
2. Select the unit for distance measurements.



L00-FMU90xxx-07-00-00-yy-028

3. Select the temperature unit.



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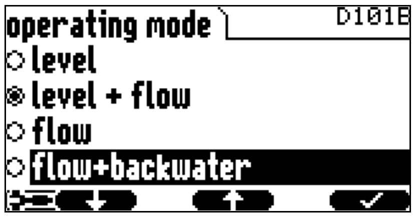
4. Select the operating mode.
   Note!
   The available options depend on the instrument version and the installation environment. If you want to configure a backwater detection, you must select the option "flow+backwater".



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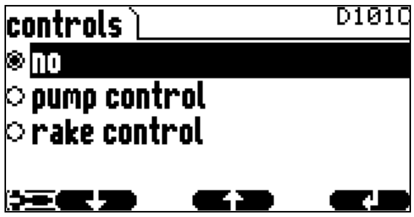
5. Select the control functions, which you are going to use.
   Note!
   This selection is not required for the "flow" and "flow+backwater" operating modes.



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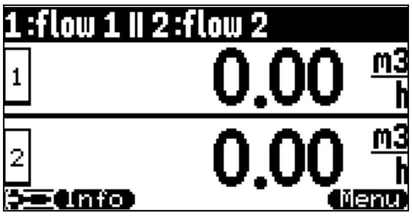
Note!
By pressing you can return to the previous parameter (e.g. in order to correct the value). All these parameters can also be changed at a later point of time in the "device properties/operating parameters" and "device properties/language" parameter sets.

6.3 Preparing the basic setup

1. After the first setup the main screen appears. However, the displayed values do not yet correspond to the real flows before you have performed the basic setup. To do so, enter the main menu by pressing "Menu" (right key).

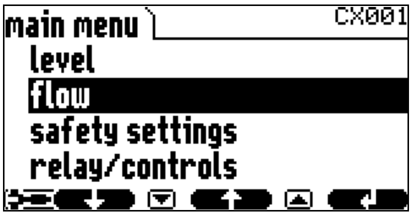


L00-FMU90xxx-07-00-00-yy-032

✎ Note!
In the "calibr. display" menu you can adjust the display to your requirements (displayed values, display format). The figure shows an example for a 2-channel instrument.

2. Select the "flow" submenu.

– Select by ↓ and ↑
– Confirm by ↵



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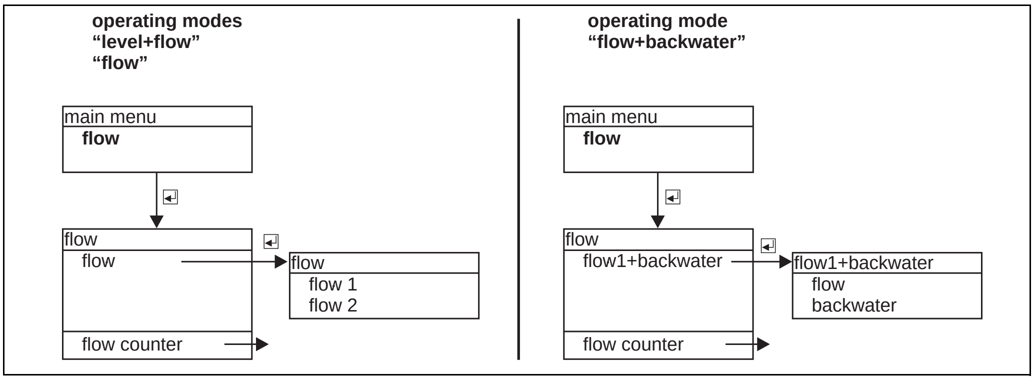
The "flow" submenu is used for the calibration of
- flow measurements (1 or 2 channels)
- back water alarm
- flow counters

The structure of the submenu depends on the selected operating mode[4]:



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Always start by calibrating the first flow channel ("flow 1" submenu).

Thereafter, you can calibrate the following as required:
- the second flow channel ("flow 2" submenu)
- the backwater detection ("backwater" submenu)
- the flow counters ("flow counter" submenu)

4) The operating mode is selected during the first setup. Nevertheless, it can be changed at any time if required ("device properties" menu, "operating params" submenu, "operating mode" parameter set).

6.4 Calibration of a flow measurement

6.4.1 Overview

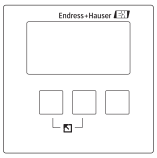
The following table gives an overview of the calibration of a flow measurement. Detailed information on the parameters can be found in sections 6.4.2 - 6.4.9.

Step	Parameter set	Parameter	Remarks	Section
1			Open the "flow 1" or "flow 2" submenu.	
2			Open the "basic setup" submenu.	
3	flow N sensor selection (N = 1 or 2)	input	Allocate a sensor to the channel.	→ Chap. 6.4.2
		sensor selection	Specify the type of sensor ("automatic" for FDU9x)	
		detected	only available for "sensor selection" = "automatic"; indicates the detected type of sensor.	
4	flow N linearisation (N = 1 or 2)	type	Select type of linearisation[1]: ■ "flume/weir" (for the pre-programmed flumes and weirs) ■ "table" (to enter a linearistion table manually) ■ "formula" (for the flow formula $Q = C\ (h^{\alpha} + \gamma h^{\beta})$)	→ Chap. 6.4.3
		flow unit	Select the flow unit.	
		curve	Select the type of flume or weir; (only present for "type" = "flume/weir"); A second page appears in which the size of the respective flume and weir must be selected (for details refer to chapter → Chap. 15.1)	
		edit	Used to enter, change or delete a linearisation table; (only available for "type" = "table")	
		status table	Enables or disables the linearisation table; (only available for "type" = table")	
		alpha	Specify the value of the parameter α; (only available for "type" = "formula"	
		beta	Specify the value of the parameter β; (only available for "type" = "formula")	
		gamma	Specify the value of the parameter γ; (only available for "type" = "formula")	
		C	Specify the value of the parameter C; (only available for "type" = "formula")	
		max. flow	Specify the maximum flow of the flume or weir; (not available for "type" = "table")	
5	flow N empty calibration (N = 1 or 2)	empty E	Specify the distance E between the reference point of the sensor and the zero of the measurement. The zero is ■ the bottom of the weir or ■ the lowest point of the weir crest	→ Chap. 6.4.4
		blocking distance	indicates the blocking distance of the respective sensor; the maximum level may not project into the blocking distance.	
6	flow N (N = 1 or 2)	flow N (N = 1 or 2)	displays the currently measured flow (for checking purposes)	→ Chap. 6.4.5
		level	displays the currently measured level (for checking purposes)	
		distance	displays the currently measured distance between the reference point of the sensor and the liquid surface (for checking purposes)	

Step	Parameter set	Parameter	Remarks	Section
7	flow N check value (N = 1 or 2)	distance	displays the currently measured distance between the reference point of the sensor and the liquid surface.	→ Chap. 6.4.6 → Chap. 6.4.7
		check distance	Compare the displayed distance with the real value: ■ "distance = ok" → "flow N mapping" (see below) ■ "distance too small" → "flow N mapping" (see below) ■ "distance too big" → basic setup completed ■ "distance unknown" → basic setup completed ■ "manual" → "flow N mapping" (see below)	
8	flow N mapping (N = 1 or 2)	distance	displays the currently measured distance between the reference point of the sensor and the liquid surface	→ Chap. 6.4.8
		range of mapping	Determines the range over which the mapping is recorded; confirm the predefined value or enter your own value.	
		start mapping	Select: ■ no: the mapping is not recorded ■ yes: the mapping is recorded; after completion, the "flow N state" function appears (see below)	
9	flow N state (N = 1 or 2)	level	displays the currently measured level	→ Chap. 6.4.9
		distance	displays the currently measured distance between the reference point of the sensor and the liquid surface. Check the value: ■ Value correct: → Basic calibration completed. Press several times to return to the measured value display. ■ Value incorrect: → go back to step 7 ("flow N check value")	
		flow N (N = 1 or 2)	displays the currently measured flow	
		status	Used to enable, disable or delete a mapping	
10			Parametrization of the counters (in the operating menu: "flow/flowcounter")	→ Chap. 6.7

1) The type of linearisation determines the relationship between the measured level and the flow.

6.4.2 "flow N sensor selection" (N = 1 or 2)



```
flow1 sensor sel.    F1003
 input:
 sensor selection:
 detected:
```

"input"

Use this parameter to allocate a sensor to the channel.

Selection
- no sensor
- sensor 1
- sensor 2 (for instruments with 2 sensor inputs)
- average level [5]

"sensor selection"

Use this parameter to specify the type of the connected ultrasonic sensor.

Note!
- For the sensors **FDU9x**, the option "automatic" is recommended (default setting). With this setting the Prosonic S recognizes the type of sensor automatically.
- For the sensors **FDU8x**, the type has to be assigned explicitly. The automatic sensor recognition does not work for these sensors.

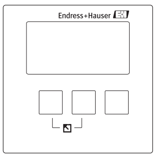
Caution!
After exchanging a sensor, observe the following:
The automatic sensor recognition is also active if a sensor has been exchanged [6]. The Prosonic S recognizes the type of the new sensor automatically and changes the "detected" parameter to fit the new sensor. The measurement continues without break.
Nevertheless, in order to ensure perfect measurement, the following checks are required:
- Check the **"empty calibration"** parameter. Adjust this value if required. Take into account the blocking distance of the new sensor.
- Go to the **"flow N check value"** parameter set and check the displayed distance. If required, perform a new interference echo suppression.

"detected" (only available for "sensor selection" = "automatic")

Indicates the type of the automatically detected sensor.

5) This option is only available if two level measurements have been calibrated. This is only possible for the "leve+flow" operating mode and a two channel instrument.
6) if the sensor is of the type FDU9x.

6.4.3 "flow N linearization" (N = 1 or 2)



```
flow 1 linearizat    F1004
 type:
 flow unit:
```

Note!
The selected linearization type determines which parameters are present.
Only the parameters "type" and "flow unit" are always present.

The "linearization" parameter set is used to calculate the flow from the measured level. The Prosonic S provides the following linearization types:

- pre-programmed flow curves for commonly used flumes and weirs
- a freely editable linearization table (up to 32 points)
- a flow formula $Q = C(h^{\alpha} + \gamma h^{\beta})$ with freely selectable parameters

Caution!
Flow measurement **always** requires a linearization.

"type"

Use this parameter to select the type of linearization.

Selection:

- **none**
  No flow linearization is performed.

  Note!
  If this option has been selected, nor further parameters are available. A flow measurement is only possible with one of the other options.

- **flume/weir**
  In this type, the linearization is performed according to a preprogrammed linearization curve. The type of curve is selected in the **"curve"** parameter. Additionally, the **"flow unit"** has to be specified. The **"max. flow"** parameter displays the max. flow of the respective flume or weir. If required, this value can be adjusted (as well as the **"width"** of the weir).
- **table**
  In this type, a linearization table consisting of up to 32 pairs of values "level – flow" is used. Additionally, the **"flow unit"** has to be specified. To enter and activate the table use the **"edit"** and **"status table"** parameters.
- **formula**
  In this type, the linearization is performed according to the formula
  $Q = C(h^{\alpha} + \gamma h^{\beta})$.
  The **"alpha"**, **"beta"**, **"gamma"** and **"C"** parameters appear, which are used to specify the details of the curve. Additionally, the **"flow unit"** and the **"max. flow"** of the weir or flume have to be specified.

"flow unit"

Use this parameter to select the desired flow unit.

Note!
After a change of the flow unit, the switching points of the limit relays have to be checked and adjusted if required.

"curve"

This parameter is available for the **"flume/weir"** linearization type.
It is used to select the type of flume or weir. After the selection, a second list appears with differnt sizes of the flume or weir[7]. When you have confirmed your selection, the Prosonic S returns to the **"linearization"** function.

7) Tables of the flume and weir parameters can be found in the Appendix.

"width"

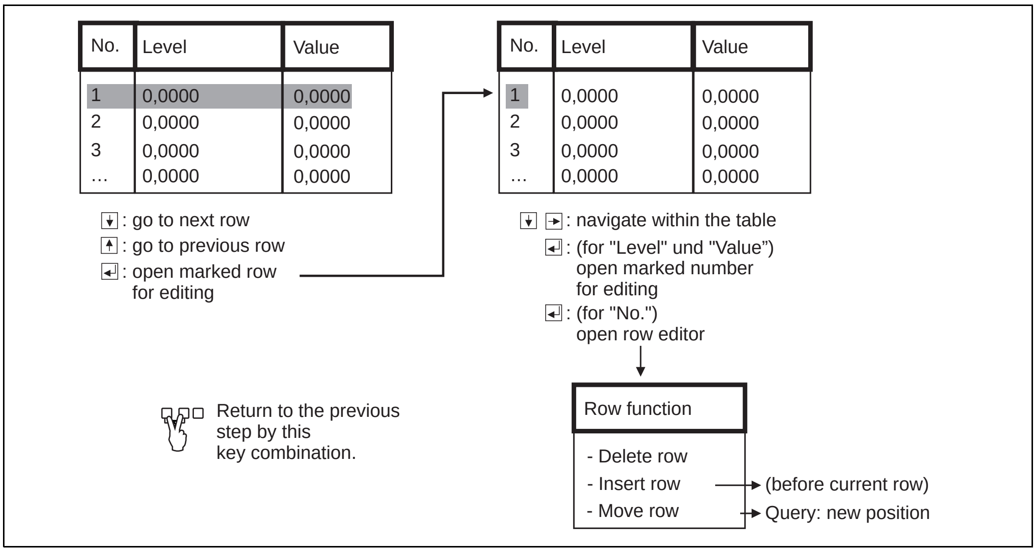
This parameter appears for the curves **"rectangular weir"**, **"NFX"** and **"trapezoidal weir"**. It is used to specify the width of the respective weir.

"edit"

This parameter is used to enter or to view the linearization table. You have got the following options:

- **read:**
  The table editor appears. An existing table can be viewed but not changed.
- **manual:**
  The table editor appears. Table values can be entered and changed.
- **delete:**
  The linearization table is deleted.

The table editor



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"status"

Use this parameter to specify if the linearization table is to be used or not.

Selection:
- **enabled**
  The table is used.
- **disabled**
  The table is not used. A flow value is not calculated.

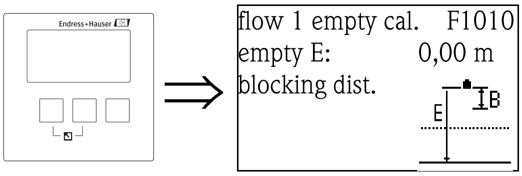
"alpha", "beta", "gamma" and "C"

These parameters are available for the **"formula"** linearization type.
They are used to specify the parameters of the flow formula:
$Q = C(h^{\alpha} + \gamma h^{\beta})$

"max flow"

This parameter is available for the linearization types **"flume/weir"** and **"formula"**.
It is used to specify the maximum flow of the respective weir or flume.
For each of the preprogrammed curves, a default value is preset. However, this value can be adjusted, e.g. if the weir/flume is applied for lower flows.
The maximum flow corresponds to an output current of 20 mA.

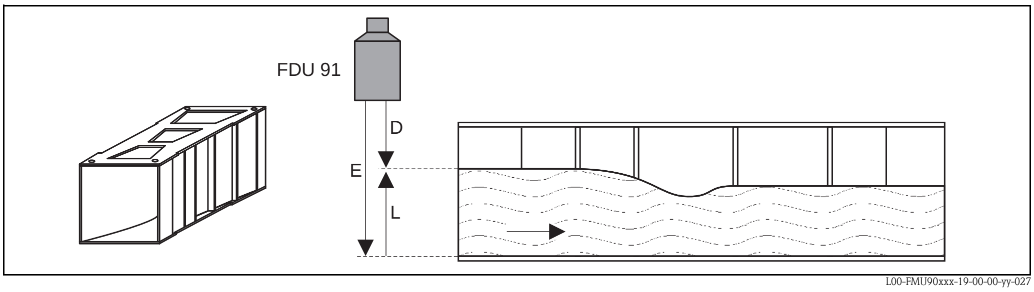
6.4.4 "flow N empty calibration" (N = 1 or 2)



"empty E"

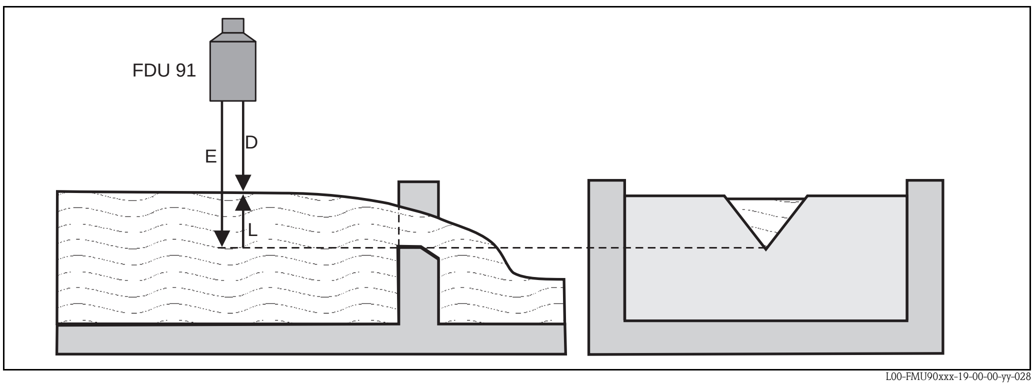
Use this parameter to enter the empty distance E, i.e. the distance between the reference point of the sensor and the zero point of the flume or weir.

For flumes, the zero point is the bottom of the flume at the narrowest position:



Example: Khafagi-Venturi flume
***E:** empty distance; **D:** measured distance; **L:** level*

For weirs, the zero point is the lowest point of the weir crest:



Example: Triangular weir
***E:** empty distance; **D:** measured distance; **L:** level*

"blocking distance"

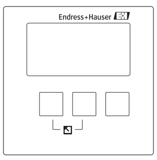
Indicates the blocking distance of the respective sensor. The blocking distance is measured from the reference point of the sensor. The maximum level may not project into the blocking distance.

Type of sensor	blocking distance (BD)	maximum measuring distance[1]
FDU90	0,07 (0.2)	3,0 (9.8) (for liquids)
FDU91/FDU91F	0,3 (1.0)	10 (33) (for liquids)
FDU92	0,4 (1.3)	20 (66) (for liquids)
FDU93	0,6 (2.0)	25 (82) (for liquids)
FDU95 - *1*** (low temperature version)	0,7 (2.3)	45 (148) (for solids)
FDU95 - *2*** (high temperature version)	0,9 (3.0)	45 (148) (for solids)
FDU96	1,6 (5.2)	70 (230) (for solids)
FDU80/FDU80F	0,3 (1.0)	5 (16) (for liquids)
FDU81/81F	0,5 (1.6)	10 (33) (for liquids)
FDU82	0,8 (2.6)	20 (66) (for liquids)
FDU83	1,0 (3.3)	25 (82) (for liquids)
FDU84	0,8 (2.6)	25 (82) (for solids)
FDU85	0,8 (2,6)	45 (148) (for solids)
FDU86	1,6 (5.2)	70 (230) (for solids)

m (ft)

1) valid for optimum process conditions

6.4.5 "flow N" (N = 1 or 2)



⇒

```
flow 1                F1005
 flow 1:
 level:
 sensor:
```

"flow N" (N = 1 or 2)

Displays the currently measured flow Q.
If the displayed value does not match the real flow, it is recommended to check the linearisation.

"level"

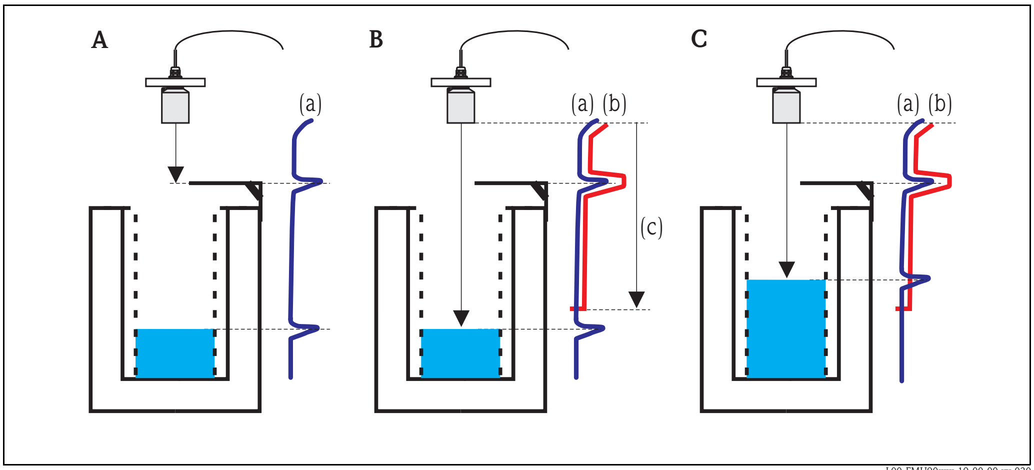
Displays the currently measured level L.
If the displayed value does not match the real level, it is recommended to check the empty calibration.

"sensor"

Displays the currently measured distance D between the reference point of the sensor and the liquid surface.
If the displayed value does not match the real distance, it is recommended to perform an interference echo suppression.

6.4.6 Interference echo suppressio: Basic principles

The **"flow N check value"** and **"flow N mapping"** parameter sets are used to configure the interference echo suppression of the Prosonic S.
The following picture shows the operating principle of the interference echo suppression:



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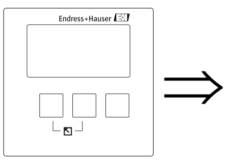
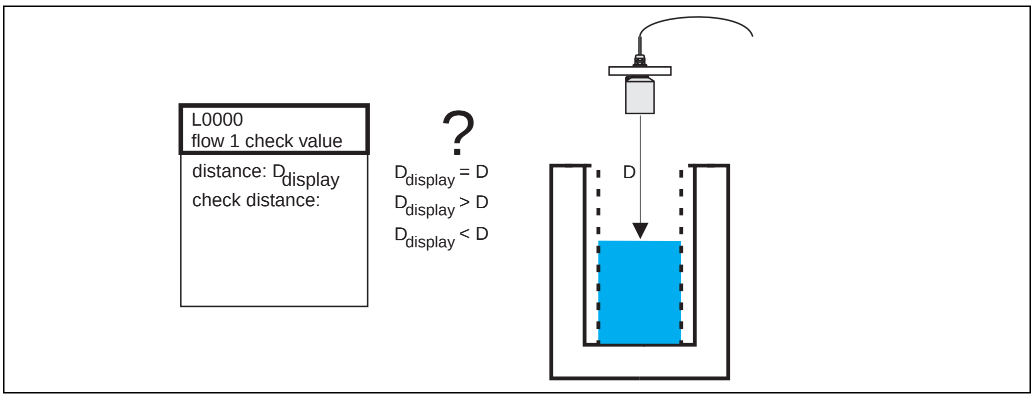
*A: The envelope curve **(a)** contains the level echo and an interference echo. Without interference echo suppression, the interference echo is evaluated.*
*B: The interference echo suppression generates the mapping curve **(b)**. This curve contains all echos which are located within the range of mapping **(c)**.*
C: From now on, only those echos are evaluated, which are higher than the mapping curve. The interference echo is ignored because it is lower than the mapping curve.

Note!
In order to include all interference echos, the interference echo suppression should be performed with the level as low as possible. If during the commissioning the channel can not be sufficiently emptied, it is advisable to repeat the interference echo suppression at a later point of time (as soon as the level reaches nearly 0%).

6.4.7 "flow N check value" (N = 1 or 2)



flow 1 check value F1006
distance:
check distance:



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"distance"

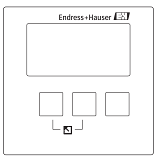
Displays the currently measured distance $D_{display}$.

"check distance"

Use this parameter to state if the displayed distance $D_{display}$ matches the real distance D. Based on your selection, the Prosonic S automatically proposes a suitable range of mapping.
You have got the following options:

- **distance = ok**
  Choose this option if the displayed value matches the real distance.
  After selecting this option, the **"flow N mapping"** parameter set appears. The preset range of mapping is equal to D. That means: all interference echos which are above the current product surface will be mapped out in the interference echo suppression.
- **distance too small**
  Choose this option if the displayed value is smaller than the real distance D.
  In this case, the currently evaluated echo is an interference echo.
  After selecting this option, the **"flow N mapping"** parameter set appears. The preset range of mapping is slightly larger than $D_{display}$. Therefore, the currently evaluated interference echo will be mapped out by the interference echo suppression.
- **distance too big**
  Choose this option if the displayed value $D_{display}$ is larger than the real distance D.
  This error is not caused by interference echos. Therefore, no interference echo suppression is performed and the Prosonic S returns to the "flow N" parameter set. Check the calibration parameters, especially the **"empty calibration"**.
- **distance unknown**
  Choose this option if you do not know the real distance D.
  In this case, an interference echo supression can not be performed and the Prosonic S returns to the "flow N" parameter set.
- **manual**
  Choose this option if you want to define the range of mapping manually.
  The **"flow N mapping"** parameter set appears, where you can define the required range of mapping.

6.4.8 "flow N mapping" (N = 1 or 2)



⇒

```
flow 1 mapping     F1008
 sensor:
 range of mapping:
 start mapping:
 status:
```

"sensor"

Displays the currently measured distance between the reference point of the sensor and the water surface. Compare this value to the real distance in order to find out if currently an interference echo is evaluated.

"range of mapping"

Use this parameter to specify the range of the mapping curve. Normally, a suitable value has already been entered automatically. Nevertheless, you can change this value if required.

"start mapping"

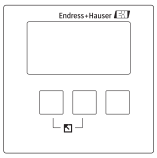
Select **"yes"** in this parameter in order to start the mapping. When the mapping is finished, the state is automatically changed to **"enable map"**.

The **"flow N state"** parameter set appears, in which the currently measured level, distance and flow are displayed. Compare the displayed distance to the real distance in order to decide if a further mapping is necessary.
If yes: Press the left-arrow key (←) in order to return to the "flow N mapping" parameter set.
If no: Press the right key (→) in order to return to the "flow N" submenu.

"status"

see below ("flow N status")

6.4.9 "flow N state" (N = 1 or 2)"



⇒

```
LVL1 state          L100C
 level:
 sensor:
 flow N:
 status:
```

"level"

Displays the currently measured level.

"sensor"

Dispalys the currently measured distance between the reference point of the sensor and the liquid surface.

"flow N" (N = 1 or 2)

Displays the currently measured flow.

"status"

Use this parameter to define the status of the interference echo suppression.

- **enable map**
  Choose this option in order activate the interference echo suppression. The mapping is then used for signal evaluation.
- **disable map**
  Choose this option in order to deactivate the interference echo suppression. The mapping is then no longer used for signal evaluation but it can be reactivated if required.
- **delete map**
  Choose this option in order to delete the mapping. It can not be reactivated again and the instrument uses the preprogrammed default mapping.

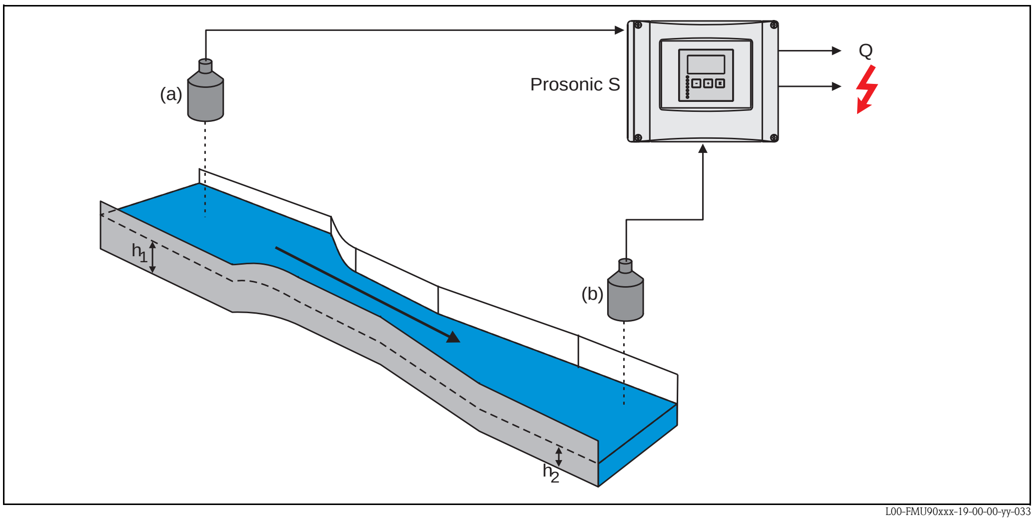
6.5 Calibration of backwater and dirt detection

6.5.1 Basics

The flow measurement can be impaired by backwater on the downstream side or by dirt within the flume. The backwater and dirt detection function can detect these errors and ensure that the Prosonic S reacts appropriately.
Two sensors are required for backwater and dirt detection. The first sensor is mounted above the upstream water, the second above the downstream water. The Prosonic S evaluates the ratio of the downstream level h_2 and the upstream level h_1.

Backwater detection
Backwater is detected if the ratio h_2/h_1 exceeds a critical value (typically 0,8 for Venturi flumes). In this case, the flow is continuously reduced to 0. An alarm relay can be configured which indicates the backwater alarm.

Dirt detection
Dirt within the flume is detected if the ratio h_2/h_1 falls below a critical value (typically 0,1). An alarm relay can be configured which indicates the dirt alarm.



(a): Upstream sensor;(b): Downstream sensor

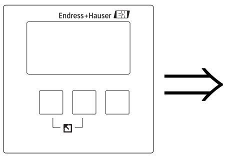
Note!
The ultrasonic sensor for the measurement of the downstream water level should be installed at a sufficient distance from the discharge of the flume. The measuring point must be selected in such a way that the surface of the water is calmed down and the level is not influenced by the flume anymore.

6.5.2 Overview

The following table gives an overview of the calibration for backwater and dirt detection. Detailed information on the parameters can be found in the sections 6.5.3 - 6.5.5.

Step	Parameter set	Parameter	Remarks	Section
Calibration of the upstream sensor				
1			Open the submenu "flow/flow1+backwater/flow". Calibrate the flow measurement for the upstream sensor.	→ Chap. 6.4
Calibration of the downstream sensor				
2			Open the submenu "flow/flow1+backwater/backwater/basic setup".	
3	backw. sensor selection	input	Select the downstream sensor.	similar to → Chap. 6.4.2
		sensor selection	Select the type of sensor ("automatic" for FDU9x)	
		detected	only available for "sensor selection" = "automatic"; Displays the detected type of sensor.	
4	backw. empty calibration	empty E	Specify the distance E between the reference point of the sensor and the bottom of the flume.	similar to → Chap. 6.4.4
		blocking distance	displays the blocking distance of the respective sensor; the maximum level may not project into the blocking distance.	
Calibration of the backwater and dirt detection				
5	backwater detection	ratio B	Specify upper limit B for the ratio h_2/h_1. Backwater alarm is active if $h_2/h_1 > B$.	→ Chap. 6.5.3
6	dirt detection	ratio D	Specify lower limit D for the ratio h_2/h_1. Dirt alarm is active if $h_2/h_1 < D$.	→ Chap. 6.5.4
7	backwater	act. backwater level	Displays the currently measured downstream level h_2 for checking purposes.	→ Chap. 6.5.5
		act flow level	Displays the currently measured upstream level h_1 for checking purposes.	
		act. ratio	Displays the currently measured ratio h_2/h_1 for checking purposes.	
		flow 1	Displays the current flow Q for checking purposes.	
Interference echo suppression for the downstream sensor				
7	backwater check value	distance	displays the currently measured distance between the membrane of the downstream sensor and the liquid surface.	similar to → Chap. 6.4.7
		check distance	Compare the displayed distance with the real value: ▪ "distance = ok" → "backwater mapping" (see below) ▪ "distance too small" → "backwater mapping" (see below) ▪ "distance too big" → basic setup completed ▪ "distance unknown" → basic setup completed ▪ "manual" → "backwater mapping" (see below)	
8	backwater mapping	distance	displays the currently measured distance between the membrane of the downstream sensor and the liquid surface	similar to → Chap. 6.4.8
		range of mapping	Determines the range over which the mapping is recorded; confirm the predefined value or enter your own value.	
		start mapping	Select: ▪ no: the mapping is not recorded ▪ yes: the mapping is recorded; after completion, the "backwater detection" parameter set appears	
9	backwater status	act backwater level	displays the currently measured downstream level.	similar to → Chap. 6.4.9
		distance	displays the currently measured distance between the membrane of the downstream sensor and the liquid surface. Check the value: ▪ Value correct: → basic setup completed. Return to the measured value display by pressing several times ▪ Value not correct: go back to step 7 ("backwater check value")	
		flow 1	displays the currently measured flow	
		status	Used to enable, disable or delete a mapping	
10	Configuration of the backwater and dirt alarm relay, → Chap. 8.2			

6.5.3 "backwater detection"

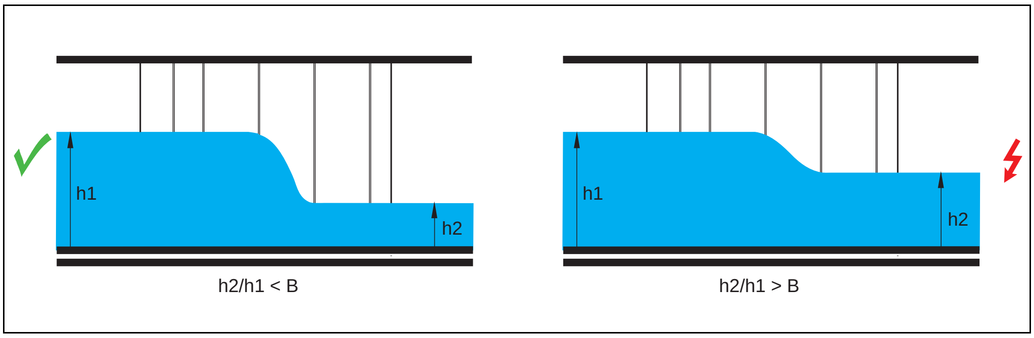


backw. detection F1305
ratio B:

"ratio B"

Use this parameter to specify the upper limit for the ratio h_2/h_1.
If during the measurement the ratio exceeds this limit, the backwater alarm becomes active, i.e.:

- the warning W 00 692 appears
- the backwater alarm relay is de-energized[8)]
- if the backwater level continues to rise, the flow (indicated on the display and registered by the counters) is continuously reduced to 0.



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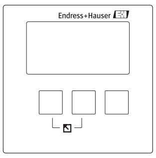
Note!
The default setting is B = 0,8.
This is the optimum value for Venturi flumes. To ensure reliable measurement it should not be exceeded.

8) In the "relay/controls" menu, one of the relays can be defined to be the backwater alarm relay.

6.5.4 "dirt detection"



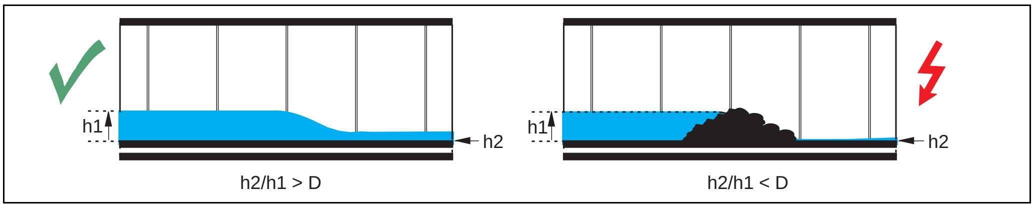
⇒

```
dirt detection        F1306
   ratio D:
```

"ratio D"

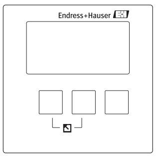
Use this parameter to specify the lower limit for the ratio h_2/h_1.
If during the measurement the ratio falls below this level, the dirt alarm becomes active, i.e.

- the warning W 00 693 appears
- the dirt alarm relay is de-energized[9].



L00-FMU90xxx-19-00-00-yy-036

6.5.5 "backwater"



⇒

```
backwater             F1307
  act. backw. level:
  act. flow level:
  actual ratio:
  flow 1:
```

The following is displayed in this parameter set:

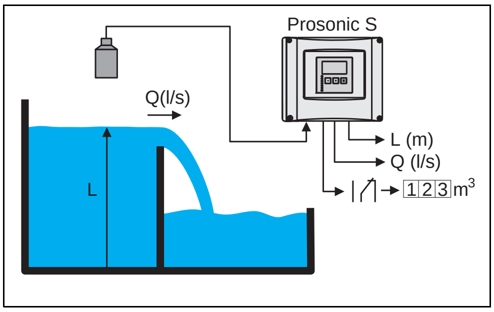
- the current backwater level h_2 (downstream level)
- the current flow level h_1 (upstream level)
- the current ratio h_2/h_1
- the current flow Q

Use these values to check the flow calibration as well as the calibration of the backwater and dirt detection.

9) In the "relay/controls" menu, one of the relays can be defined to be the dirt alarm relay

6.6 Calibration for simultaneous level and flow measurement with one sensor

It is possible to measure level and flow simultaneously with one sensor. This is especially useful for stormwater overflow basins. For this type of measurement the sensor must be mounted above the basin and the appropriate distance to the weir crest must be observed (for details refer to the description of weirs in the appendix).
The measured values can be communicated by the current outputs or the HART signal.



L00-FMU90xxx-15-00-00-xx-006

Calibration

1. Go to the "device properties/operating param./operating mode" parameter and select the option "level+flow".
2. Go to the "level" menu and calibrate the level measurement as described in the Operating Instructions BA00288F/00.
3. Go to the "flow" menu and calibrate the flow measurement as described in → Chap. 6.4 of this manual. Select the same sensor as for the level measurement.

Note!
It is recommended to perform the interference echo suppression when calibrating the level measurement. This suppression is automatically valid for the flow measurement as well. Therefore, the interference echo suppression can be skipped when calibrating the flow measurement.

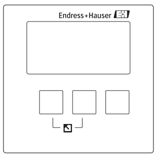
6.7 Parametrization of the counters

6.7.1 Overview

The following table gives an overview of the parametrization of the counters. Detailed information on the parameters can be found in sections 6.7.2. - 6.7.4.

Step	Parameter set	Parameter	Remarks	Section
1			Open the "flow/flow counter" submenu.	
2			Select the type of counter: ▪ totalizer (not resettable) ▪ daily counter (resettable)	
3			Select the number of the totalizer or daily counter you are going to calibrate.	
4	totalizer N daily counter N (N = 1 - 3)	allocation	Select the flow to which the counter refers.	→ Chap. 6.7.2
		counting unit	Select the counting unit.	
5	totalizer N daily counter N (N = 1 - 3)	value	Indicates the current value of the counter.	→ Chap. 6.7.3
		overflow	Indicates the number of times the counter has passed the overflow. The total flow volume is : overflow x 10^7 + value	
		reset	Select "yes" to reset the counter (not available for totalizers).	
6	totalizer N daily counter N (N = 1 - 3)	error handling	Define the reaction of the counter in the case of an error: ▪ actual value: the current flow value is used (although its reliability is not ensured) ▪ hold: the counter uses the flow value which was present when the error ocurred. ▪ stop: Counting is interrupted.	→ Chap. 6.7.4
7	daily counter N (only for instruments with external switch inputs: FMU90-********B***)	external reset	allocate external input (digin) for reset	→ Chap. 6.7.5
		external start	allocate externao input (digin) for start and stop of the counter	

6.7.2 "totalizer N/daily counter N" (N = 1 -3)



⇒

totalizer 1 F1202
allocation:
counting unit:

"allocation"

Use this parameter to allocate a flow to the counter.

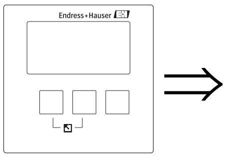
Selection:
- none (default)
- flow 1, Q1
- flow 2, Q2 (for 2-channel instruments only)
- average flow, (Q1 + Q2)/2, (for 2-channel instruments only)
- flow 1-2, Q1 - Q2, (for 2-channel instruments only)
- flow 2-1, Q2 - Q1, (for 2-channel instruments only)
- flow 1+2, Q1 + Q2, (for 2-channel instruments only)

"counting unit"

Use this parameter to select the unit for the flow volume.

Selection:
- m^3
- l
- hl
- igal
- usgal
- barrels
- $inch^3$
- ft^3
- USmgal
- Ml

6.7.3 "totalizer N/daily counter N" (N = 1 - 3)



totalizer 1	F1203
value:	
overflow:	

"value"

Displays the current flow volume.

"overflow"

Whenever the counter passes the overflow, this parameter is incremented by 1. The total flow volume thus is:
V_{total} = overflow x 10^7 + value

Note!
The totalizer value can also be displayed on the measured value screen (menu: "display", parameters: "value 1" ... "value 6", → 76)
In order to display the total value of the totalizer (value and overflow), select the "1 value + bargraph" or "value max. size" option in the "type" parameter (→ 75).

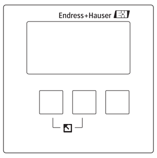
"reset" (only for the daily counters)

Use this parameter to reset the counter to "0".

Selection:

- **no (default)**
  "value" and "overflow" retain their values.
- **yes**
  "value" und "overflow" are reset to "0".

6.7.4 "totalizer N/daily counter N" (N = 1 - 3)



⇒

totalizer 1 F1204
error handling:

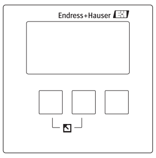
"error handling"

Use this parameter to define the reaction of the Prosonic S in the case of an error.

Selection:

- **stop**
  The Prosonic S stops counting.
- **hold**
  The Prosonic S continues counting. It uses the flow value which was present at the moment the error occured.
- **actual value**
  The Prosonic S continues counting. It uses the current flow value (although its reliability is no longer ensured).

6.7.5 "daily counter N" (N = 1 - 3)




```
daily counter 1        F1105
  external reset:
  externl start:
```

Note!
This parameter set is only available in instruments with external limit switches (FMU90-********B***).

"external reset"

This parameter allocates one of the external switch inputs to the counter by which it can be reset.

Selection:
- disabled
- ext. digin 1
- ...
- ext. digin 4

"external start"

This parameter allocates one of the external switch inputs to the counter by which it can be started.

Selection:
- disabled
- ext. digin 1
- ...
- ext. digin 4

6.8 Envelope curve display

After the basic setup it is recommended to assess the measurement by the envelope curve (→ Chap. 10.3).

6.9 After the calibration

After the calibration the Prosonic S transmitts the measured value via

- the display module
- the current output
  (by default the complete measuring range (0 ... Q_{max}) is mapped to the current range (4 ... 20 mA)
- the HART signal

Note!
Sensor management
For instruments with multiple sensor inputs it is possible to deactivate inputs (or sensors) which are not used. To do so, go to the function "sensor management/FDU sensor N/sensor operation" and select the desired option:

- **on**
  The sensor is switched on.
- **hold**
  The sensor is switched off. The last measured value is held.
- **off**
  The sensor is switched off. No measured value is transmitted.

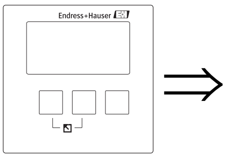
Additional parameters are available for optimization of the measuring point. They can be parametrized as required. A detailed description of all instrument parameters is given in the operating manual BA00290F/00, "Prosonic S FMU90 – Description of Instrument Functions". A PDF file of this document is available from

- the supplied CD-ROM
- the internet at "www.endress.com"

The following chapters describe the "calibration display", "relays/controls" and "output/calculations" submenus.

7 The "display" menu

7.1 "display"

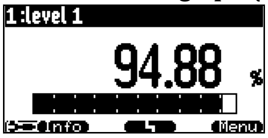


calibr. display DX202
type:
time:
value 1:
cust. text 1:

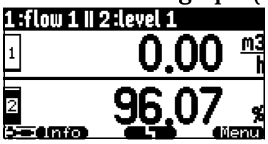
"type"
Use this parameter to select the format of the measured value display.

Selection:

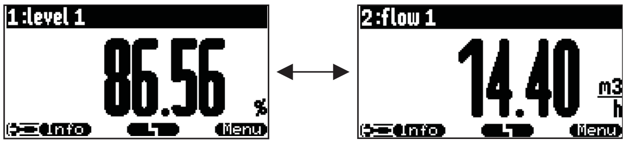
- **1x value+bargraph (default for instruments with 1 current output)**



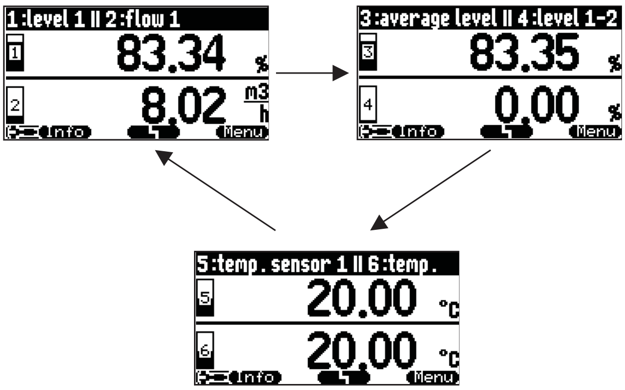
- **2x value+bargraph (default for instruments with 2 current outputs)**



- **value max. size**
  Up to two values are displayed alternately using the entire display:



- **alter 3x2 values**
  Up to 6 values can be displayed on three alternating pages. Each pages contains two values.



"time"
This parameter is used for the options "value max. size" and "alter 3x2 values". It specifies the time after which the next page appears.

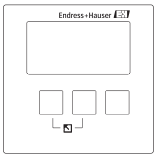
Note!
To change to the next page immediately, press  .

"value 1" ... "value 6"
Use these parameters to allocate a measured or calculated value to each of the display values. The selection depends on the instrument version and installation environment.

Note!
If "temp. sensor 1/2" is selected, depending on the setting in "sensor management/FDU sensor N" one of the following is displayed:
- the sensor temperature
- the average of the sensor temperature and the temperature of the external temperature probe
- the temperature of the external temperature probe

"cust. text 1" ... "cust. text 6"
These parameters can be used to allocate a text string to each of the display values. This text is displayed together with the value if **"customized text"** (in the "display format" parameter set) has been set to **"yes"**.

7.2 "display format"



⇒

```
display format      DX201
 format:
 no. of decimals:
 sep. character:
 customized text:
```

"format"
Use this parameter to select the display format for numbers.

Selection:
- decimal (Default)
- ft-in-1/16"

"no. of decimals"
Use this parameter to select the number of decimals for the representation of numbers.

Selection:
- x
- x.x
- x.xx (Default)
- x.xxx

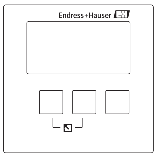
"sep. character"
Use this parameter to select the separation character for the representation of decimal numbers.

Selection:
- point (.) (Default)
- comma (,)

"customized text"
Determines if "text 1" to "text 6" from the "calibration display" parameter set are displayed.

Selection:
- no (Default)
- yes

7.3 "back to home"



⇒

back to home DX200
back to home:

"back to home"
Use this parameter to specify the return time. If no entry is made during the specified time, the display returns to the measured value display.

- Range of values: 3 ... 9999 s
- Default: 900 s

8 The "Relay/Controls" menu

The "relay/controls" menu is used to configure the relays and control functions of the Prosonic S. The following relay functions are available for flow measurements:

- Limit relay
- Alarm and diagnostics relay
- Counting pulses and time pulses

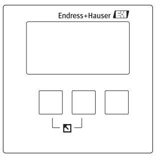
The configuration of these functions is described in the following sections.

8.1 Configuration of a limit relay

8.1.1 Overview

Step	Parameter set or submenu	Parameter	Remarks	Section
1	"relay/controls" menu		Select "relay configuration".	
2	relay allocation		Select a relay.	→ Chap. 8.1.2
3	relay N (N= 1 -6)	function	1. Select "limit" 2. Select the measured or calculated value to which the limit refers.	→ Chap. 8.1.3
4	relay N (N = 1 - 6)	limit type	Select a limit type.	→ Chap. 8.1.4
		switch on point	Define the switch on point. (only available for "limit type" = "standard" or "tendency/speed")	
		switch off point	Define the switch off point. (only available for "limit type" = "standard" or "tendency/speed")	
		upper switch point	Define the upper switch point. (only available for "limit type" = "inband" or "out of band")	
		lower switch point	Define the lower switch point. (only available for "limit type" = "inband" or "out of band")	
		hysteresis	Define the hysteresis. (only available for "limit type" = "inband" or "out of band")	
5	relay N (N = 1 - 6)	switch delay	Define the switch delay (Default: 0s).	→ Chap. 8.1.5
		invert	Select if the relay signal is to be inverted (default: no)	
		error handling	Define the reaction of the relay in the case of an error.	

8.1.2 "relay allocation"



⇒

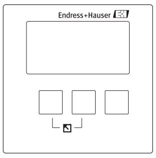
```
relay allocation     RX101
 relay 1
 relay 2
 relay 3
 relay 4
```

Use this parameter to select the relay you are going to configure.

Selection:
- All relays of the instrument version at hand

Note!
If a function has already been allocated to one of the relays, the name of this function is displayed next to the relay number.

8.1.3 "relay N" (N = 1 - 6) (Part 1: relay function)



⇒

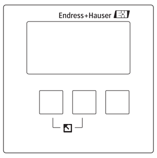
```
relay 1              R1103
 function:
```

After selecting a relay, the parameter set **"relay N"** (N =1 - 6) appears, which is used to configure the relay. Initially, it contains the "function" parameter only. To configure a limit relay, proceed according to the following steps:

1. Select the **"function"** parameter. The **"select function"** screen appears.
2. Select **"limit"**. The **"function"** selection list appears.
3. Select the measured or calculated value to which the limit relay refers. The selection depends on the instrument version and the parametrization.

Note!
If temperature measurement of sensor N is selected as the function, it always refers to the temperature which has been assigned to the respective sensor in "sensor management/FDU sensor N". Possible temperatures are:
- sensor temperature
- average of sensor temperature and temperature of an external temperature sensor
- temperature of an external temperature sensor

8.1.4 "relay N" (N = 1 - 6) (Part 2: Limit type and switching points)



⇒

```
relayN              RX101
 function: limit
 limit type:
 switch on point:
 switch off point:
```

"Limit type"

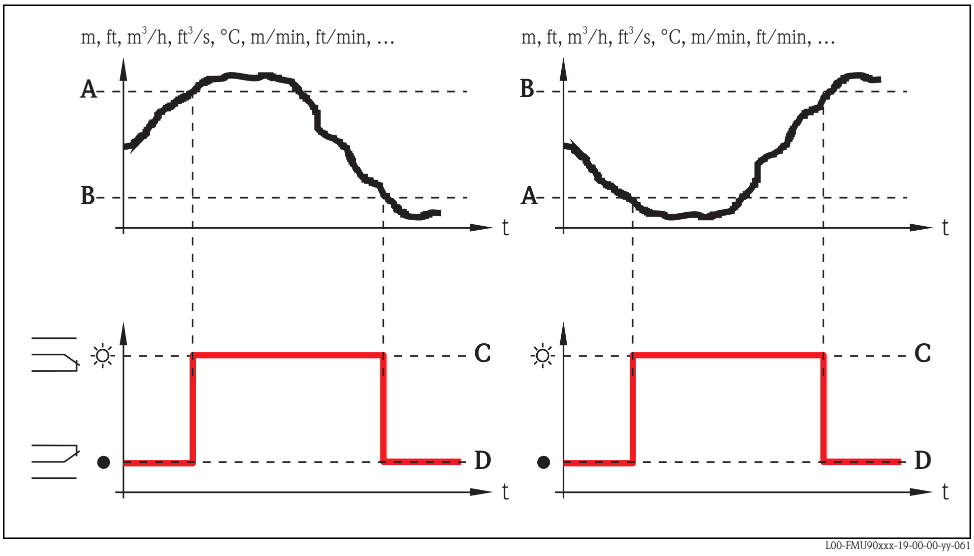
Use this parameter to define the type of limit.

Selection:

- **standard**
  For this limit type, a switch on point and a switch off point have to be defined. The switching behaviour depends on the relative position of these switching points.

  a. **switch on point > switch off point**
  The relay is energized if the measured value rises above the switch on point.
  The relay is de-energized if the measured value falls below the switch off point.

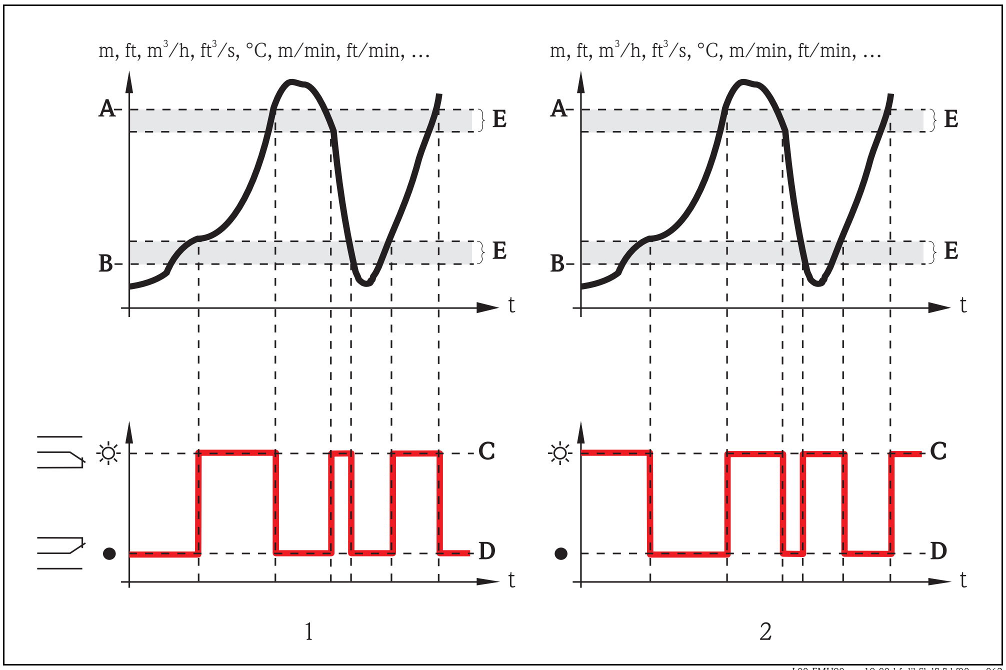
  b. **switch on point < switch off point**
  The relay is energized if the measured value falls below the switch on point.
  The relay is de-energized if the measured value rises above the switch off point.



A: switch on point; B: switch off point; C: relay energized; D: relay de-energized

- **tendency/speed**
  This limit type is similar to the "standard" type. The only difference is that variations with time of the measured value are examined instead of the measured value itself. Therefore, the unit for the switching points is "measuring value unit per minute".
- **inband**
  For this limit type, an upper and a lower switching point have to be defined.
  The relay is energized if the measured value is between the two switching points.
  The relay is de-energized if the measured value is above the upper or below the lower switching point.
  Additionally, a hystersis can be defined, which affects both switching points.
- **out of band**
  For this limit type, an upper and a lower switching point have to be defined.

The relay is energized if the measured value is above the upper or below the lower switching point.
The relay is de-energized if the measured value is between the two switching points.
Additionally, a hystersis can be defined, which affects both switching points.



1: "inband" limit relay; 2: "out of band" limit relay
A: upper switching point; B: lower switching point; C: relay energized; D: relay de-energized; E: hysteresis

"switch on point" and "switch off point"
(for the "standard" limit type)

Define the switching points in these parameters.
They have the same unit as the measured value.

Caution!
After a change of the "unit level" or "flow unit" the switching points have to be checked and adjusted if required.

"switch on /min" and "switch off /min"
(for the "tendency/speed" limit type)

Define the switching points in these parameters.
Their unit is the measured value unit per minute.

Caution!
After a change of the "unit level" or "flow unit" the switching points have to be checked and adjusted if required.

"upper switching point" and "lower switching point"
(for the "inband" and "out of band" limit types)

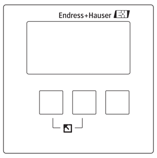
Define the switching points in these parameters.
They have the same unit as the measured value.

Caution!
After a change of the "unit level" or "flow unit" the switching points have to be checked and adjusted if required.

"hysteresis"
(for the "inband" and "out of band" limit types)

Define the hysteresis in this parameter. It has the same unit as the measured value.
The hysteresis affects the upper and the lower swtiching point.

8.1.5 "relay N (N = 1 - 6)" (Part 3: Relay behavior)



```
relay X            RX104
 switch delay:
 invert:
 error handling:
```

"switch delay"

Use this parameter to specify the switch delay (in seconds).

The relay does not switch immediately after the switch on point has been exceeded but only after the specified delay.
The measured value must exceed the switch-on point during the entire delay time.

"invert"

Use this parameter to specify if the switching direction of the relay is to be inverted.

Selection:
- **no (default)**
  The switching direction of the relay is **not** inverted. The relay switches as described in the above sections.
- **yes**
  The switching direction of the relay **is** inverted. The states "energized" and "de-energized" are interchanged as compared to the above description.

"error handling"

Use this parameter to specify the reaction of the relay in the case of an error.

Selection:
- **actual value**
  The relay switches according the the currently measured value (although its reliability is not ensured).
- **hold (default)**
  The current switching state of the relay is maintained.
- **switch on**
  The relay is energized.
- **switch off**
  The relay is de-energized.

8.2 Configuration of an alarm or diagnostic relay

8.2.1 Overview

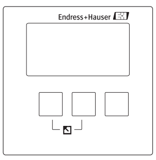
Step	Parameter set or submenu	Parameter	Remark	Section
1	"relay controls" menu		Select "relay configuration"	
2	relay allocation		Select a relay	→ Chap. 8.2.2
3	relay N (N= 1 -6)	function	1. Select "alarm/diagnostics" 2. Select – "alarm relay", if the relay is to indicate an alarm state of the Prosonic S.[1] – "diagnostics", if the relay is to indicate one or two user selectable states of the instrument. – "backwater alarm" if the relay is to indicate detected backwater[2] – "dirt alarm" if the relay is to indicate detected dirt within the flume[3]	→ Chap. 8.2.3
4	relay N (N = 1 - 6)	allocation 1	Select the first instrument state which is to be indicated by the relay. (only available if "diagnostics" has been selected in the previous function)	→ Chap. 8.2.4
		allocation 2	Select the seccond instrument state which is to be indicated by the relay. (only available if "diagnsotics" has been selected in the previous function)	
5	relay N (N = 1 - 6)	invert	Select if the relay signal is to be inverted (default: no)	→ Chap. 8.2.5

1) This is the default setting for relay 1.

2) Condition: a backwater detection must have been configured (→ Chap. 6.5)

3) Condition: a dirt detection must have been configured (→ Chap. 6.5)

8.2.2 "relay allocation"



⇒

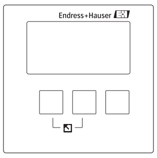
```
relay allocation     RX101
  relay 1
  relay 2
  relay 3
  relay 4
```

Use this parameter to select the relay you are going to configure.

Selection:
- All relays of the instrument version at hand

Note!
If a function has already been allocated to one of the relays, the name of this function is displayed next to the relay number.

8.2.3 "relay N" (N = 1 - 6) (Part 1: relay function)



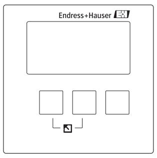
⇒

```
relay 1            R1103
 function:
```

After selecting a relay, the parameter set **"relay N"** (N =1 - 6) appears, which is used to configure the relay. Initially, it contains only the "function" parameter. To configure an alarm relay or diagnostic relay, proceed according to the following steps:

1. Select the **"function"** parameter. The **"select function"** screen appears.
2. Select **"alarm/diagnostics"**. The **"function"** selection list appears.
3. Select
   – "alarm relay", if the relay si to indicate an alarm state of the Prosonic S[10].
   – "diagnostics" if the relay is to indicate one or two user selectable states of the instrument.
   – "backwater detection" if the relay is to indicate detected backwater. This option is only available if a backwater detection has been configured (see "flow" menu)
   – "dirt detection" if the relay is to indicate detected dirt within the flume. This option is only available if a dirt detection has been configured (see "flow" menu).

8.2.4 "relay N" (N = 1 - 6) (Part 2: Allocation of the switching condition)



⇒

```
relay N           RN103
 function: diagnostics
 allocation 1:
 allocation 2:
```

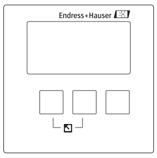
"allocation 1/2"

A specific instrument state or event can be allocated to each of these parameters. The relay is de-energized as soon as one of these states or events occurs.

Selection:
- echoloss sensor 1/2/1+2
- defective temperature sensor1/2
- defective external temperature sensor
- Accumulated alarm: defective temperature sensor
- overtemp. sensor 1/2
- Accumulated Alarm: overtemp.
- safety distance channel 1/2
- Accumulated Alarm: safety distance
- pump alarm
- pump operation

10) This is the default setting for relay 1.

8.2.5 "relay N" (N = 1 - 6) (Part 3: Relay behavior)



⇒

```
relay N            RN104
  invert:
```

"invert" subfunction

Use this parameter to specify if the switching direction of the relay is to be inverted.

Selection:

- **no (default)**
  The switching direction of the relay is **not** inverted. The relay switches as described in the above sections.
- **yes**
  The switching direction of the relay **is** inverted. The states "energized" and "de-energized" are interchanged as compared to the above description.

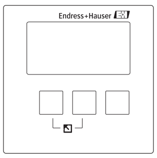
8.3 Configuration of a time pulse relay

8.3.1 Overview

A time pulse relay generates a short pulse in regular time intervals. To configure the time pulse relay, perform the following steps:

Step	Parameter set	Parameter	Remarks	Section
1	"relay/controls" submenu		Select "relay configuration"	
2	relay allocation		Selec a relay	→ Chap. 8.3.2
3	relay N (N= 1 -6)	function	Select "time pulse".	→ Chap. 8.3.3
4	relay N (N = 1 - 6)	pulse width	Define pulse width (default: 200 ms)	→ Chap. 8.3.4
		pulse time	Define the time interval between the individual pulses.	
5	relay N (N = 1 - 6)	invert	Determine if the relay signal is to be inverted (default: no)	→ Chap. 8.3.5
		error handling	Determine the relay behaviour in the case of an error (default: actual value)	

8.3.2 "relay allocation"



⇒

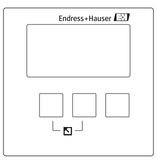
```
relay allocation      RX101
  relay 1
  relay 2
  relay 3
  relay 4
```

Use this parameter to select the relay you are going to configure.

Selection:
- All relays of the instrument version at hand

✎ Note!
If a function has already been allocated to one of the relays, the name of this function is displayed next to the relay number.

8.3.3 "relay N" (N = 1 - 6) (Part 1: relay function)



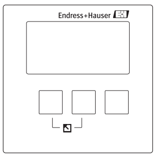
⇒

```
relay 1               R1103
  function:
```

After selecting a relay, the parameter set **"relay N"** (N =1 - 6) appears, which is used to configure the relay. Initially, it contains the "function" parameter only. To configure a time pulse relay, proceed according to the following steps:

1. Select the **"function"** parameter. The **"select function"** screen appears.
2. Select **"time pulse"**. The **"function"** selection list appears.
3. Confirm you choice by selecting **"time pulse"** again.

8.3.4 relay N (N = 1 - 6) (Part 2: Definition of the pulses)



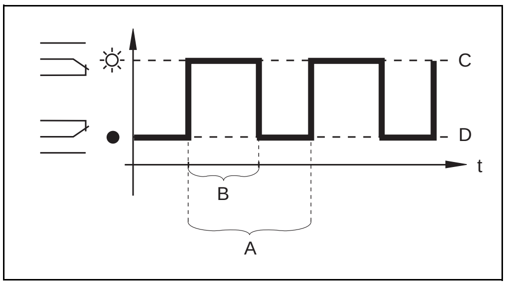
⇒

```
relay 1              RX103
 function: time pulse
 pulse width:
 pulse time:
```

"pulse width" and "pulse time"

Use these parameters to specify the time interval between two pulses (pulse time) and the duration of each pulse (pulse width).

- unit of pulse time: min
- default pulse time: 1 min
- unit of pulse width: ms
- default pulse width: 200 ms



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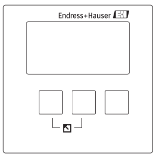
A: pulse time; B: pulse width;
C: relay energized; D: relay de-energized

8.3.5 "relay N" (N = 1 - 6) (Part 3: Relay behavior)



⇒

```
relay 1              RX104
 invert:
 error handling:
```

"invert"

Use this parameter to specify if the switching direction of the relay is to be inverted.

Selection:
- **no (default)**
  The switching direction of the relay is **not** inverted. The relay switches as described in the above sections.
- **yes**
  The switching direction of the relay **is** inverted. The states "energized" and "de-energized" are interchanged as compared to the above description.

"error handling"

Use this parameter to specify the reaction of the relay in the case of an error.

Selection:
- **actual value**
  The Prosonic S continues generating pulses.
- **stop**
  No pulses are generated in the case of an error.

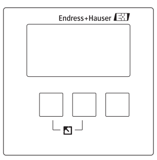
8.4 Configuration of a counting pulse relay

8.4.1 Overview

A counting pulse relay generates a short pulse each time a certain amount of the fluid has passed the flume or weir. To configure a counting pulse relay proceed according to the following steps:

Step	Parameter set	Parameter	Remarks	Section
1	"relay/controls" menu		Select "relay configuration"	
2	relay allocation		Select a relay	→ Chap. 8.4.2
3	relay N (N= 1 -6)	function	1. Select "counting pulse" 2. Select the flow to which the pulses refer.	→ Chap. 8.4.3
4	relay N (N = 1 - 6)	counter unit	Select the unit for the flow volume.	→ Chap. 8.4.4
		pulse value	Select the flow volume after which a pulse is to be generated.	
		pulse width	Specify the width of each pulse.	
5	relay N (N = 1 - 6)	pulse counter	Indicates, how many pulses have already been generated.	→ Chap. 8.4.5
		overflow	Indicates, how often the counter has passed the overflow (10^7). The total number of pulses is: overflow x 10^7 + pulse counter	
		reset counter	Is used to reset the pulse counter and overflow. ▪ yes: the counter is reset ▪ no: the counter is not reset.	
		start counter	Define the minimum flow for pulse counting.	
		stop counter	Define the maximum flow for pulse counting.	
6	relay N (N = 1 - 6)	invert	Determine if the relay signal is to be inverted (default: no)	→ Chap. 8.4.6
		error handling	Determine the relay behaviour in the case of an error (default: actual value).	

8.4.2 "relay allocation"



⇒

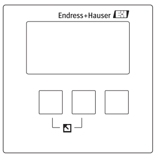
```
relay allocation      RX101
 relay 1
 relay 2
 relay 3
 relay 4
```

Use this parameter to select the relay you are going to configure.

Selection:
- All relays of the instrument version at hand

Note!
If a function has already been allocated to one of the relays, the name of this function is displayed next to the relay number.

8.4.3 "relay N" (N = 1 - 6) (Part 1: relay function)

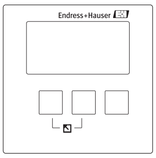


```
relay 1            R1103
 function:
```

After selecting a relay, the parameter set **"relay N"** (N =1 - 6) appears, which is used to configure the relay. Initially, it contains the "function" parameter only. To configure a counting pulse relay, proceed according to the following steps:

1. Select the **"function"** parameter. The **"select function"** screen appears.
2. Select **"counting pulse"**. The **"function"** selection list appears.
3. Select the flow to which the counting puslses are to refer.

8.4.4 "relay N" (N = 1 - 6) (Part 2: definition of the pulses)



```
relay 1            RX103
 function: pulse flow 1
 counter unit:
 pulse value:
 pulse width:
```

"counter unit"

Use this parameter to select the unit for the flow volume.

Selection:
- l (default)
- hl
- Ml
- m^3
- dm^3
- cm^3
- ft^3
- $inch^3$
- us gal
- us mgal
- i gal
- barrels

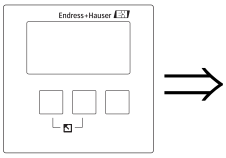
"pulse value"

Use this parameter to specify the flow volume after which a pulse is generated.
Default: 100 m^3

"pulse width"

Use this parameter to specify the width of each pulse.
Default: 200 ms

8.4.5 "relay N " (N = 1 - 6) (Part 3: counting value)



relay 1	RX105
pulse counter:	
overflow x 10^7:	
reset counter:	
start counter:	

"pulse counter"

Displays the number of pulses which have been generated since the last overflow.

"overflow"

Displays, how many times the pulse counter has already passed the overflow.

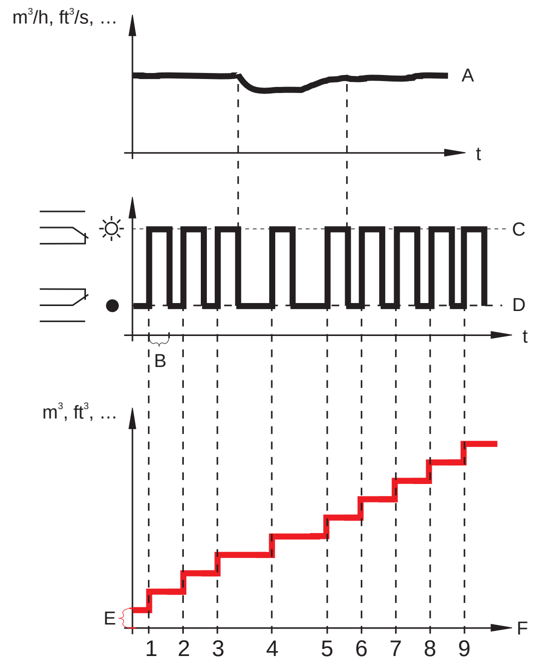
Note!
The total flow volume is:
V_{total} = (overflow x 10^7+ pulse counter) x pulse value

"reset counter"

Use this parameter to reset the counter.

Selection:

- **no (default)**
  "pulse counter" and **"overflow"** retain their values.
- **yes**
  "pulse counter" and **"overflow"** are reset to "0".



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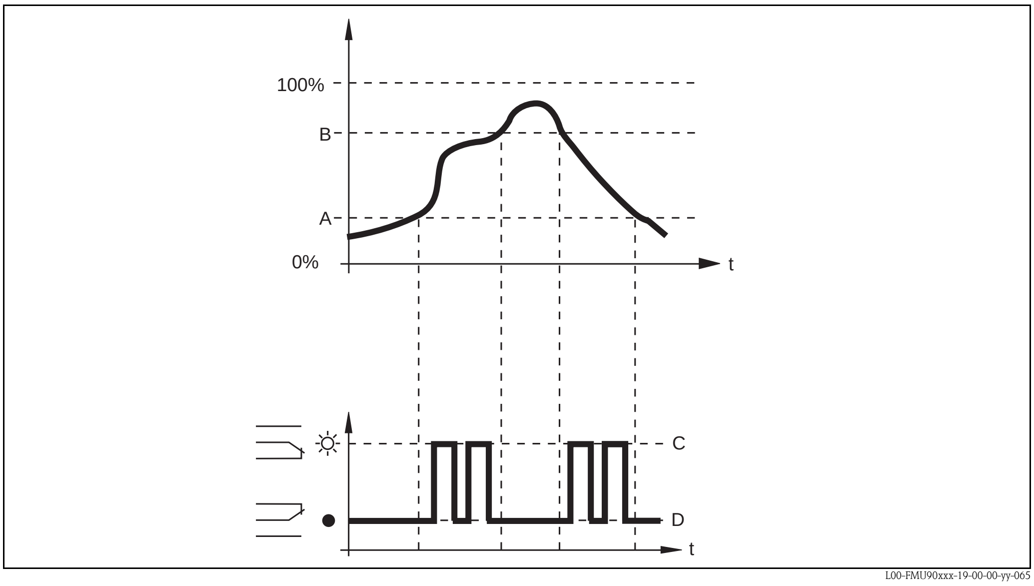
A: flow; B: pulse width; C: relay energized; D: relay de-energized; E: pulse value; F: pulse counter

"start counter" and "stop counter"

You can use these parameters to exclude very small and very large flows from being counted.
If the flow is below "start counter" or above "stop counter" no pulses are generated. Both values are to be specified as a percentage of the maximum flow (Q_{max}).

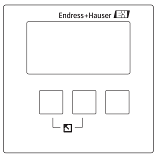
- Default of "start counter": 0%
- Default of "stop counter": 100%



A: start counter; B: stop counter; C: relay energized; D: relay de-energized

Note!
These parameters can be used for dual range (nested) flumes in order to limit the pulses to the lower or upper part of the flume. For details refer to the manual "Prosonic S – Description of the instrument functions", BA00290F/00.

8.4.6 "relay N" (N = 1 - 6) (Part 4: relay bahavior)



```
relay 1            RX104
 invert:
 error handling:
```

"invert"

Use this parameter to specify if the switching direction of the relay is to be inverted.

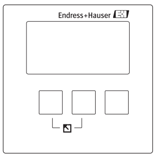
Selection:
- **no (default)**
  The switching direction of the relay is **not** inverted. The relay switches as described in the above sections.
- **yes**
  The switching direction of the relay **is** inverted. The states "energized" and "de-energized" are interchanged as compared to the above description.

"error handling"

Use this parameter to specify the reaction of the relay in the case of an error.

Selection:
- **actual value**
  The currently measured flow value is used (although its reliability is not ensured).
- **hold**
  The counter uses the flow value which was present when the error occurred.
- **stop**
  No pulses are generated in the case of an error.

9 The "output/calculations" menu



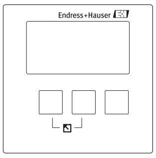
⇒

main menu CX001
output/calculat
device properties
system informat.

The "output/calculations" menu can be used to

- configure calculations such as averaging and subtraction
- configure the current outputs and the HART interface.

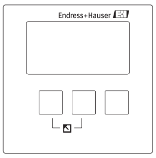
After entering the "output/calculations" menu, a selection screen appears in which you must choose the output you are going to configure.



⇒

output/calculat OX001
current output 1
(current output 2)

After this selection, additional submenus appear, which can be used to configure the output:

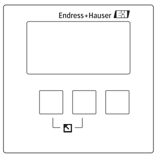


⇒

current output 1 O1302
allocat./calculat
extended calibr.
HART settings
simulation

9.1 The "allocation/calculations" submenu

9.1.1 "allocation current N " (N = 1 or 2)



⇒

```
allocat. curr. 1      O1201
 output:
 output current:
```

"output"

Allocates a measured or calculated value to the current output.

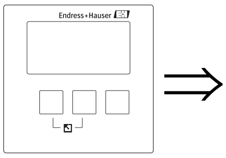
Selection:
The available options depend on the instrument version, the connected sensors and the instrument configuration. The following measured and calculated values may occur:
- level 1
- level 2
- flow 1
- flow 2
- average level: (level1 + level2)/2
- level 1-2
- level 2-1
- level 1+2
- average flow
- flow 1-2
- flow 2-1
- flow 1+2
- backwater ratio downstream/upstream
- rake control ratio downstream/upstream

"output current"

Displays the output current (mA).

9.2 The "extended calibration" submenu

9.2.1 "mode current N" (N = 1 or 2)

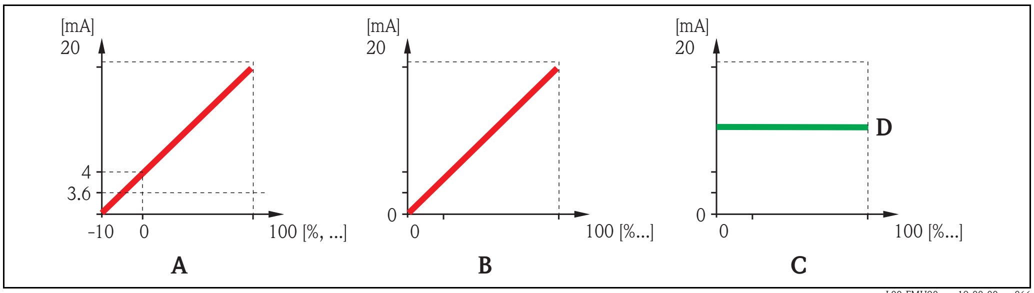


```
mode current 1    OX202
 current span:
 output damping:
 4mA threshold:
 curr. turn down:
```

"current span"

Used to select the current span to which the measuring range is mapped.

Selection:
- **4-20 mA (default)**
  The measuring range (0%-100%) is mapped to the current range 4-20 mA.
- **0-20 mA**
  The measuring range (0%-100%) is mapped to the current range 0-20 mA.
- **fixed current HART**
  A fixed current is output. The value can be defined in the "mA value" parameter. The measured value is transmitted by the HART signal.



A: current span = 4-20 mA; B: current span = 0-20 mA; C: current span = fixed current HART;
D: mA value

"mA value" (only available for "current span" = "fixed current HART")

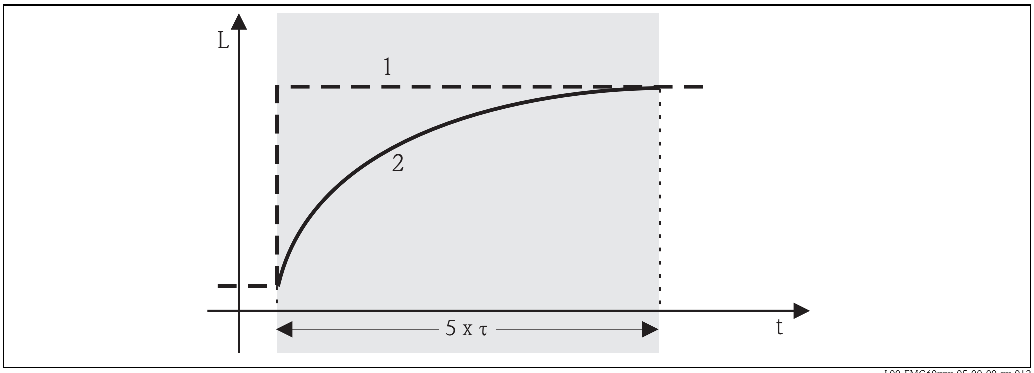
Specifies the value of the fixed current.

- range of values: 3,6 - 22 mA
- default: 4 mA

"output damping"

Specifies the output damping τ by which changes of the measured value are attenuated.
After a surge in the level it takes 5 x τ until the new measured value is reached.

- range of values: in preparation
- default: 1 s



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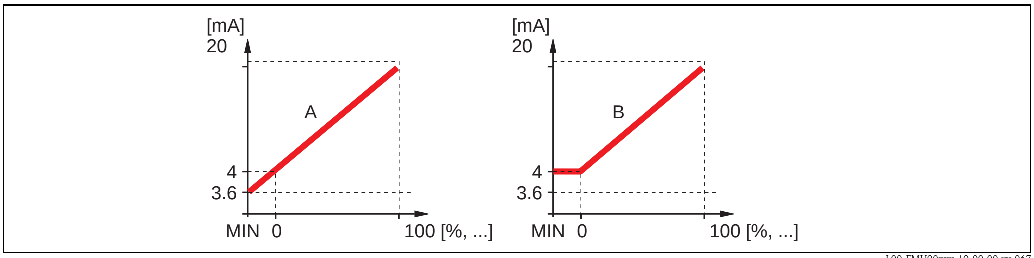
1: measured value; 2: output current

"4 mA threshold" (only available for "current span" = "4-20mA")

Used to switch on the 4mA threshold. The 4-mA threshold makes sure that the current never falls below 4 mA, even if the measured value is negative.

Selection:
- **off (default)**
  The threshold is switched off. Currents less than 4 mA may occur.
- **on**
  The threshold is switched on. The current never falls below 4 mA.



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A: 4mA threshold off; B: 4mA threshold on

"current turn down" (not present for "current span" = "fixed current HART")

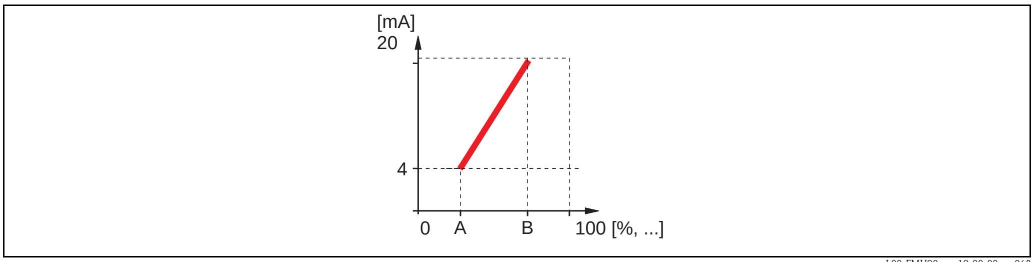
Used to map only a part of the measuring range to the current output. The selected part is enlarged by this mapping.

"turn down 0/4 mA" (only for "current turn down" = "on")

Specifies the measured value for which the current is 0 or 4 mA (depending on the selected current span).

"turn down 20 mA" (only for "current turn down" = "on")

Specifies the measured value for which the current is 20 mA.



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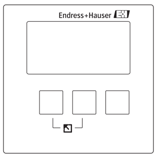
A: turn down 4mA ; B: turn down 20 mA

9.3 "HART settings" submenu (only for current output 1)

9.3.1 "HART settings"



⇒

```
HART settings      O1203
 HART address:
 no. of preambles:
 short TAG HART:
```

"HART address"

Defines the communication address for the instrument.

Range of values:
- for standard operation: **0 (default)**
- for multidrop operation: **1 – 15**

Note!
In multidrop operation, the ouptput current is 4 mA by default. However, it can be adjusted in the "mA value" parameter of the "mode current" parameter set (see above).

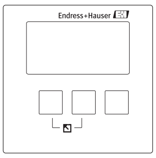
"no. of preambles"

Specifies the number of preambles for the HART protocol. For lines with communication problems a slight increase of this value is recommended.

"short TAG HART"

in preparation

9.3.2 "additional HART value 2/3/4"



⇒

```
add. HART value2  O2205
 measured value 2:
 output 2:
 output damping:
```

Use these parameter sets to configure the additional values transmitted by the HART protocol:

- measured value 2
- measured value 3
- measured value 4

The parameters are the same for all three measured values.

✎ Note!
"measured value 1" is identical to the main value, which is linked to current output 1.

"measured value 2/3/4"

Specifies which measured value is transmitted.

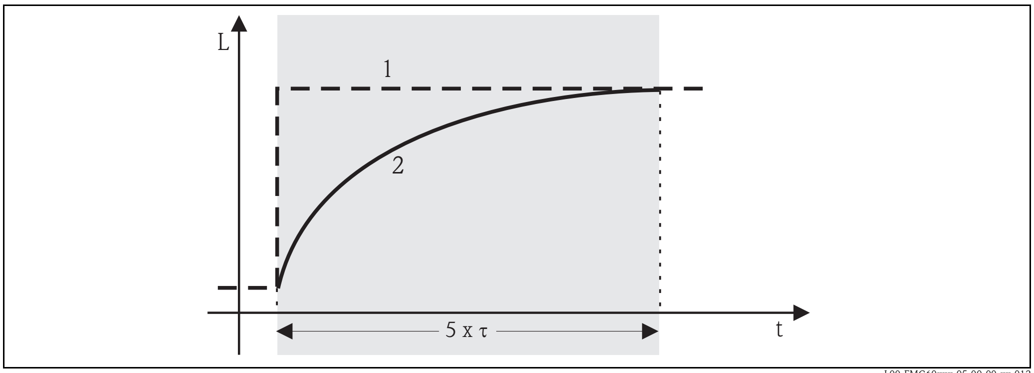
Selection:
The selection depends on the instrument version, the connected sensors and the configuration. The following options may occur:
- none (default)
- level 1/2
- flow 1/2
- average level
- level 1-2 / 2-1 / 1+2
- rake control ratio
- backwater ratio
- temperature external sensor
- temperature sensor 1/2
- counter 1/2/3
- totalizer 1/2/3
- average flow
- flow 1-2 / 2-1 / 1+2
- distance sensor 1/2

✎ Note!
If "temperature sensor 1/2" is selected, it always refers to the temperature which has been assigned to the repsective sensor in "sensor management/FDU sensor N". Possible temperatures are:
- sensor temperature
- average of sensor temperature and temperature of an external temperature sensor
- temperature of an external temperature sensor

"output damping 2/3/4"

Specifies the output damping τ by which a change of the measured value is attenuated.
After a surge of the measured value it takes 5 x τ till the HART value has adopted the new value.

- range of values: in preparation
- default: 1 s



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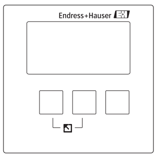
1: measured value; 2: HART output value

9.4 "Simulation" submenu

9.4.1 "simulation"



⇒

```
simulation              O1204
 simulation:
 simulation value:
```

"simulation"

Used to switch on the simulation of the current.

Selection:
- **off (default)**
  No simulation is performed. The instrument is in the measuring mode.
- **on**
  The instrument is in the simulation mode. No measured value is transmitted to the output. Instead, the current output assumes the value specified in the "simulation value" subfunction.

"simulation value" (only for "simulation" = "on")

Specifies the value of the simulated output current (in mA).

10 Troubleshooting

10.1 System error messages

10.1.1 Error signal

Errors occurring during commissioning or operation are signalled in the following way:

- Error symbol, error code and error description on the display and operating module
- Current output, configurable ("output on alarm" function).
  - MAX, 110%, 22 mA
  - MIN, -10%, 3,6 mA
  - HOLD (the last value is held)
  - user-specific value
- In the menu: "system information/error list/actual error"

10.1.2 Last error

To access a list of the last errors which have been cleared, go to "system information/error list/last error".

10.1.3 Types of errors

Type of error	Display symbol	Meaning
Alarm (A)	 continuous	The output signal assumes a value which can be defined by the "output on alarm" function: ■ MAX: 110%, 22 mA ■ MIN: -10%, 3,6 mA ■ Hold: last value is held ■ user-specific value Additionaly, an error message appears on the display.
Warning (W)	 flashing	The instrument continues to measure. An error message is displayed.

10.1.4 Error codes

The error code consists of 6 digits with the following meaning:

- Digit 1: Type of error
  – A: alarm
  – W: warning
  – E: error (the user can define if the error behaves like an alarm or a warning.)
- Digits 2 and 3:
  indicate the input channel, output channel or the relay to which the error refers. "00" means that the error does not refer to a specific channel or relay.
- Digits 4-6:
  indicate the error according to the following table.

Example:

W 01 641	▪ W: Warning ▪ 01: sensor input 1 ▪ 641: loss of echo

Code	Description of error	Remedy
A 00 100	software version does not fit to hardware version	
A 00 101	checksum error	full reset and recalibration required
A 00 102	checksum error	full reset and recalibration required
W 00 103	initializing - please wait	if the message does not disappear after a couple of seconds: replace electronics
A 00 106	downloading - please wait	wait for completion of the download
A 00 110	checksum error	full reset and recalibration required
A 00 111 A 00 112 A 00 114 A 00 115	electronics defective	switch instrument off/on; if the error persists: call Endress+Hauser service
A 00 116	download error	repeat download
A 00 117	hardware not recognised after exchange	
A 01 121 A 02 121	current output 01 or 02 not calibrated	call Endress+Hauser service
A 00 125	electronics defective	replace electronics
A 00 152	checksum error	full reset and recalibration required
W 00 153	initializing	if the message does not disappear after a couple of seconds: replace electronics
A 00 155	electronics defective	replace electronics
A 00 164	electronics defective	replace electronics
A 00 171	electronics defective	replace electronics
A 00 180	synchronization faulty	check synchronization wiring (s. chapter "Wiring")
A 00 183	hardware not supported	check if the installed board complies with the order code of the instrument; call Endress+Hauser service
A 01 231 A 02 231	sensor 01 or 02 defective - check connection	check for correct connection of the sensor (s. chapter "Wiring")
A 00 250	failure in external temperature sensor	check external temperature sensor and connection
A 01 281 A 02 281	temperature measurement 01 or 02 defective - check connection	check for correct connection of the sensor (s. chapter "Wiring")

Code	Description of error	Remedy
W 01 501 W 02 501	no sensor selected for channel 01 or 02	allocate sensor (s. "level" or "flow" menu)
A 01 502 A 02 502	Sensor 01 or 02 not recognized	Enter type of sensor manually ("level" or "flow" menu, submenu "basic calibration".
A 00 511	no factory calibration present	
A 01 512 A 02 512	mapping in process	wait for completion of mapping
W01 521 W02 521	new sensor 01 or 02 detected	
W01 601 W02 601	non-monotonic linearisation curve for level 01 or 02	re-enter linearisation (s. "level" menu")
W 01 602 W 02 602 W 01 603 W 02 603	non-monotonic linearisation for flow 01 or 02	re-enter linearisation (s. "flow" menu)
A 01 604 A 02 604	faulty calibration for level 01 or 02	adjust calibration (s. "level" menu)
A 01 605 A 02 605 A 01 606 A 02 606	faulty calibration flow 01 or 02	adjust calibration (s. "flow" menu)
W01 611 W02 611	linearisation points level 01 or 02: number < 2	enter further linearisation points (s. "level" menu)
W01 612 W02 612 W01 613 W02 613	linearisation points flow 01 or 02: number < 2	enter further linearisation points (s. "flow" menu)
W 01 620 ... W 06 620	pulse value too low for relay 01 - 06	check counting unit (see "flow" menu, "flow counter" submenu)
E 01 641 E 02 641	no usable echo sensor 01 or 02	check basic calibration for the respective sensor (s. "level" or "flow" menu)
A 01 651 A 02 651	Safety distane reached for sensor 01 or 02 - danger of overfilling	Error disappears if the level is out of the safety distance again. Possibly, the function "acknowledge alarm" must be used (s. "safety settings" menu)
E 01 661 E 02 661	temperature sensor 01 or 02 too high	
W 01 682 W 02 682	Current 01 or 02 out of measuring range	Perform basic calibration; check linearisation
W01 691 W02 691	filling noise detected sensor 01 or 02	
W00 692	backwater detected (if backwater detection is active)	
W00 693	dirt detected (if dirt detection is active)	
W 01 701	Operating hours alarm pump 1 ctrl 1	Reset operating hours
W 02 701	Operating hours alarm pump 1 ctrl 2	Reset operating hours
W 01 702	Operating hours alarm pump 2 ctrl 1	Reset operating hours
W 02 702	Operating hours alarm pump 2 ctrl 2	Reset operating hours
W 01 703	Operating hours alarm pump 3 ctrl 1	Reset operating hours
W 02 703	Operating hours alarm pump 3 ctrl 2	Reset operating hours
W 01 704	Operating hours alarm pump 4 ctrl 1	Reset operating hours
W 02 704	Operating hours alarm pump 4 ctrl 2	Reset operating hours

Code	Description of error	Remedy
W 01 705	Operating hours alarm pump 5 ctrl 1	Reset operating hours
W 02 705	Operating hours alarm pump 5 ctrl 2	Reset operating hours
W 01 706	Operating hours alarm pump 6 ctrl 1	Reset operating hours
W 02 706	Operating hours alarm pump 6 ctrl 2	Reset operating hours
W 01 711	Failure of pump 1 ctrl 1	check pump[1)]
W 02 711	Failure of pump 1 ctrl 2	check pump[1]
W 01 712	Failure of pump 2 ctrl 1	check pump[1]
W 02 712	Failure of pump 2 ctrl 2	check pump[1]
W 01 713	Failure of pump 3 ctrl 1	check pump[1]
W 02 713	Failure of pump 3 ctrl 2	check pump[1]
W 01 714	Failure of pump 4 ctrl 1	check pump[1]
W 02 714	Failure of pump 4 ctrl 2	check pump[1]
W 01 715	Failure of pump 5 ctrl 1	check pump[1]
W 02 715	Failure of pump 5 ctrl 2	check pump[1]
W 01 716	Failure of pump 6 ctrl 1	check pump[1]
W 02 716	Failure of pump 6 ctrl 2	check pump[1]
W00 801	simulation level swichted on	switch off level simulation (s. "level" menu)
W01 802 W02 802	simulation sensor 01 or 02 switched on	switch off simulation
W01 803 W02 803 W01 804 W02 804	simulation flow switched on	switch off simulation (see "flow" menu)
W01 805	simulation current 01 switched on	switch off simulation (s. "output/calculations" menu)
W02 806	simulation current 02 switched on	switch off simulation (see "output/calculations" menu)
W01 807 ... W06 807	simulation relay 01 – 06 switched on	switch off simulation
W01 808 W02 808	sensor 01 or 02 switched off	switch on sensor (see "device properties/sensor management" menu)
W01 809 W02 809	current calibration D/A active	
A 00 820 ... A 00 832	Different units for calculation of average value, sum, difference or rake control	Check the units of the respective basic calibrations (s. "level" or "flow" menu)

1) After a repair of the pump the pump control must be reset (BA00290F/00) or the FMU90 must be switched off and on.

10.2 Possible calibration errors

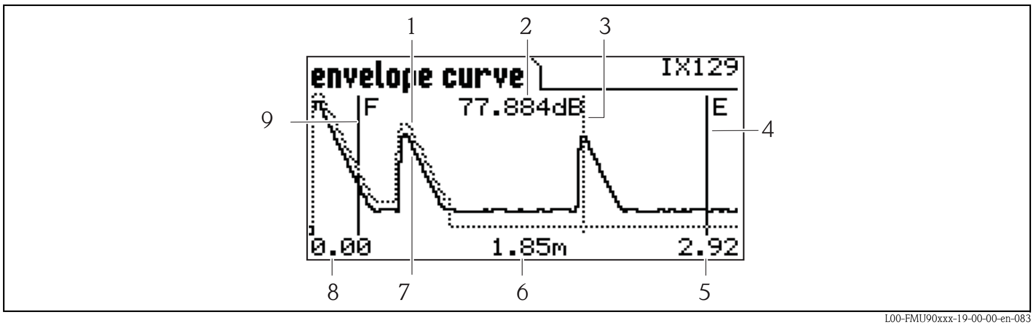
Error	Remedy
Incorrect measured value	Check "actual distance" a. **"Actual distance" is incorrect** – For measurements in bypasses or ultrasound guide pipes: Select the appropriate option in the "application parameters" parameter set. – Perform tank map ("distance mapping") b. **"Actual distance" is correct** – Check "empty calibration" and "full calibration" – Check the linearization
Measured value does not change when filling or emptying a vessel	a. Perform tank map (interference echo suppression) b. clean sensor if necessary c. choose better mounting position of the sensor (to avoid interference echos)
With an uneven surface the measured value jumps sporadically to higher levels	a. Perform tank map (interference echo suppression) b. Select "turbulent surface" or "additional agitator" in the "process conditions" parameter c. Increase "output damping" d. if possible: choose better mounting position and/or larger sensor
When filling the vessel, the measured value sporadically drops to lower levels	a. Change the "tank geometry" to "dome ceiling" or "horizontal cylinder" ("application parameters" parameter set) b. If possible: avoid central mounting position of the sensor. c. if possible: install sensor in bypass or ultrasound guide pipe.
Echo loss (Error E@@641)	a. Check all settings in the "application parameters" parameter set. b. if possible: choose better mounting position and/or larger sensor. c. Align the sensor membrane parallely to the product surface (especially for solid applications).

10.3 Envelope curve display

The measuring signal can be checked by the envelope curve display. From the envelope curve it is possible to see if there are interference echos and if they are completely suppressed by the interference echo suppression.
The envelope curve can be displayed on the display and operating module of the Prosonic S or in the FieldCare operating program.

10.3.1 Envelope curve on the display module

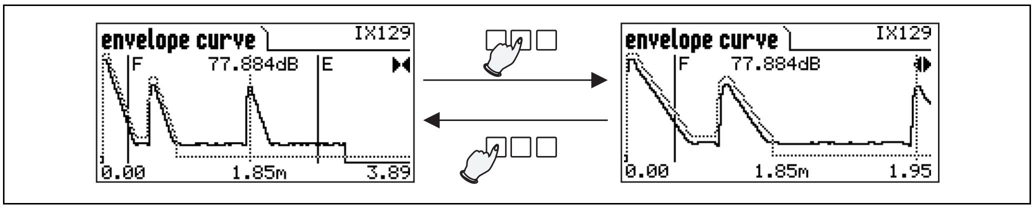
1. Go to the "system information" submenu.
2. Select the "envelope curve" submenu.
3. (only relevant for instruments with two sensor inputs): Select the sensor whose envelope curve you want to check.
4. Select the curves to be displayed:
   – **Envelope curve**: Only the envelope curve is displayed.
   – **Env. curve + FAC**: The envelope curve and the Floating Average Curve (FAC) are displayed.
   – **Env. curve + cust. map**: The envelope curve and the customer mapping curve (for interference echo suppression) are displayed.
5. Select the plot setting:
   – **single curve**
   – **cyclic**
6. Now, the envelope curve display appears:



1 Customer mapping curve (dotted line[11])
2 Echo quality of the evaluated echo[12]
3 Marking of the evaluated echo
4 Marking of the empty calibration E
5 Upper limit of the display range
6 Distance of the evaluated echo (measured from the reference point of the sensor)
7 Envelope curve (solid line)
8 Lower limit of the display range
9 Marking of the full calibration F

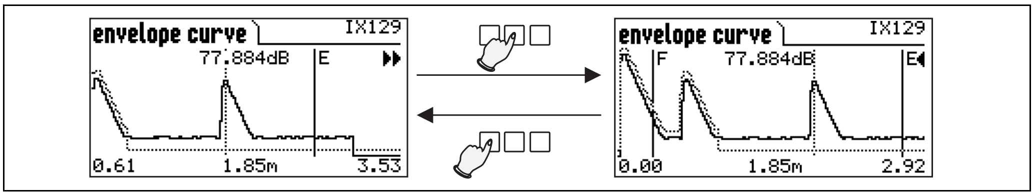
7. **Scaling of the envelope curve display**
   To display a part of the envelope curve in more detail, the curve can be scaled horizontically. To do so, press the left or middle key. The ◀▶ or ▶◀ symbol appears in the upper right corner of the display. You have got the following options:
   – Press the **middle key** to **zoom in** the envelope curve.
   – Press the **left key** to **zoom out** the envelope curve.

11) The Floating Average Curve (FAC) is represented by a dotted line as well.
12) The echo quality is the distance (in dB) between the peak of the echo and the Floating Average Curve (FAC).



L00-FMU90xxx-19-00-00-en-084

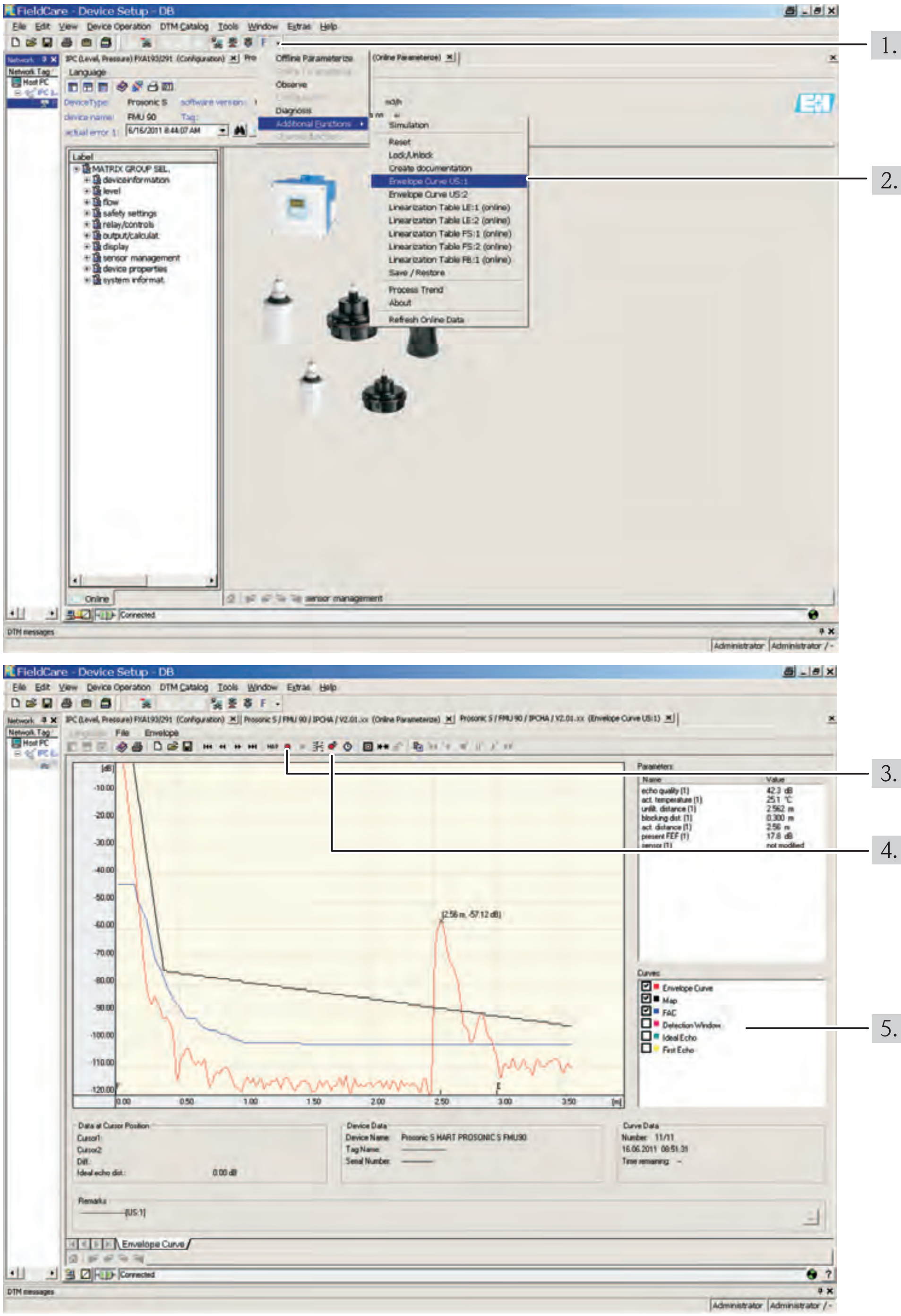
8. **Moving the envelope curve display**
   To move the envelope curve display, press the right key a second time. The ◀◀ or ▶▶ symbol appears in the upper right corner of the display. You have got the following options:
   – Press the **middle key** to move the envelope curve **to the right**.
   – Press the **left key** to move the envelope curve **to the left**.



L00-FMU90xxx-19-00-00-en-085

9. **Quitting the envelope curve display**
   Press to quit the envelope curve display.

10.3.2 Envelope curve display in the FieldCare



L00-FMU90xxx-19-00-00-xx-208

1. Klick on **"F"** → **"Additional Function"** → **"Envelope Curve"**.
2. Select the **sensor** whose envelope curve you want to check.
3. Click on **"read curve"** to display a **single curve**.
4. Click on **"cyclic read"** to display the curves **cyclically**.
5. Select the curves you want to check in the **"Curves" window**:
   - Envelope Curve
   - Map (= mapping of the interference echo suppression)
   - FAC (= Floating Average Curve)

10.4 Software history

Date	Software version	Changes to software	Documentation
12.2005	V 01.00.00	original software	▪ for level measurements: BA288F/00/en/12.05 52024316 ▪ for flow measurements: BA289F/00/en/12.05 52024318
06.2006	V 01.00.02	Relay functions for limit detection revised. No updates of "ToF Tool – Fieldtool Package" or "Fieldcare" required	
04.2007	V 02.00.00	Introductionof new options: binary inputs, e.g. for acquisition of limits or pump/motor switch positions	▪ for level measurements: BA288F/00/en/10.07 52024316 ▪ for flow measurements: BA289F/00/en/10.07 52024318
07.2009	V 02.01.00	Integration of the FDU90 sensor	▪ for level measurements: BA288F/00/en/07.09 71098292 ▪ BA00288F/00/EN/13.12 71164411 ▪ for flow measurements: BA289F/00/en/07.09 71098296 ▪ BA00289F/00/EN/13.12 71164415
02.2010	V02.01.01	Integration Temperaturplausibilisierung	
05.2011	V02.01.03	Improvement temperature plausibility; flow counter limitation; bugfix	

11 Maintenance

11.1 Exterior cleaning

When cleaning the exterior, always use cleaning agents that do not attack the surface of the housing and the seals.

11.2 Repairs

The Endress+Hauser repair concept assumes that the measuring devices have a modular design and that customers are able to undertake repairs themselves → 🗎 111, "Spare Parts". For more information on service and spare parts, If you have any questions, please contact your Endress+Hauser sales representative.

11.3 Repairs to Ex-approved devices

When carrying out repairs to Ex-approved devices, please note the following:
- Repairs to Ex-approved devices may only be carried out by trained personnel or by the Endress+Hauser Service.
- Comply with the prevailing standards, national Ex-area regulations, safety instructions (XA) and certificates.
- Only use original spare parts from Endress+Hauser.
- When ordering a spare part, please note the device designation on the nameplate. Only replace parts with identical parts.
- Carry out repairs according to the instructions. On completion of repairs, carry our the specified routine test on the device.
- Only Endress+Hauser Service may convert a certified device into a different certified variant.
- Document all repair work and conversions.

11.4 Replacement

After a complete instrument or electronic module has been replaced, the parameters can be downloaded into the instrument again via the communication interface. Prerequisite to this is that the data were uploaded to the PC beforehand using FieldCare. Measurement can continue without having to carry out a new setup. Only a linearisation and a tank map (interference echo suppression) have to be recorded again.

11.5 Replacing a sensor

Sensors can be replaced if required.
After replacing a sensor, the following parameters of the "basic setup" submenu must be checked:

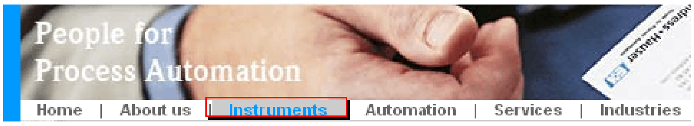
- for sensors FDU8x: sensor type
  (sensors of the type FDU9x are automatically detected by the Prosonic S)
- the empty calibration
- for level measurements: the full calibration
- the interference echo suppression

After that, the measurement can be continued without further restrictions.

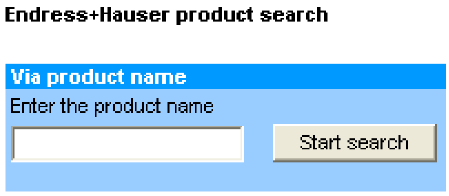
11.6 Spare Parts

An overview of the spare parts for your device is available in the internet at www.endress.com. To obtain information on the spare parts, proceed as follows:

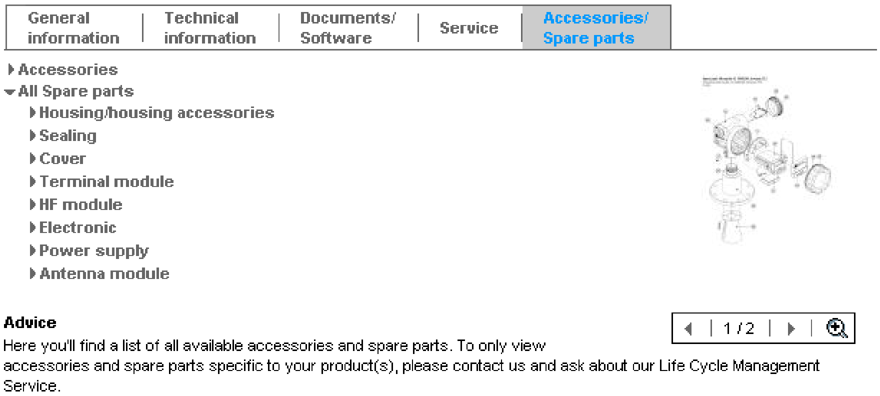
1. Go to "www.endress.com" and select your country.
2. Click "Instruments".



3. Enter the product name into the "product name" field.



4. Select the device.
5. Click the "Accessories/Spare parts" tab.



6. Select the required spare parts (You may also use the overview drawing on the right side of the screen.)

When ordering spare parts, always quote the serial number indicated on the nameplate. As far as necessary, the spare parts also include replacement instructions.

11.7 Return

Returning devices
The measuring device must be returned if repairs or a factory calibration are required, or if the wrong measuring device has been ordered or delivered. According to legal regulations, Endress+Hauser, as an ISO-certified company, is required to follow certain procedures when handling returned products that are in contact with medium.
To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material

11.8 Disposal

In case of disposal please seperate the different components according to their material consistence.

11.9 Contact addresses of Endress+Hauser

Contact addresses can be found on our homepage: www.endress.com/worldwide. If you have any questions, please contact your Endress+Hauser sales representative.

12 Accessories

12.1 Commubox FXA195 HART

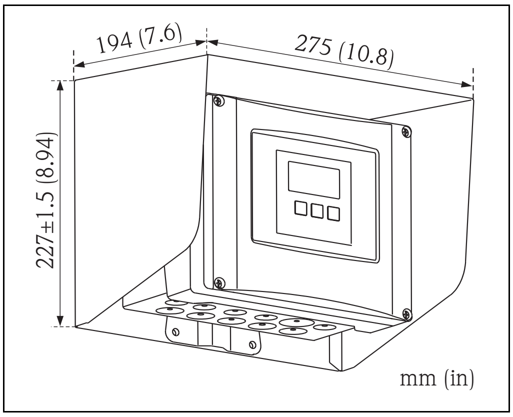
For intrinsically safe communication with FieldCare via the USB interface. For details refer to TI00404F/00/EN.

12.2 Commubox FXA291

For intrinsically safe communication with FieldCare via the service interface (IPC) of the instrument and the USB interface of a PC/Notebook.
Ordering Code: 51516983

12.3 Protection cover for the field housing

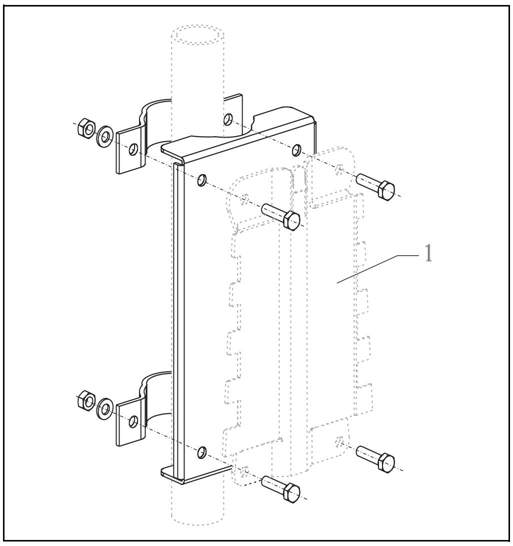
- Material: 316Ti (1.4571)
- is mounted by the mounting help of the Prosonic S
- Order-Code: 52024477



L00-FMU90xxx-06-00-00-xx-003

12.4 Mounting plate for the field housing

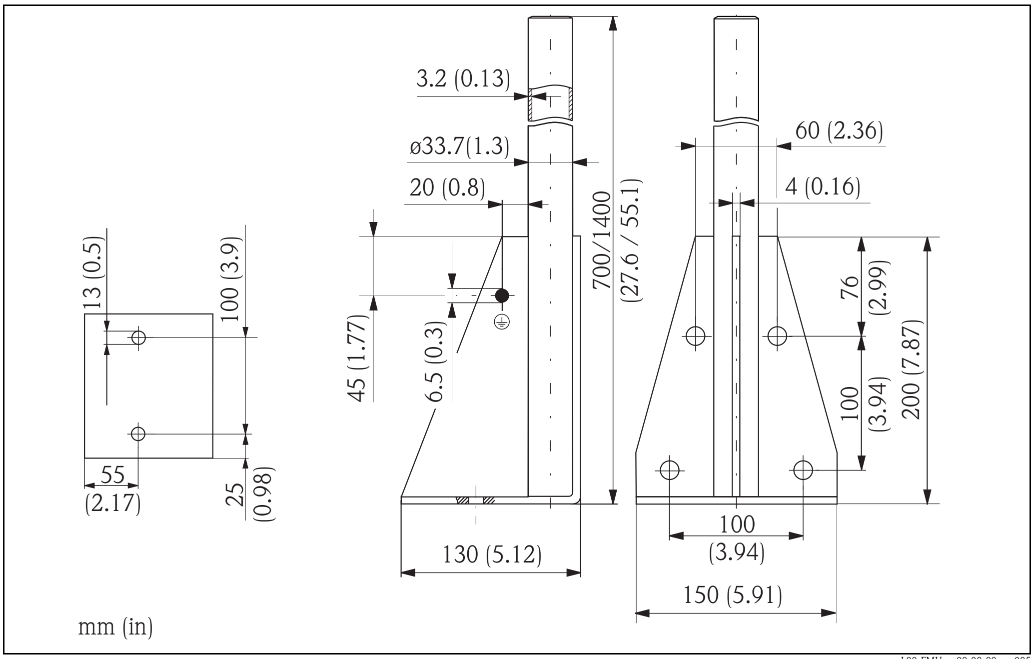
- suited for the mounting help of the Prosonic S
- for 1" - 2" tubes
- Dimensions: 210 x 110 mm (8.27 x 4.33 in)
- Material: 316Ti (1.4571)
- fixing clips, screws and nuts are supplied
- Order code: 52024478



L00-FMU90xxx-00-00-00-xx-001

1 Mounting help of the field housing

12.5 Mounting bracket



L00-FMUxx-00-00-00-xx-005

Height	Material	Order Code
700 (27.6)	galv. steel	919791-0000
700 (27.6)	316Ti (1.4571)	919791-0001
1400 (55.16)	galv. steel	919791-0002
1400 (55.16)	316Ti (1.4571)	919791-0003

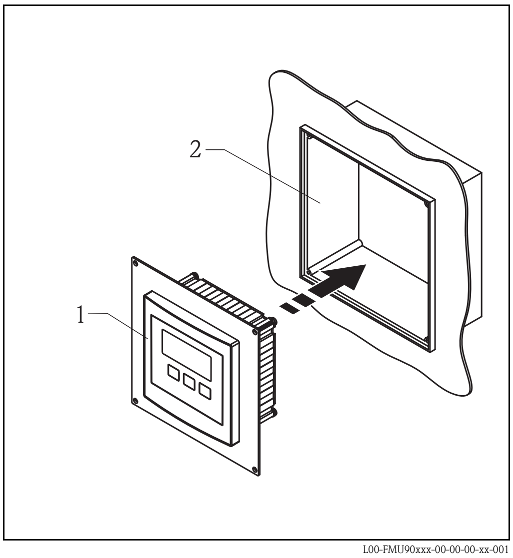
mm (in)

12.6 Adaption plate for remote display

Used to mount the remote display into the opening (138 x 138 mm (5.43 x 5.43 in)) of the remote display module of the Prosonic FMU860/861/862 (Display size: 144 x 144 mm (5.67 x 5.67 in)).

Order-Code: 52027441

✎ Note!
The adapter plate will be mounted directly in the old remote display of the FMU86x series. The housing of the remote display of FMU860/861/862 is the holder for the adapter plate and the new remote display of the FMU90/95 in the format 96 x 96 mm (3.78 x 3.78 in).



1 Remote display of the Prosonic S with adaption plate
2 Opening of the remote display FMU860/861/862

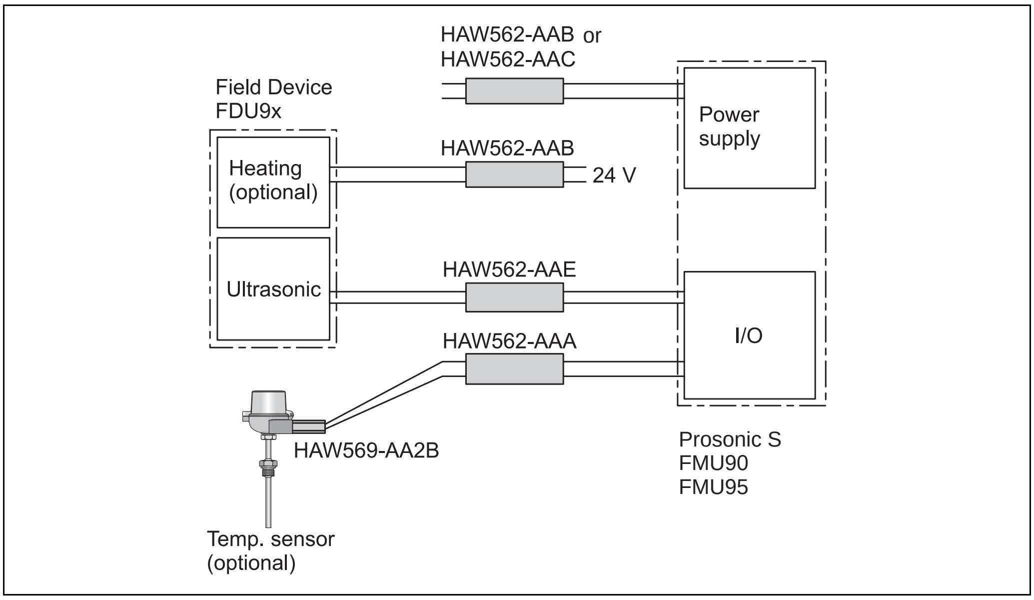
Option:
Adaption plate 160 x 160 mm (6.3 x 6.3 in), thickness 3mm (0.12 in), aluminum, opening 92 x 92 mm (3.62 x 3.62 in) for remote display of the FMU90 (size of the display: 96 x 96 mm (3.78 x 3.78 in)).
Can be used to replace the FMU86x remote display or DMU2160/2260.
Order Code: TSPFU 0390
Please contact your Endress+Hauser sales representative.

12.7 Overvoltage protection (in IP66 housing)

- Overvoltage protection for the mains voltage and up to 3 signal outputs
- Dimensions of housing: 292 x 253 x 106 mm (11.5 x 9.96 x 4.17 in)
- Order Code: 215095-0001

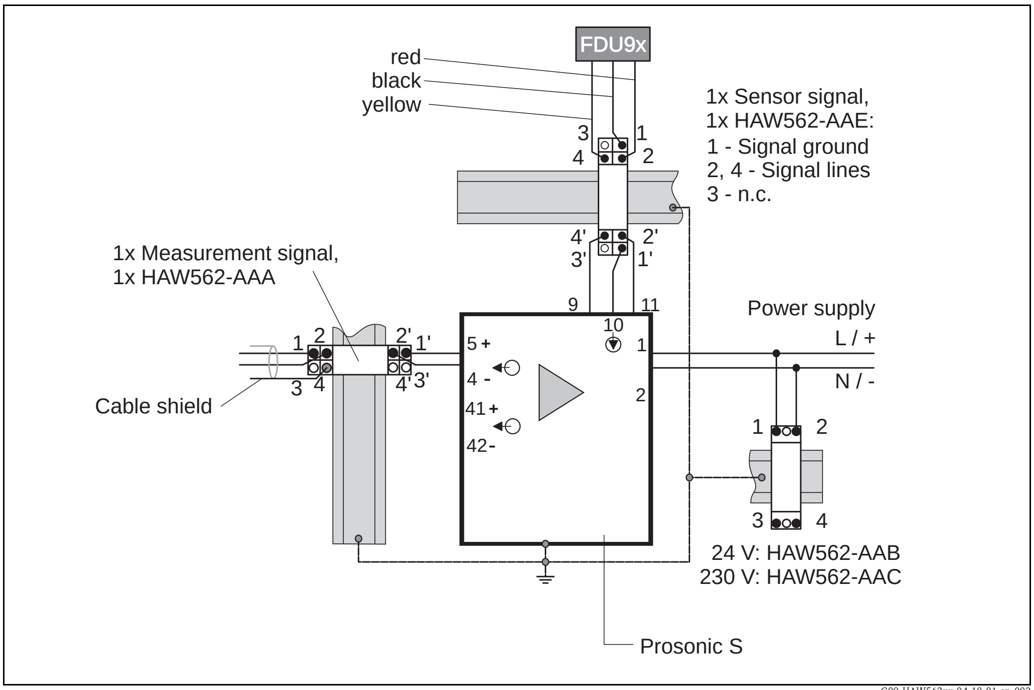
12.8 Overvoltage protection HAW562

12.8.1 System principle



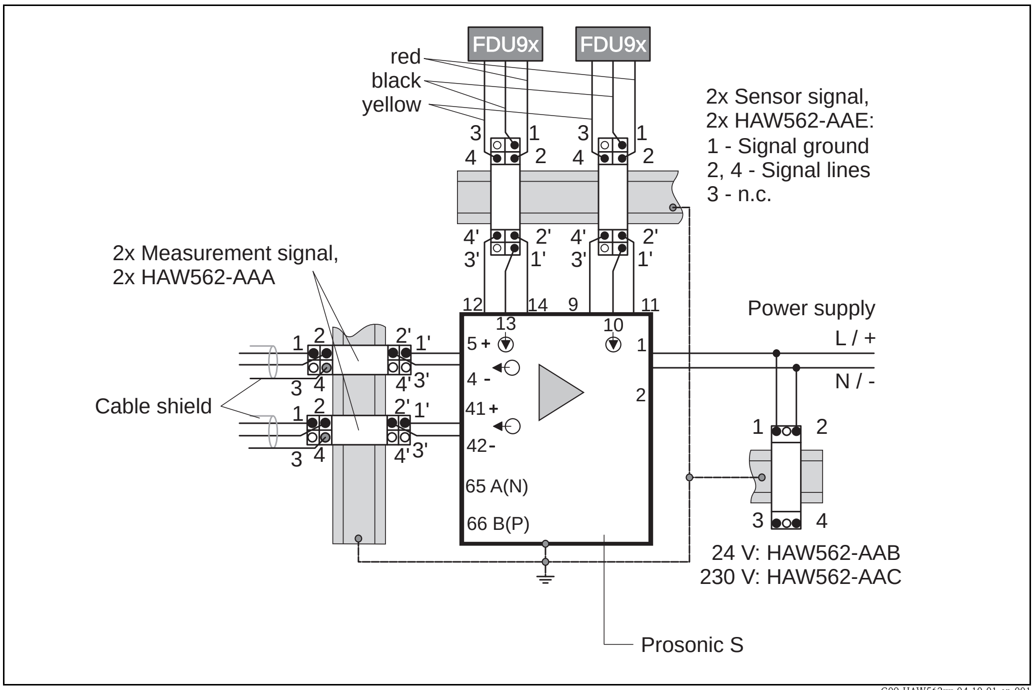
L00-FMU9x-15-00-00-en-001

12.8.2 Application examples



G09-HAW562xx-04-10-01-en-002

Level measurement with 1 Prosonic FDU9x level sensor, version 4 to 20 mA HART



G09-HAW562xx-04-10-01-en-001

Level measurement with 2 Prosonic FDU9x level sensors, version 4 to 20 mA HART

12.8.3 Ordering information

Surge Arrester HAW562, compact device for DINrail installation in signal and power supply lines andcommunication lines protecting field devices and systems against overvoltage and magnetic induction.

	Approval	
	AA	Non-hazardous area
	8D	ATEX II 2 (1)G Ex ia IIC T6

		Application	
		A	Measuring signal 0/4-20 mA, PFM, PA, FF
		B	Supply voltage 10-55 V (+/-20%)
		C	Supply voltage 90-230 V (+/-10%)
		D	Communication RS485/MOD-Bus/PROFIBUS DP
		E	Protection module Prosonic FMU90

			+	**Additional selection (option)**

				Additional approvals	
				LA	SIL

					Accessory enclosed	
					PA	Screen grounding terminal
					PB	Field housing
					PC	Mounting bracket, wall/pipe

						Marking	
						Z1	Tagging (TAG), metal
						Z3	Commissioning label, paper
						Z6	Tagging (TAG), by customer

HAW562 -			+				complete product designation

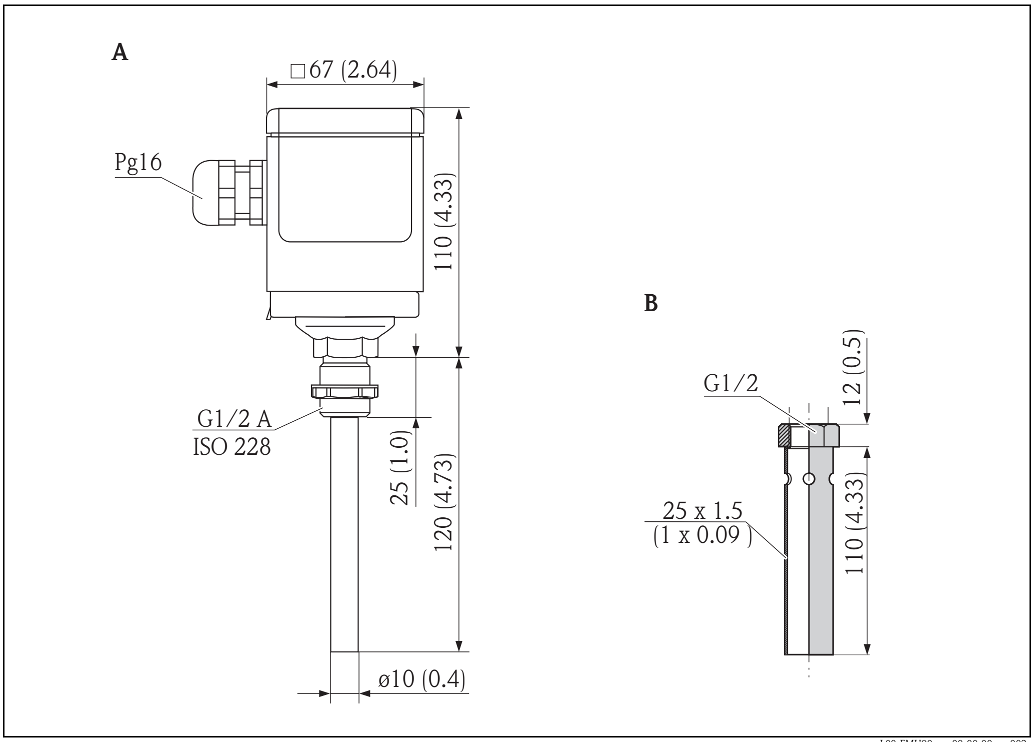
For details see Technical Informations TI01012K und TI01013K and the Operating Instruction BA00306K.

12.9 Extension cable for sensors

for Sensor	Material	Cable type	Order code
▪ FDU90 ▪ FDU91 ▪ FDU92	PVC	LiYCY 2x(0.75)	71027742
▪ FDU91F ▪ FDU93 ▪ FDU95	PVC (-40 to +105 °C) (-40 to +221 °F)	LiYY 2x(0.75)D+1x0.75	71027743
▪ FDU95 ▪ FDU96	Silicone (-40 to +150 °C) (-40 to +302 °F)	Li2G2G 2x(0.75)D+1x0.75	71027745
▪ FDU90/FDU91 with heater	PVC	LiYY 2x(0.75)D+2x0.75	71027746

Total length (sensor cable + extension cable): up to 300 m (984 ft)

12.10 Temperature sensor FMT131



L00-FMU90xxx-00-00-00-xx-002a

A Temperature sensor FMT131
B Weather protector

Product structure

010	**Approval**			
	R	Non-hazardous area		
	J	ATEX II 2G EEx m II T6/T5		
	Q	FM Cl.I Div. 1 Gr. A-D, zone 1, 2		
	U	CSA General Purpose (in preperation)		
	S	CSA Class I Div. 1		
020		**Cable length**		
		1	5 m/16 ft	
		2	10 m/ 32 ft	
		3	15 m/49 ft	
		4	20 m/65 ft	
		5	25 m/82 ft	
		6	30 m/98 ft	
		7	w/o cable, gland Pg16, IP66	
		8	... m	
		A	... ft	
995			**Marking**	
			1	Tagging (TAG)
FMT131 -				complete product designation

Weather protection cover for FMT131
Order code: 942046-0000

13 Technical Data

13.1 Technical data at a glance

13.1.1 Input

Sensor inputs

Depending on the instrument version, 1 or 2 of the sensors FDU90, FDU91, FDU91F, FDU92, FDU93, FDU95 and FDU96 can be connected. The Prosonic S identifies these sensors automatically.

Sensor	FDU90	FDU91 FDU91F	FDU92	FDU93	FDU95	FDU96
max. range[1)] in liquids	3 (9.8)	10 (33)	20 (66)	25 (82)	–	–
max. range[1] in solids	1.2 (3.9)	5 (16)	10 (33)	15 (49)	45 (148)	70 (230)

m (ft)

1) This table gives the maximum range. The range depends on the measuring conditions. For an estimation see Technical Information TI00396F/00, chapter "Input".

In order to support existing installations, the sensors of the series FDU8x can be connected as well. The type of sensor must be entered manually.

Sensor	FDU80 FDU80F	FDU81 FDU81F	FDU82	FDU83	FDU84	FDU85	FDU86
max. range[1)] in liquids	5 (16)	10 (33)	20 (66)	25 (82)	–	–	–
max. range[1] in solids	2 (6.6)	5 (16)	10 (33)	15 (49)	25 (82)	45 (148)	70 (230)

m (ft)

1) This table gives the maximum range. The range depends on the measuring conditions. For an estimation see Technical Information TI00189F/00, chapter "Planning Recommendations".

Warning!
The sensors FDU83, FDU84, FDU85 and FDU86 with an ATEX, FM or CSA certificate are not certified for connection to the transmitter FMU90.

External limit switches (option)

Optionally, the Prosonic S FMU90 has four inputs for external limit switches (FMU90-********B***).

Switching options
- external passive limit switch (NC/NO switch)
- 0: < 8 V; 1: > 16 V

Usage (examples)
- pump feedback (for FMU90-*3******B***) and FMU90-*4******B***)
- pump tariff control (for FMU90-*3******B***) and FMU90-*4******B***)
- start/stop/reset of daily counters (for flow measurements) (for FMU90-*2******B*** and FMU90-*4******B***)
- min/max level detection, e.g. by Liquiphant

External temperature sensor

Optionally, the Prosonic S FMU90 has an input for an external temperature sensor (FMU90-********B***).

Connectable sensors
- Pt100 (3-wire or 4-wire connection)
  A Pt100 with 2-wire connection may not be used due to its insufficient accuracy.
- FMT131(from Endress+Hauser, → 113, "Accessories")

Usage (example)
- Time-of-flight correction for a heated sensor (FDU90-***B*, FDU91-***B*).

13.1.2 Output

Analogue outputs

Number	1 or 2, depending on instrument version
Output signal	configurable at the instrument: ■ 4 ... 20 mA with HART[1)] ■ 0 ... 20 mA without HART
Signal on alarm	■ for setting 4 ... 20 mA, selectable: – -10% (3,6 mA) – 110% (22 mA) – HOLD (last current value is held) – user specific ■ for setting 0 ... 20 mA: – 110% (21,6 mA) – HOLD (last current value is held) – user specific
Output damping	freely selectable, 0 ... 1000 s
Load	max. 600 Ω, influence negligible
max. ripple	U_{SS} = 200 mV at 47 ... 125 Hz (measured at 500Ω)
max. noise	U_{eff} = 2,2 mV at 500 Hz... 10 kHz (measured at 500Ω)

1) The HART signal is assigned to the first analogue output. The second analogue output does not carry a HART signal.

Relay outputs

Number	1, 3 or 6; depending on the instrument version
Type	potential-free relay, SPDT, can be inverted
Assignable functions	■ limit (inband, out-of-band, trend, level limit) ■ counting pulse[1] for flow counting (max. frequency 2 Hz; pulse width adjustable) ■ time pulse[1] (max. frequency 2 Hz; pulse width adjustable) ■ alarm/diagnosis (e.g. indication of backwater[1)], sludge[1], echo loss etc.) ■ pump control (alternating/fixed limit/pump rate) ■ for FMU90-*3********** and FMU90-*4**********): additional pump control (standby pump, storm function to avoid unnecessary run times of the pumps, pump function test, flush control to clean pump shafts, operating hours alarm, pump alarm) ■ rake control (difference or relative measurement) ■ fieldbus relay (to be switched direclty from the Profibus DP-bus)
Switching power	■ DC voltage: 35 V_{DC}, 100 W ■ AC voltage: 4 A, 250 V, 100 VA at cosφ = 0,7
State on error	selectable: ■ HOLD (last value is held) ■ energized ■ de-energized ■ present value is used
Behaviour after power failure	switch-on delay selectable

LEDs[2]	A yellow LED on the front panel is allocated to each relay, which lights if the relay is energized. The LED of an alarm relay lights during normal operation. The LED for a pulse relay briefly flashes at every pulse.

1) for instrument versions with flow software (FMU90 - *2**********)

2) for instrument versions with display and operating module

13.1.3 Power supply

Supply voltage/
Power consumption/
Current consumption

Instrument version	Supply voltage	Power consumption	Current consumption
AC voltage (FMU90 - ****A****)	90 ... 253 V_{AC} (50/60 Hz)	max. 23 VA	max. 100 mA at 230 V_{AC}
DC voltage (FMU90 - ****B****)	10,5 ... 32 V_{DC}	max. 14 W (typically 8 W)	max. 580 mA at 24 V_{DC}

Galvanic isolation

The following terminals are galvanically isolated from each other:
- auxiliary energy
- sensor inputs
- analogue output 1
- analogue output 2
- relay outputs
- bus connection (PROFIBUS DP)

Fuse

- 2 A T /DC
- 400 mA T /AC

accesible in the terminal compartment

13.1.4 Performance characteristics

Reference operating conditions

- Temperature = 24±5 °C (75±9 °F)
- Pressure = 960±100 mbar (14±1.45 psi)
- Relative humidity = 60±15 %
- Ideally reflecting surface, sensor vertically aligned (e.g. calm, plane liquid surface of 1 m^2 (10.76 ft^2))
- No interference echoes within the signal beam
- Settings of the application parameters:
  – tank shape = flat ceiling
  – medium property = liquid
  – process condition = calm surface

Measuring uncertainty[13]

±0,2 % of the maximum span of the sensor

Typical accuracy[14]

±2 mm (0.08 in) + 0.17 % of the measured distance

Measured value resolution

1 mm (0.04 in) with FDU90/FDU91

13) according to NAMUR EN 61298-2
14) after calibration

Measuring frequency	max. 3 Hz The exact value depends on the settings of the application parameters and the instrument version. Note! The maximum measuring frequency is obtained for "empty E" ≤ 2 m (≤ 6.6 ft) and "process condition" = "test: no filter".
Influence of the vapor pressure	The vapor pressure at 20 °C (68 °F) gives a hint on the accuracy of the ultrasonic level measurement. If the vapor pressure at 20 °C (68 °F) is below 50 mbar (1 psi), ultrasonic level measurement is possible with a very high accuracy. This is valid for water, aqueous solutions, water-solid-solutions, dilute acids (hydrochloric acid, sulfuric acid, ...), dilute bases (caustic soda, ...), oils, greases, slurries, pastes, ... High vapor pressures or outgassing media (ethanol, acetone, ammonia, ...) can influence the accuracy. If conditions like these are present, please contact your Endress+Hauser sales representative.

13.1.5 Environment

Ambient temperature	-40 to 60 °C (-40 to 140 °F) The functionality of the LC display becomes restricted at T_U < -20 °C (T_U < -4 °F). If the device is operated outdoors in strong sunlight, a protective cover should be used (→ 113, "Accessories").
Storage temperature	-40 to 60 °C (-40 to 140 °F)
Climate class	▪ **Field housing:** according to DIN EN 60721-3 4K2/4K5/4K6/4Z2/4Z5/4C3/4S4/4M2 (DIN 60721-3 4K2 corresponds to DIN 60654-1 D1) ▪ **Housing for DIN rail mounting:** according to DIN EN 60721-3 3K3/3Z2/3Z5/3B1/3C2/3S3/3M1 (DIN 60721-3 3K3 corresponds to DIN 60654-1 B2)
Vibration resistance	▪ Housing for DIN rail: DIN EN 60068-2-64 / IEC 68-2-64; 20 ... 2000 Hz; 0,5 $(m/s^2)^2/Hz$ ▪ Field housing: DIN EN 60068-2-64 / IEC 68-2-64; 20 ... 2000 Hz; 1,0 $(m/s^2)^2/Hz$
Ingress protection	▪ Field housing: IP66 / NEMA 4x ▪ Housing for DIN rail: IP20 ▪ separate display: – IP65 / NEMA 4 (front panel , if mounted in cabinet door) – IP20 (rear panel, if mounted in cabinet door)
Electromagnetic compatibility (EMC)	▪ Electromagnetic compatibility according to all relevant requirements of the EN 61326- series and NAMUR recommendation EMC (NE21). For details see declaration of conformity. ▪ With respect to interference emission the devices meet the requirements of class A and are only provided for use in an "industrial environment"!

13.1.6 Mechanical construction

Dimensions

→ 🗎 11 "Installation"

Weight

Housing version	Weight
Field housing	approx. 1.6 to 1.8 kg (3.53 to 3.97 lbs); depending on instrument version
Housing for DIN rail	approx. 0.5 to 0.7 kg (1.10 to 1.54 lbs); depending on instrument version (→ 🗎 13 "Dimensions of the DIN-rail housing")
separate display and operating module	approx. 0.5 kg (1.10 lbs)

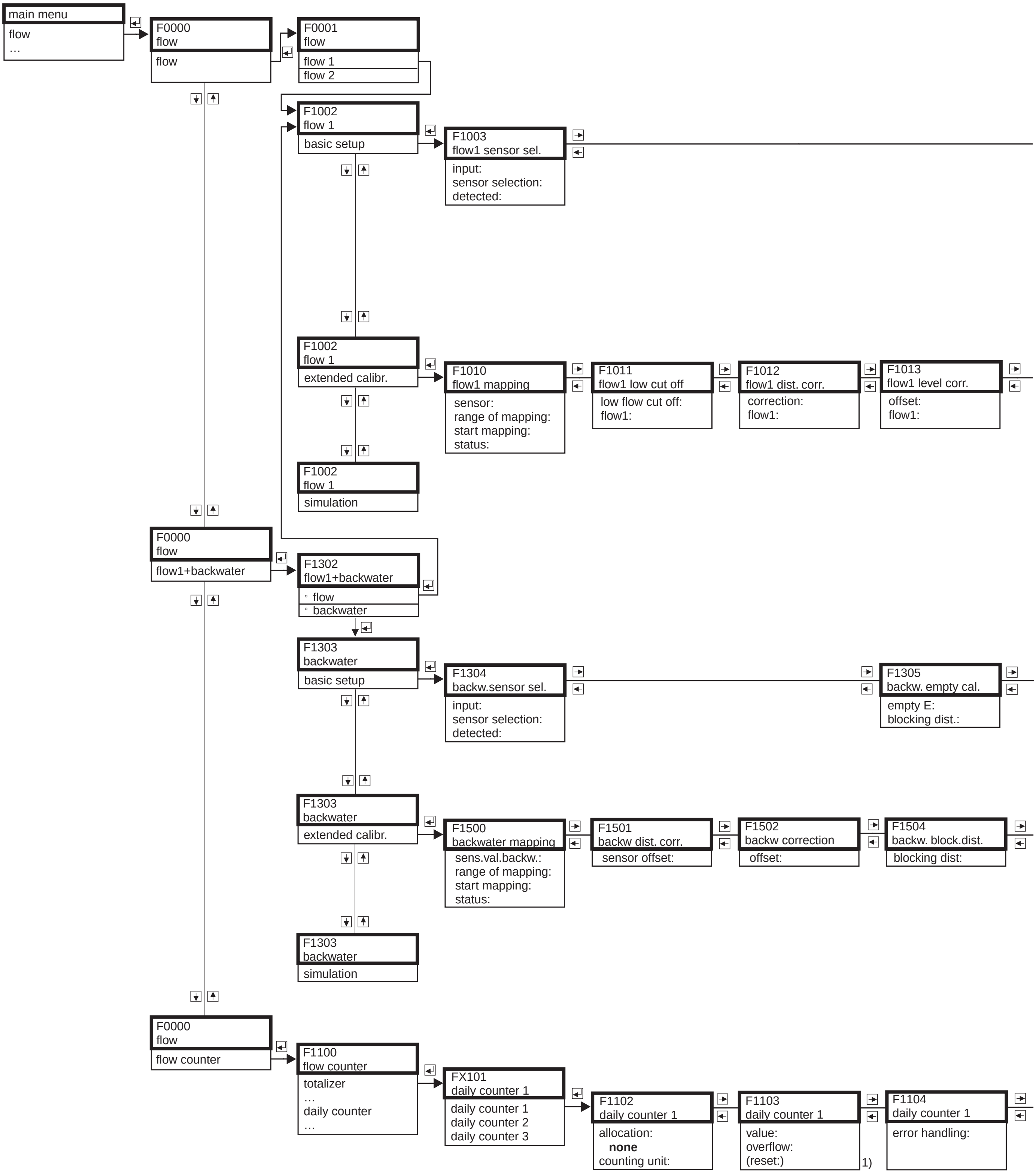
Materials

Part	Material
Housing bracket	PC-FR
Field housing	PC-FR
Housing for DIN rail	PBT-GF

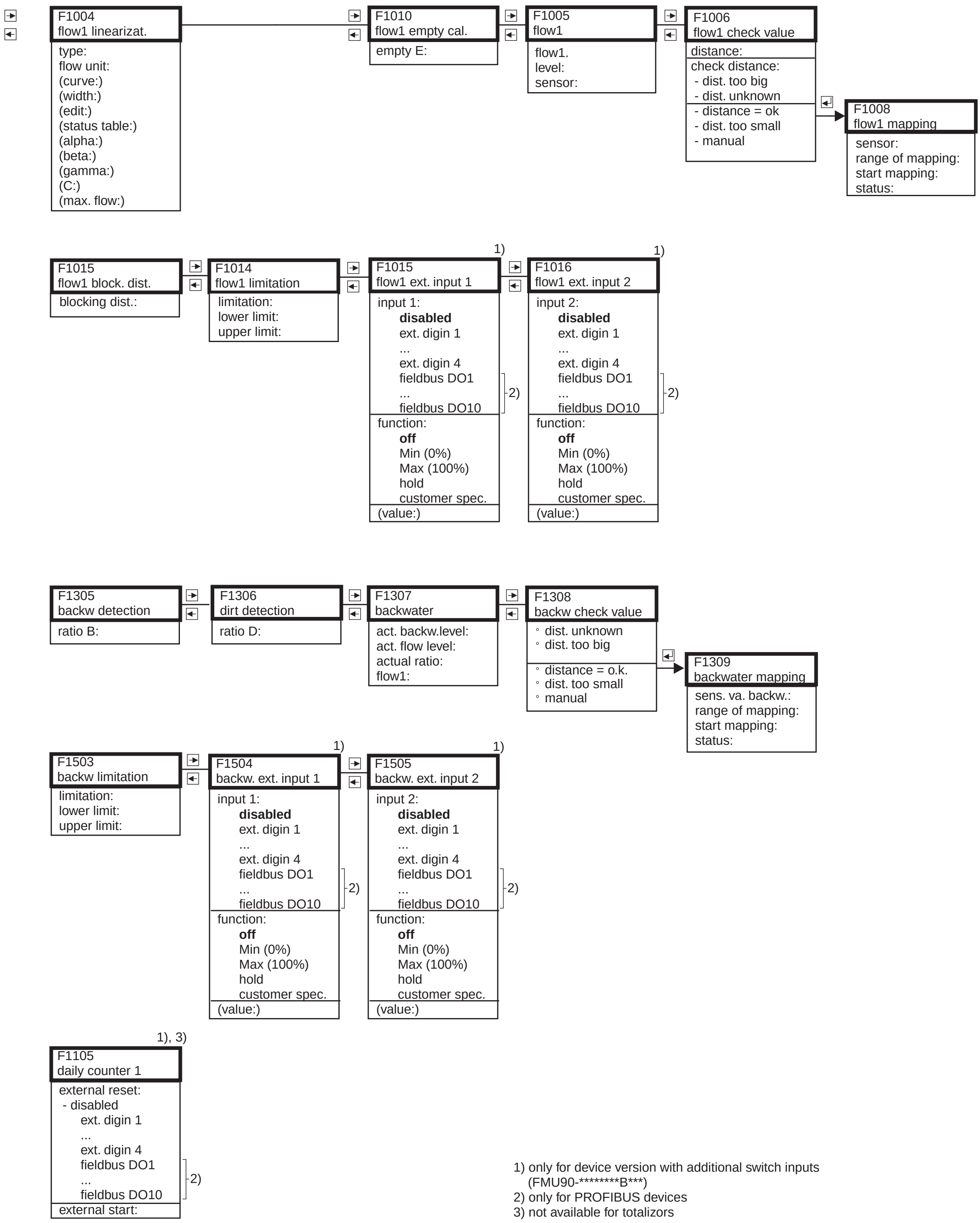
For details see Technical Information TI00397F/00.

14 Operating menu

14.1 "flow"



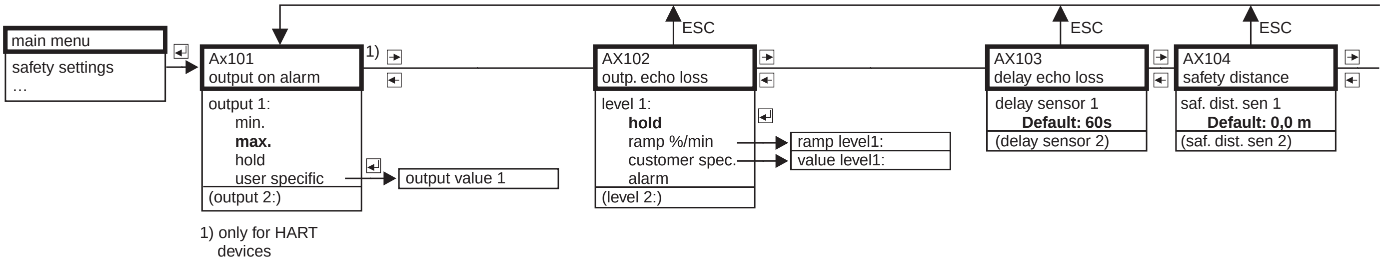
L00-FMU90xxx-19-02-01-de-106



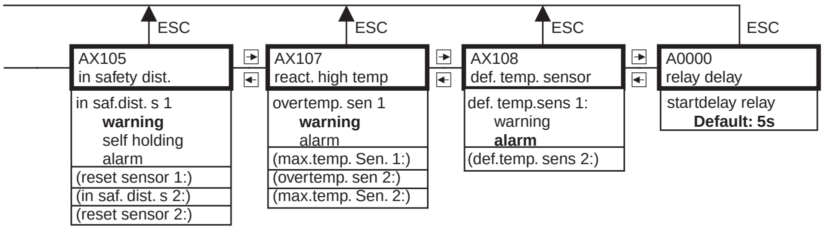
1) only for device version with additional switch inputs (FMU90-********B***)
2) only for PROFIBUS devices
3) not available for totalizors

L00-FMU90xxx-19-02-02-en-106

14.2 "safety settings"

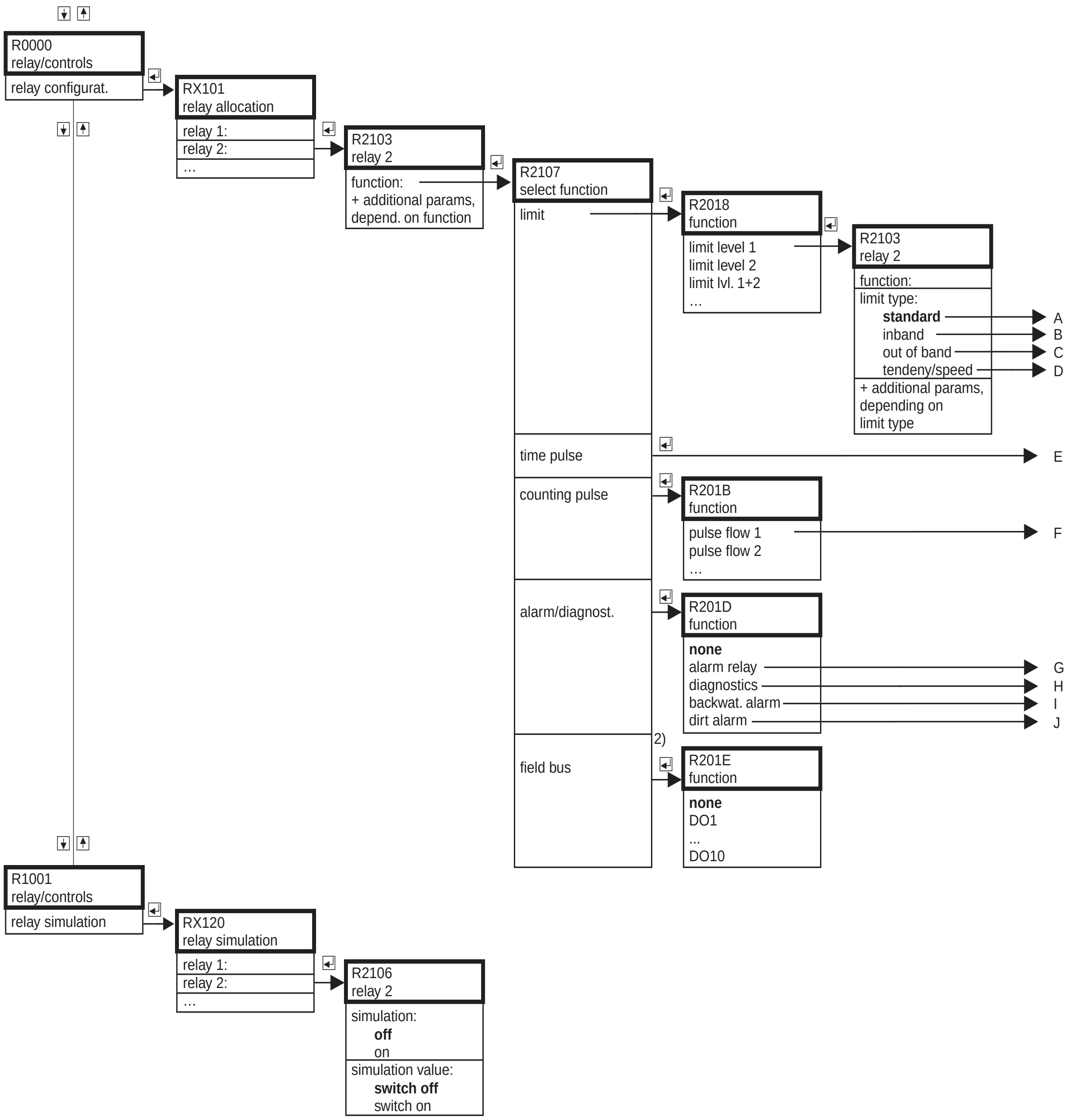


L00-FMU90xxx-19-03-01-en-106

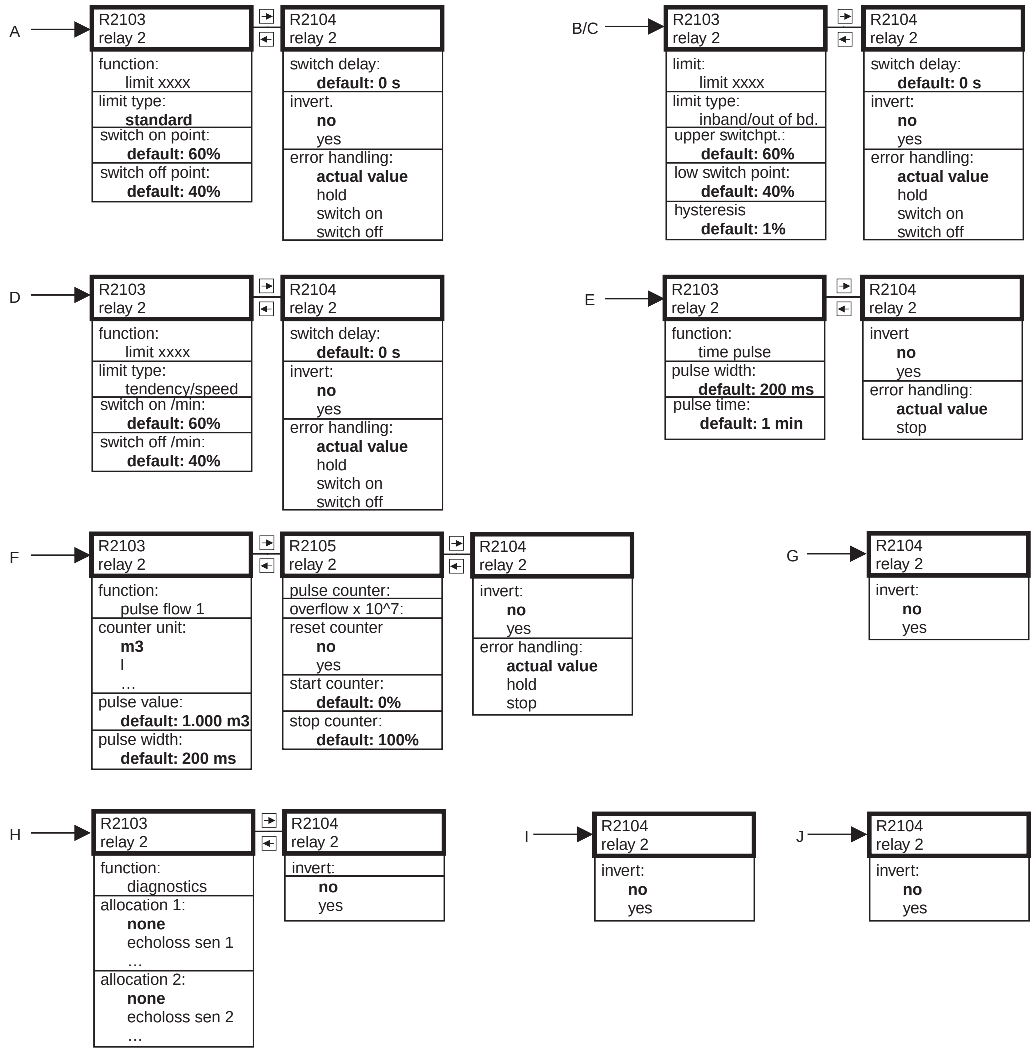


L00-FMU90xxx-19-03-02-en-106

14.3 "relay/controls"

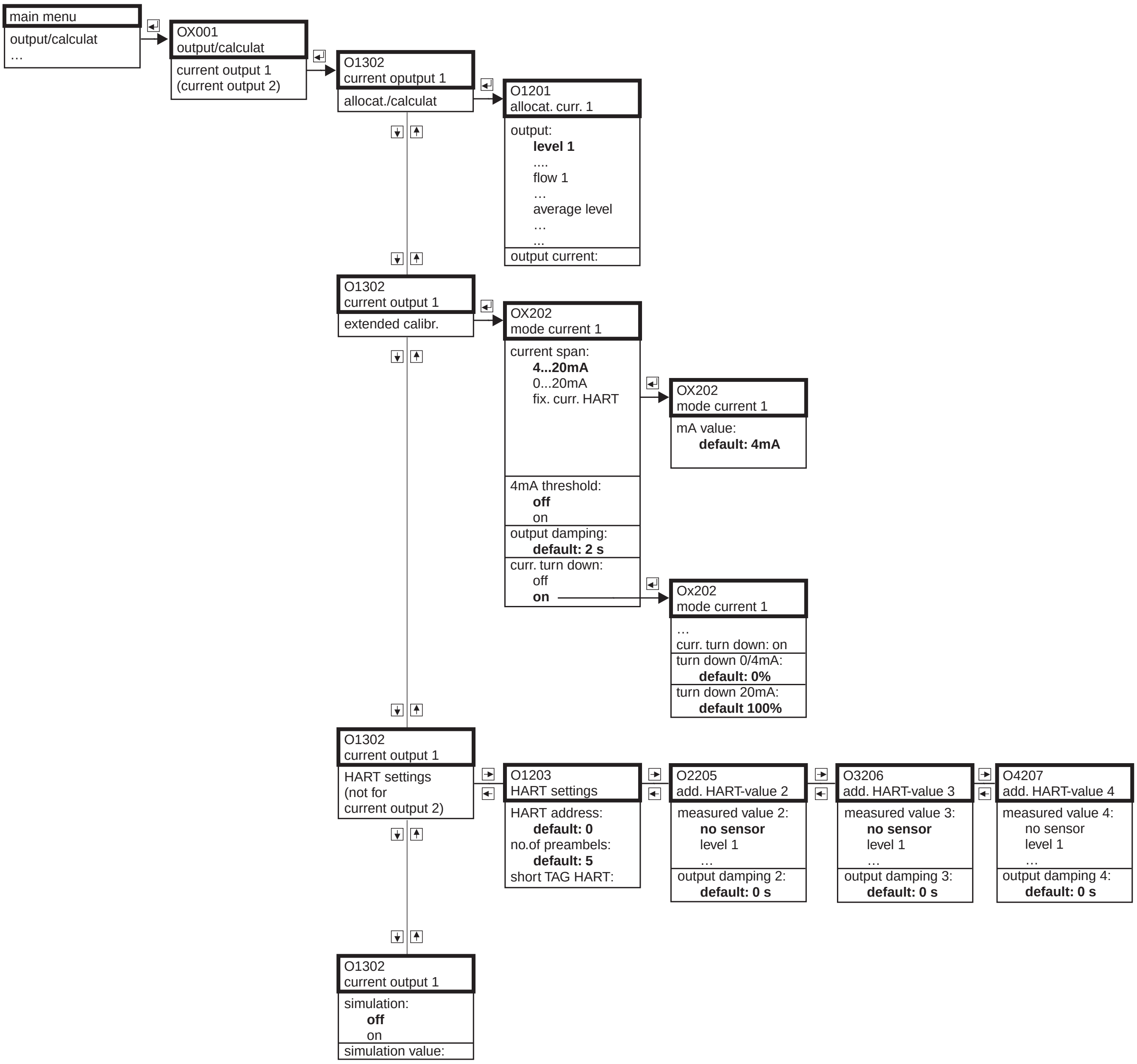


L00-FMU90xxx-19-08-01-en-106



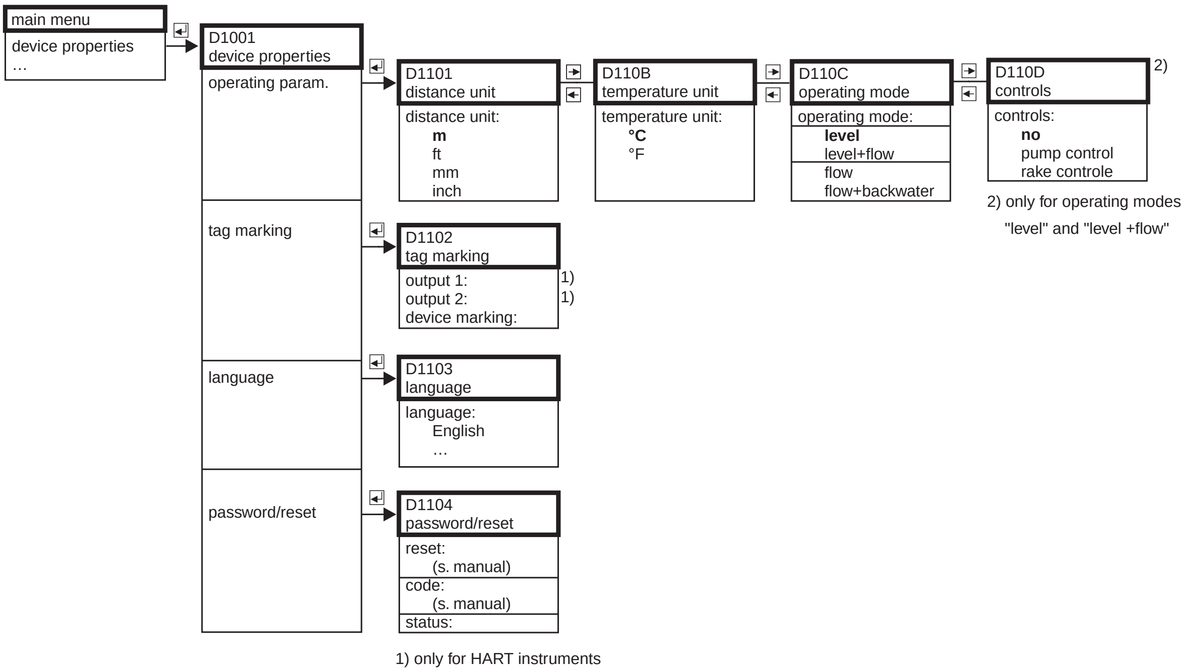
L00-FMU90xxx-19-08-02-en-106

14.4 "output/calculations"



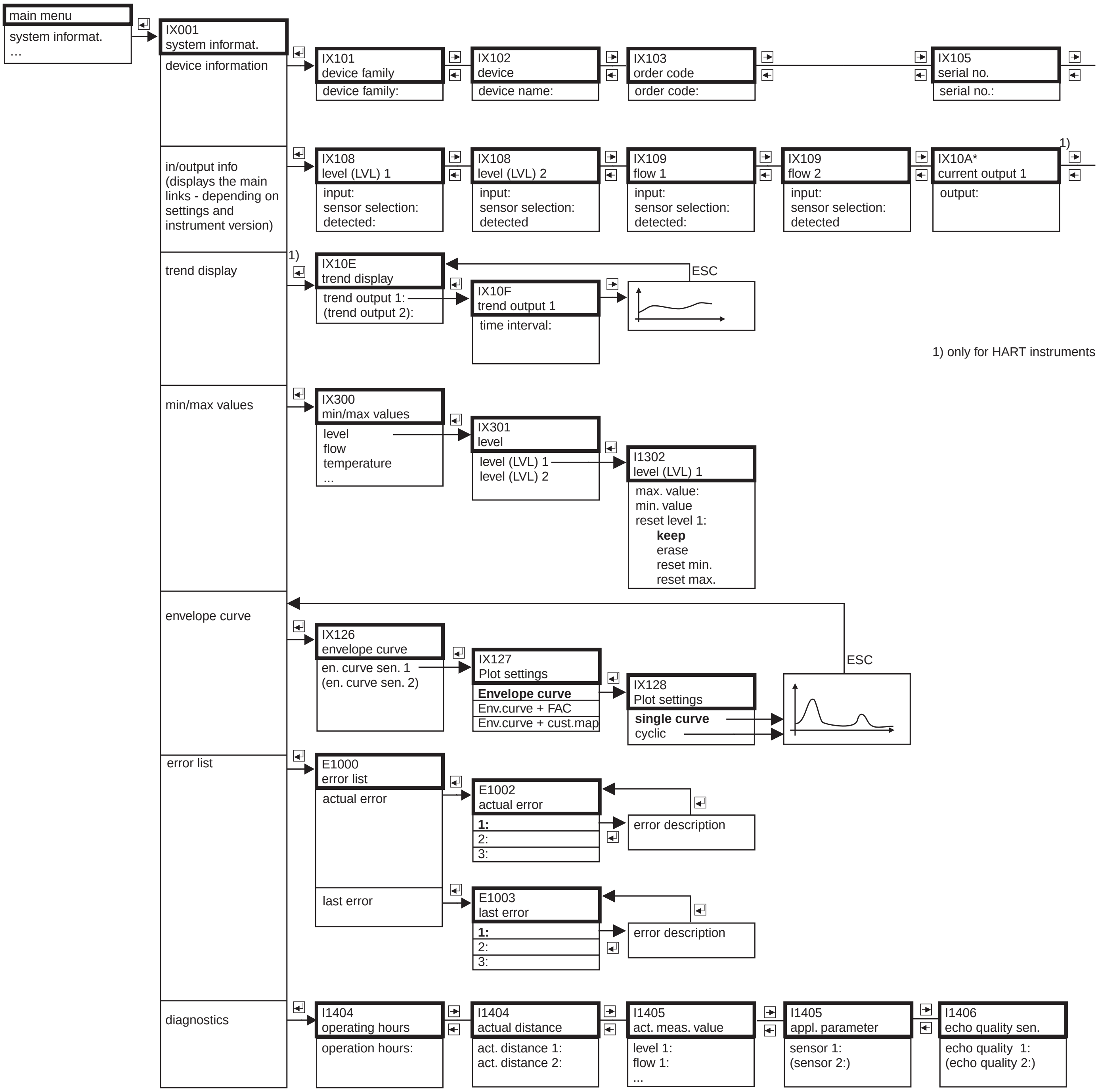
L00-FMU90xxx-19-05-01-en-106

14.5 "device properties"

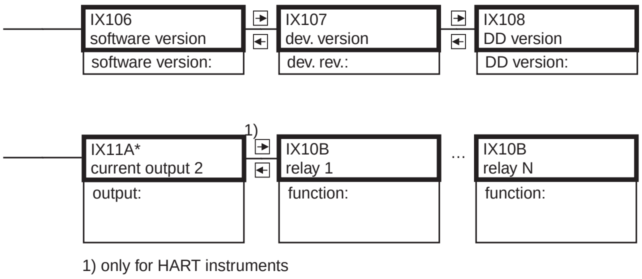


L00-FMU90xxx-19-06-01-en-106

14.6 "system information"

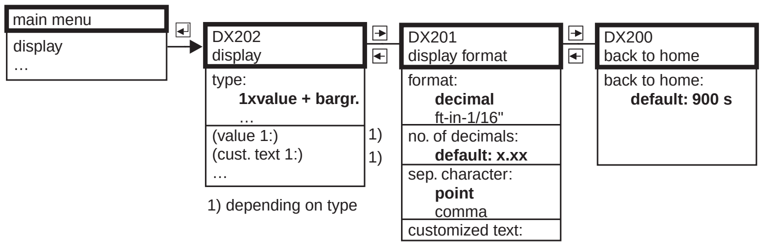


L00-FMU90xxx-19-07-01-en-106



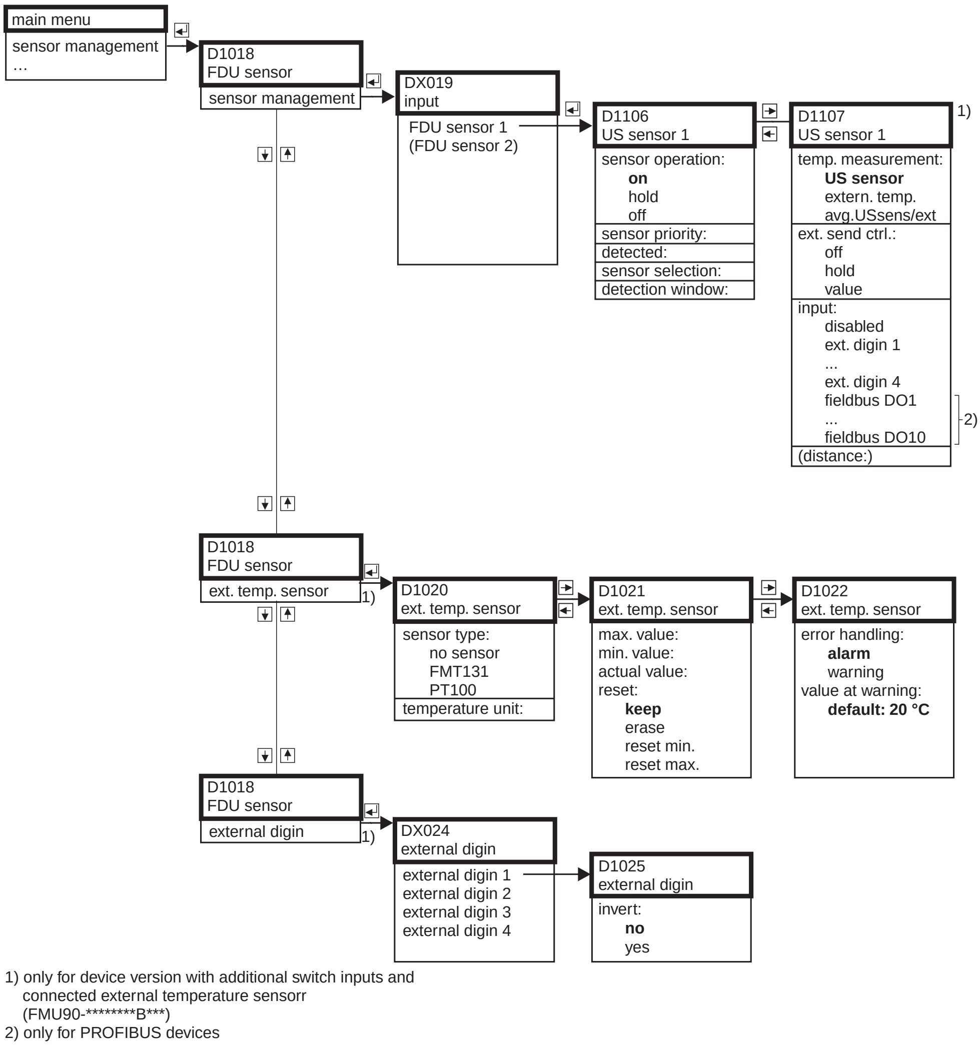
L00-FMU90xxx-19-07-02-en-106

14.7 "display"



L00-FMU90xxx-19-09-01-en-106

14.8 "sensor management"

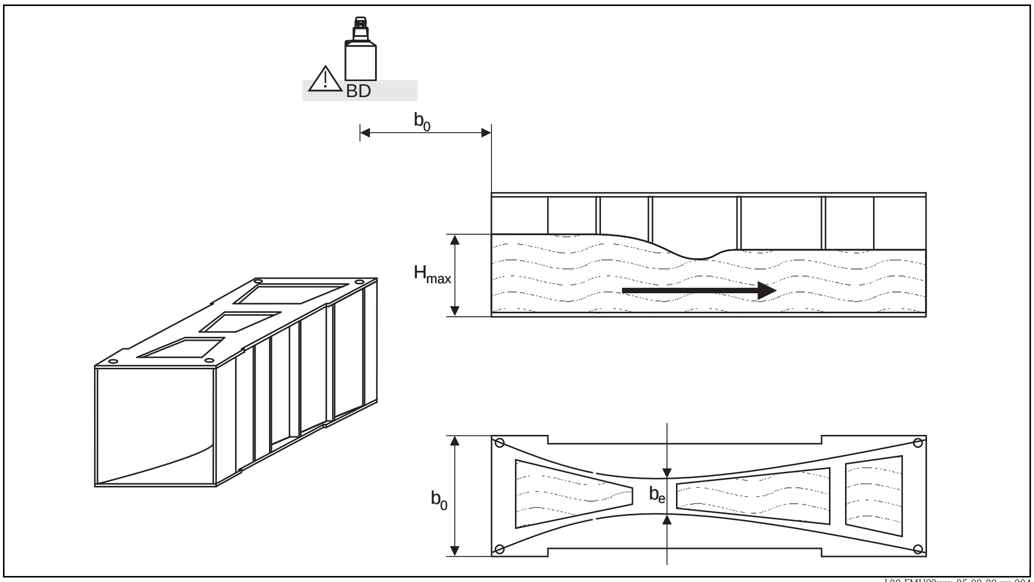


L00-FMU90xxx-19-10-01-en-106

15 Appendix

15.1 Pre-programmed flow curves

15.1.1 Khafagi-Venturi flumes



BD: blocking distance of the sensor

Type of flume	b_0	b_e	H_{max}	Q_{max} [m^3/h]
Khafagi-Venturi QV 302	120 (4.72)	48 (1.89)	220 (8.66)	40,09
Khafagi-Venturi QV 303	300 (11.8)	120 (4.72)	250 (9.84)	104,3
Khafagi-Venturi QV 304	400 (15.7)	160 (6.30)	350 (13.8)	231,5
Khafagi-Venturi QV 305	500 (19.7)	200 (7.87)	380 (15.0)	323,0
Khafagi-Venturi QV306	600 (23.6)	240 (9.45)	400 (15.7)	414,0
Khafagi-Venturi QV 308	800 (31.5)	320 (12.6)	600 (23.6)	1024
Khafagi-Venturi QV 310	1000 (39.4)	400 (15.7)	800 (31.5)	1982
Khafagi-Venturi QV 313	1300 (51.2)	520 (20.5)	950 (37.4)	3308
Khafagi-Venturi QV 316	1600 (63.0)	640 (25.2)	1250 (49.2)	6181

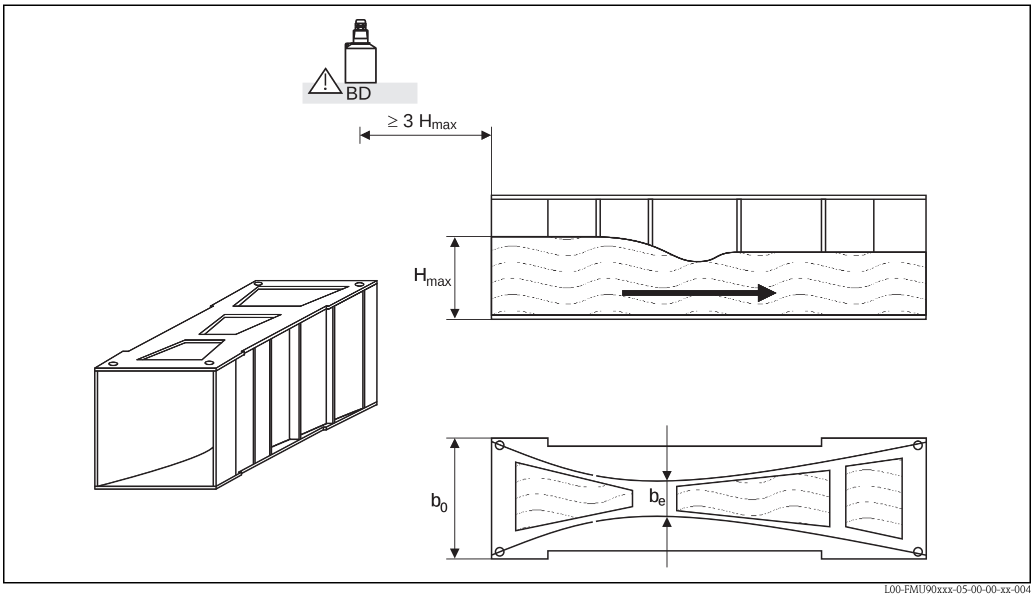
mm (in)

The pre-programmed curves can also be used for Khafagi-Venturi flumes with elevated walls. To do so, Q_{max} has to be adjusted (**"linearization"** function, **"max. flow"** subfunction):

Type of flume	H_{max} [mm (in)]	Q_{max} [m^3/h]
Khafagi-Venturi QV 302	330 (13.0)	81,90
Khafagi-Venturi QV 303	360 (14.2)	187,9
Khafagi-Venturi QV 304	460 (18.1)	359,9
Khafagi-Venturi QV 305	580 (22.8)	637,7
Khafagi-Venturi QV 306	580 (22.8)	748,6
Khafagi-Venturi QV 308	850 (33.5)	1790
Khafagi-Venturi QV 310	1200 (47.2)	3812
Khafagi-Venturi QV313	1350 (53.1)	5807
Khafagi-Venturi QV 316	1800 (70.9)	11110

✎ Note!
After selecting the type of flume, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.2 ISO-Venturi flumes



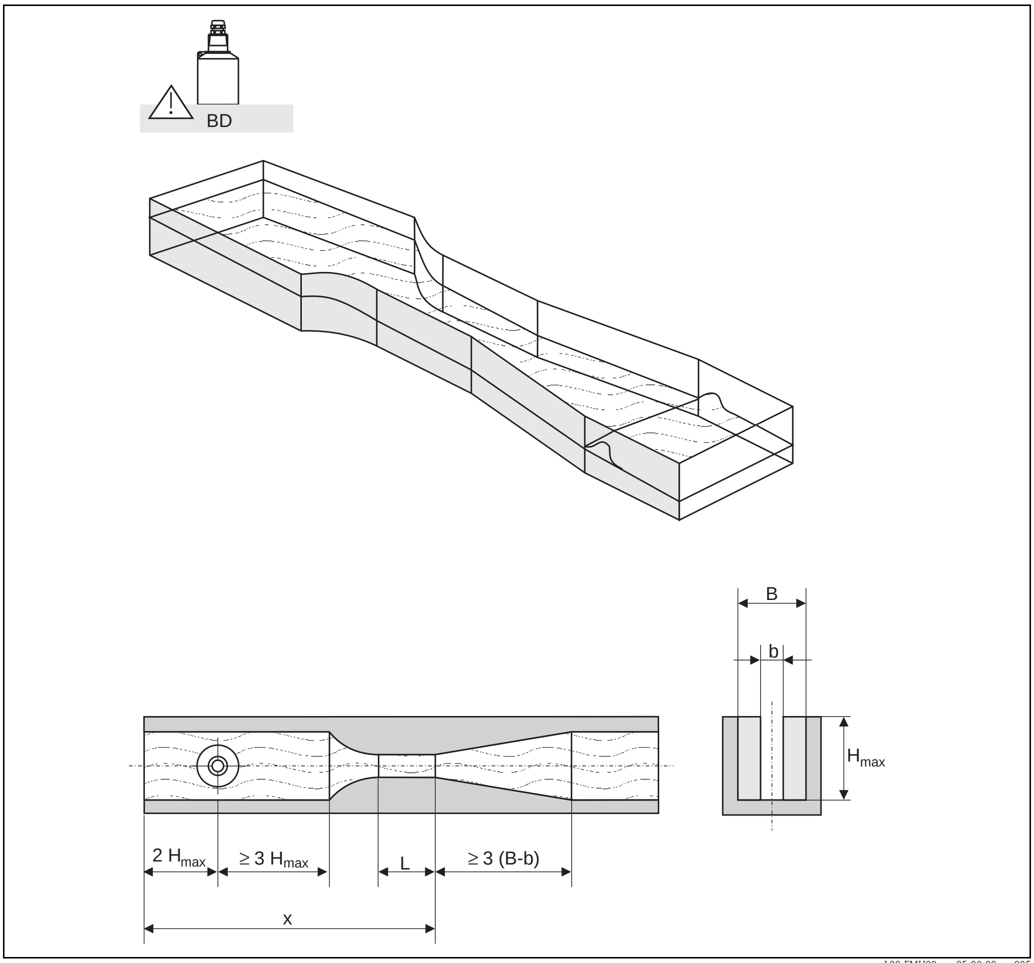
BD: blocking distance of the sensor

Type of flume	b_0	b_e]	H_{max}	Q_{max} [m^3/h]
ISO-Venturi 415	150 (5.91)	75 (2.95)	200 (7.87)	42.5
ISO-Venturi 425	250 (9.84)	125 (4.92)	300 (11.8)	130.3
ISO-Venturi 430	400 (15.7)	200 (7.87)	400 (15.7)	322.2
ISO-Venturi 440	400 (15.7)	267 (10.5)	625 (24.6)	893.6
ISO-Venturi 450	500 (19.7)	333 (13.1)	700 (27.6)	1318.9
ISO-Venturi 480	800 (31.5)	480 (18.9)	800 (31.5)	1862.5

mm (in)

Note!
After selecting the type of flume, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.3 British standard Venturi flumes (BS 3680)



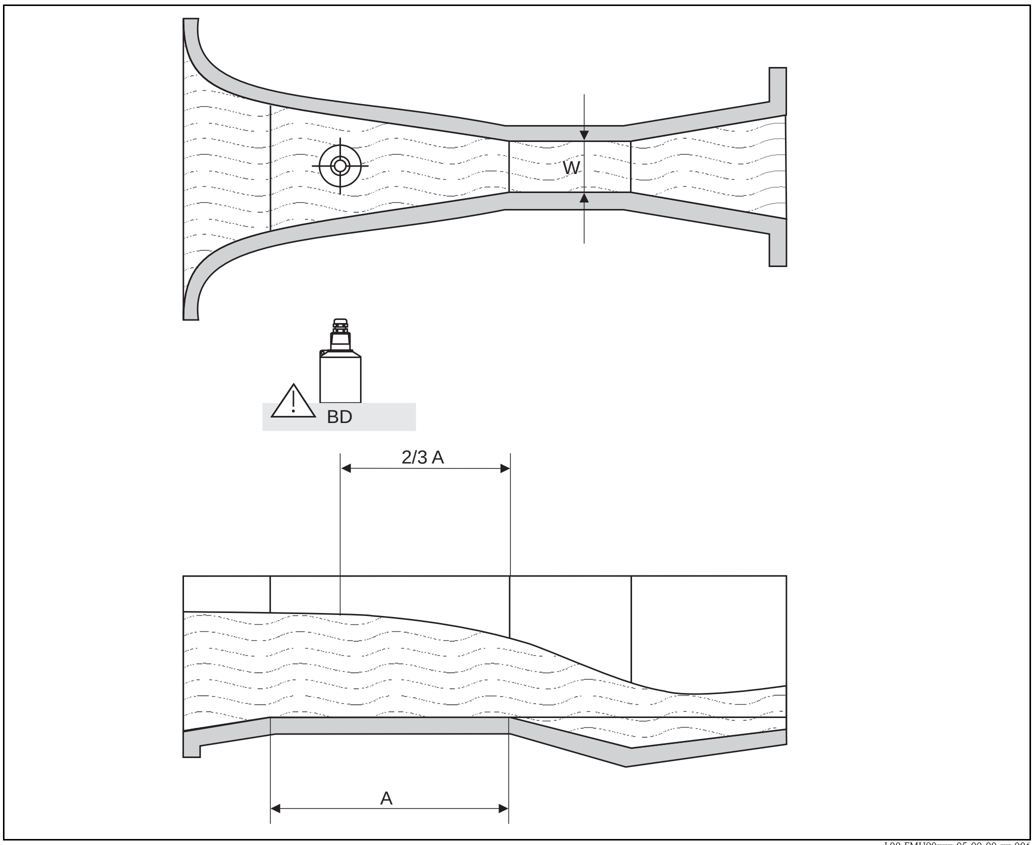
L00-FMU90xxx-05-00-00-xx-005

BD: blocking distance of the sensor
The bottom of the flume may not have any slope throughout the length x. (no measuring flume with data threshold)

Type of flume	b	H_{max} [mm (in)]	Q_{max} [m^3/h]
BST Venturi 4"	4"	150 (5.91)	36.25
BST Venturi 7"	7"	190 (7.48)	90.44
BST Venturi 12"	12"	340 (13.4)	371.1
BST Venturi 18"	18"	480 (18.9)	925.7
BST Venturi 30"	30"	840 (33.1)	3603

Note!
After selecting the type of flume, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.4 Parshall flumes

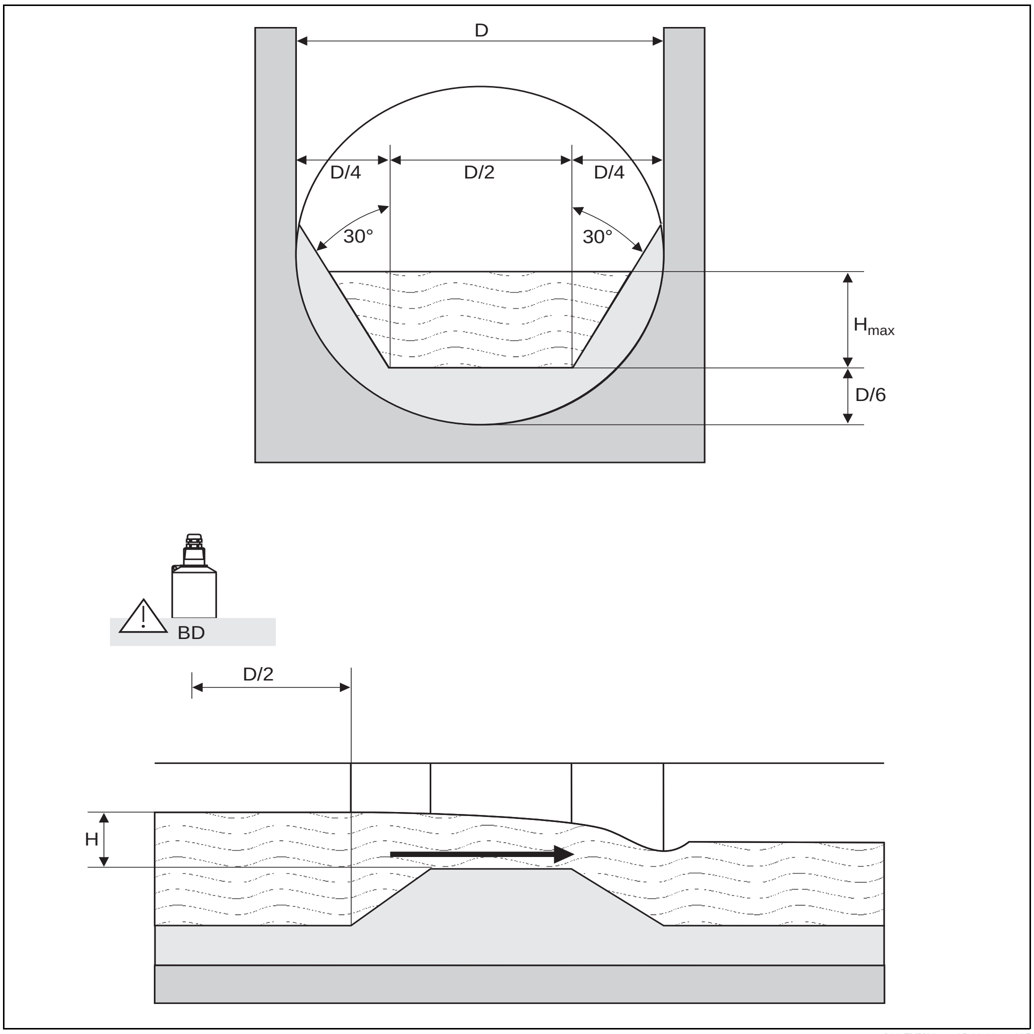


BD: blocking distance of the sensor
A: horizontal bottom of the channel

Type of flume	W	H_{max} [mm (in)]	Q_{max} [m^3/h]
Parshall 1"	1"	180 (7.09)	15.23
Parshall 2"	2"	180 (7.09)	30.46
Parshall 3"	3"	480 (18.9)	203.8
Parshall 6"	6"	480 (18.9)	430.5
Parshall 9"	9"	630 (24.8)	950.5
Parshall 1 ft	1.0 ft	780 (30.7)	1704
Parshall 1.5 ft	1.5 ft	780 (30.7)	2595
Parshall 2 ft	2.0 ft	780 (30.7)	3498
Parshall 3 ft	3.0 ft	780 (30.7)	5328
Parshall 4 t	4.0 ft	780 (30.7)	7185
Parshall 5 ft	5.0 ft	780 (30.7)	9058
Parshall 6 ft	6.0 ft	780 (30.7)	10951
Parshall 8 ft	8.0 ft	780 (30.7)	14767

Note!
After selecting the type of flume, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.5 Palmer-Bowlus flumes

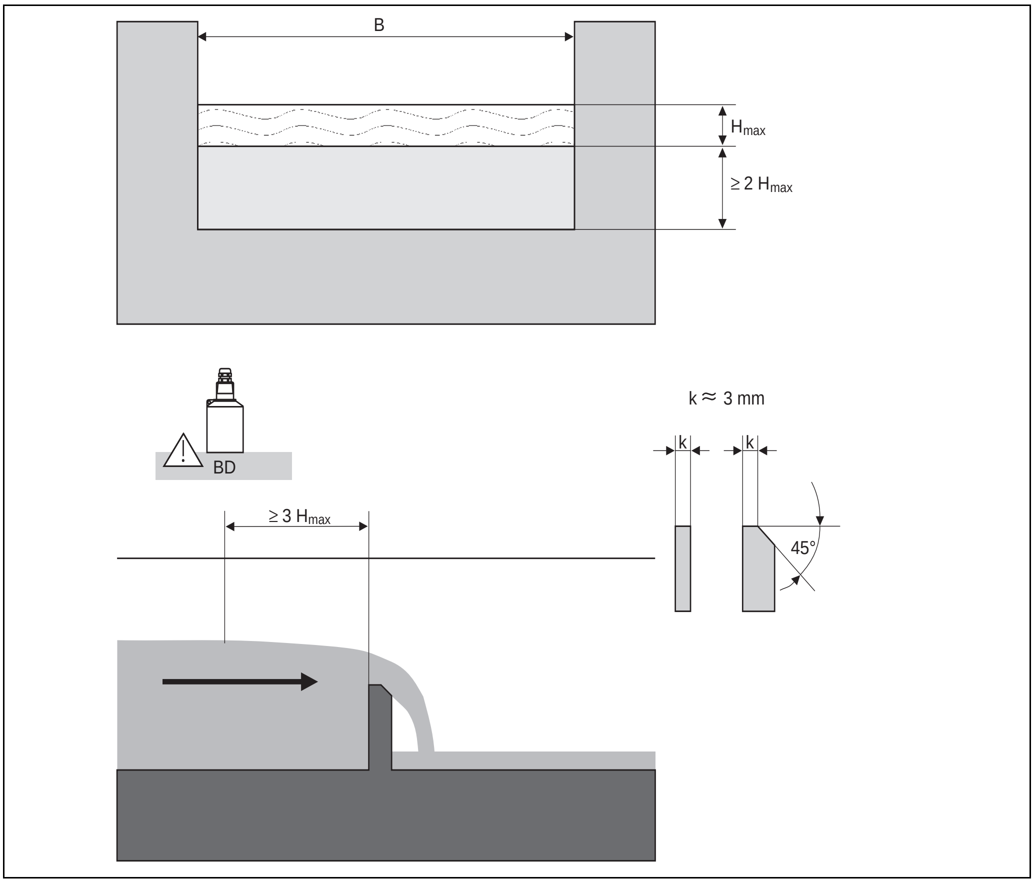


L00-FMU90xxx-05-00-00-xx-007

Type of flume	D	H_{max} [mm (in)]	Q_{max} [m^3/h]
Palmer-Bowlus 6"	6"	120 (4.72)	37.94
Palmer-Bowlus 8"	8"	150 (5.91)	68.62
Palmer-Bowlus 10"	10"	210 (8.27)	150.55
Palmer-Bowlus 12"	12"	240 (9.45)	215.83
Palmer-Bowlus 15"	15"	300 (11.8)	376.97
Palmer-Bowlus 18"	18"	330 (13.0)	499.86
Palmer-Bowlus 21"	21"	420 (16.5)	871.05
Palmer-Bowlus 24"	24"	450 (17.7)	1075.94
Palmer-Bowlus 27"	27"	540 (21.3)	1625.58
Palmer-Bowlus 30"	30"	600 (23.6)	2136.47

Note!
After selecting the type of flume, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.6 Rectangular weirs



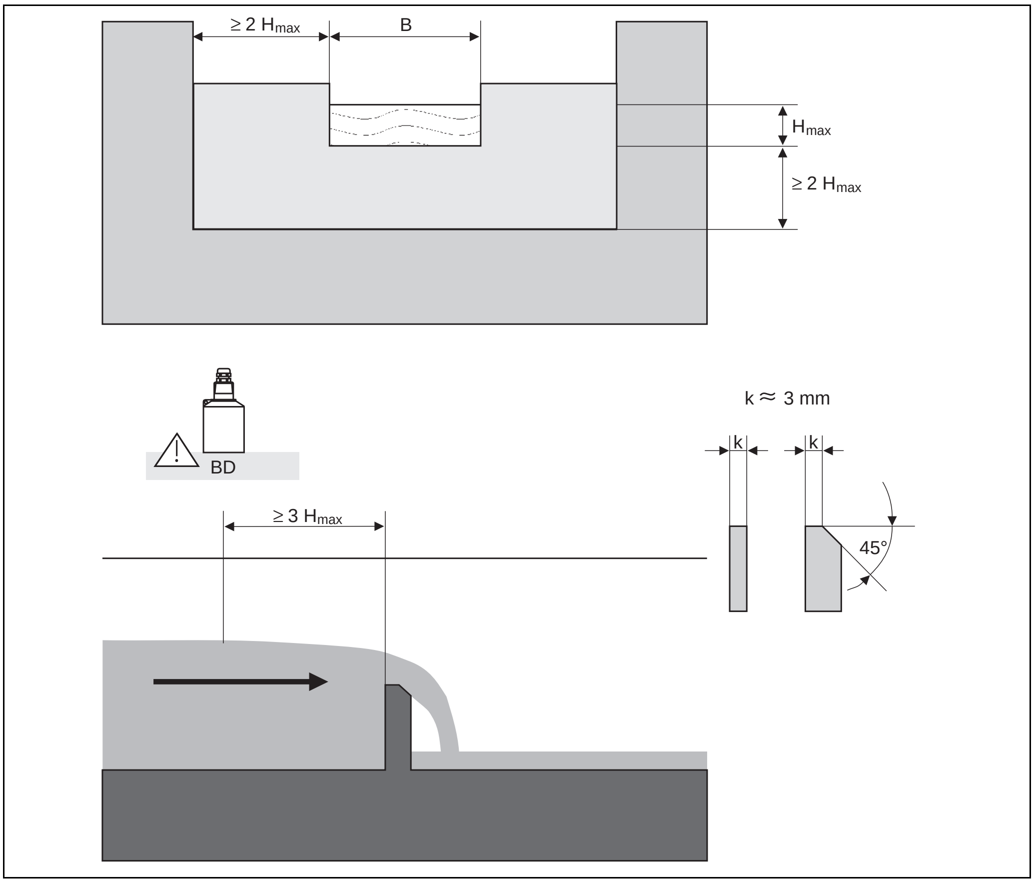
L00-FMU90xxx-05-00-00-xx-008

Type of weir	B	H_{max}	Q_{max} [m^3/h]
RectWT0/5H	1000 (39.4)	500 (19.7)	2418
RectWT0/T5	1000 (39.4)	1500 (59.1)	12567

mm (ft)

Note!
- In the "width" parameter, the width of the weir can be adjusted. The corresponding change of the flow curve is automatically performed by the Prosonic S.
- After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.7 Constricted rectangular weirs



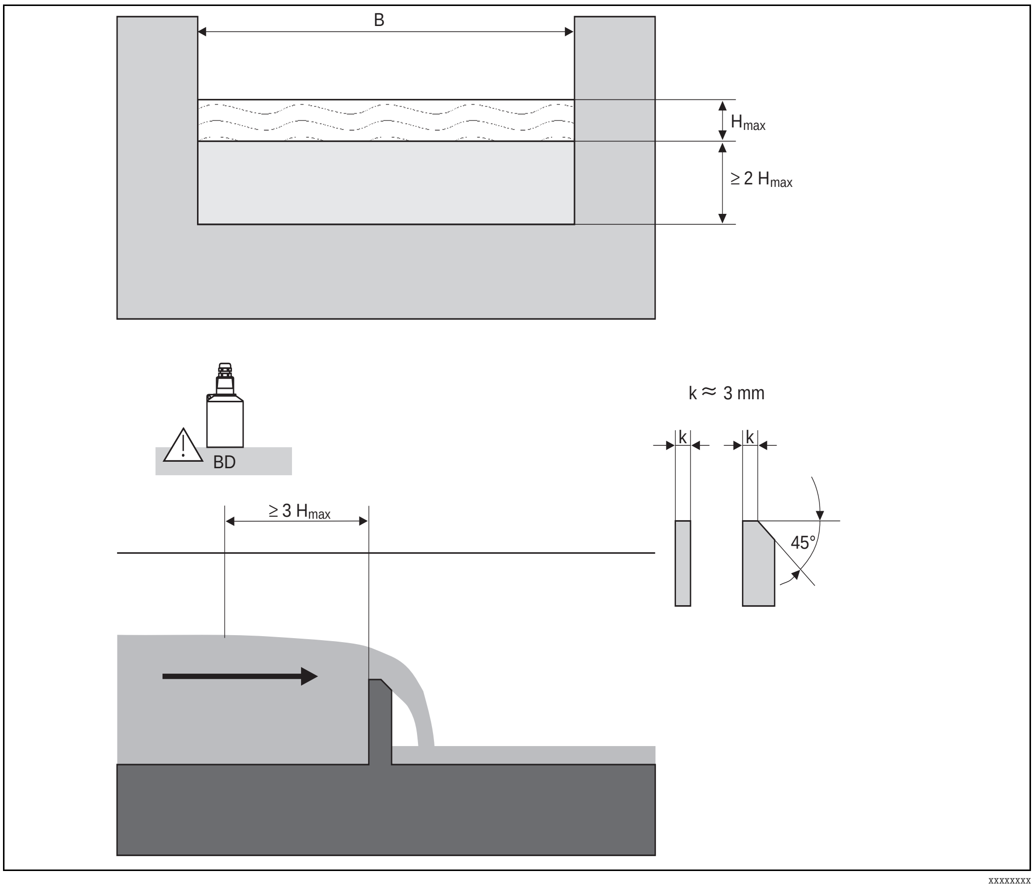
L00-FMU90xxx-05-00-00-xx-009

Type of weir	B	H_{max}	Q_{max} [m³/h]
RectWThr 2H	200 (7.87)	120 (4.72)	51.18
RectWThr 3H	300 (11.8)	150 (5.91)	108.4
RectWThr 4H	400 (15.7)	240 (9.45)	289.5
RectWThr 5H	500 (19.7)	270 (10.6)	434.6
RectWThr 6H	600 (23.6)	300 (11.8)	613.3
RectWThr 8H	800 (31.5)	450 (17.7)	1493
RectWThr T0	1000 (39.4)	600 (23.6)	2861
RectWThr T5	1500 (59.1)	725 (28.5)	6061
RectWThr 2T	2000 (78.7)	1013 (39.9)	13352

mm (in)

Note!
- In the "width" parameter, the width of the weir can be adjusted. The corresponding change of the flow curve is automatically performed by the Prosonic S.
- After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.8 Rectangular weirs according to French standard NFX

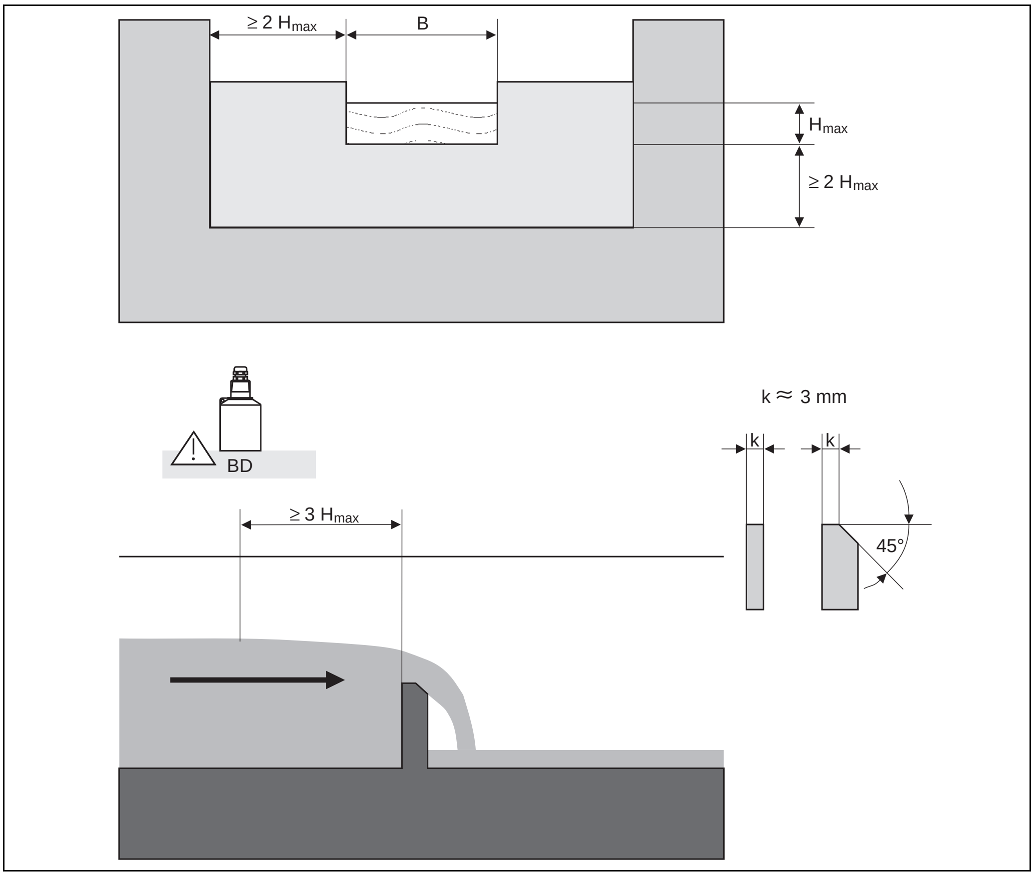


Type of weir	B	H_{max}	Q_{max} [m^3/h]
NFX Rect T0/5H	1000 (39.4)	500 (19.7)	2427.3
NFX Rect T0/T5	1000 (39.4)	1500 (59.1)	12582.5

mm (in)

Note!
- In the "width" parameter, the width of the weir can be adjusted. The corresponding change of the flow curve is automatically performed by the Prosonic S.
- After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.9 Constricted rectangular weirs according to French standard NFX



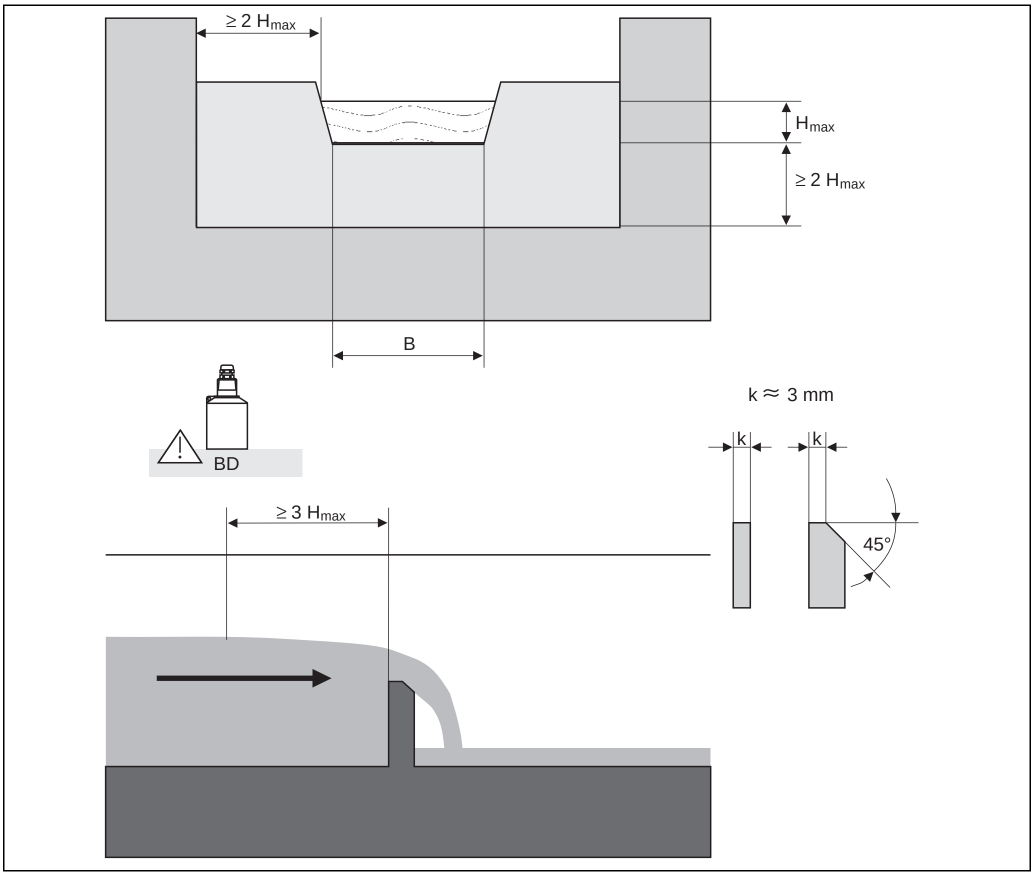
xxxxxxxx

Type of weir	B	H_{max}	Q_{max} [m^3/h]
NFX Rect WThr 2H	200 (7.87)	120 (4.72)	53.5
NFX Rect WThr 3H	300 (11.8)	150 (5.91)	111.7
NFX Rect WThr 4H	400 (15.7)	240 (9.45)	299.1
NFX Rect WThr 5H	500 (19.7)	270 (10.6)	445.8
NFX Rect WThr 6H	600 (23.6)	300 (11.8)	626.2
NFX Rect WThr 8H	800 (31.5)	450 (17.7)	1527.8
NFX Rect WThr T0	1000 (39.4)	600 (23.6)	2933.8

mm (in)

Note!
After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.10 Trapezoidal weirs



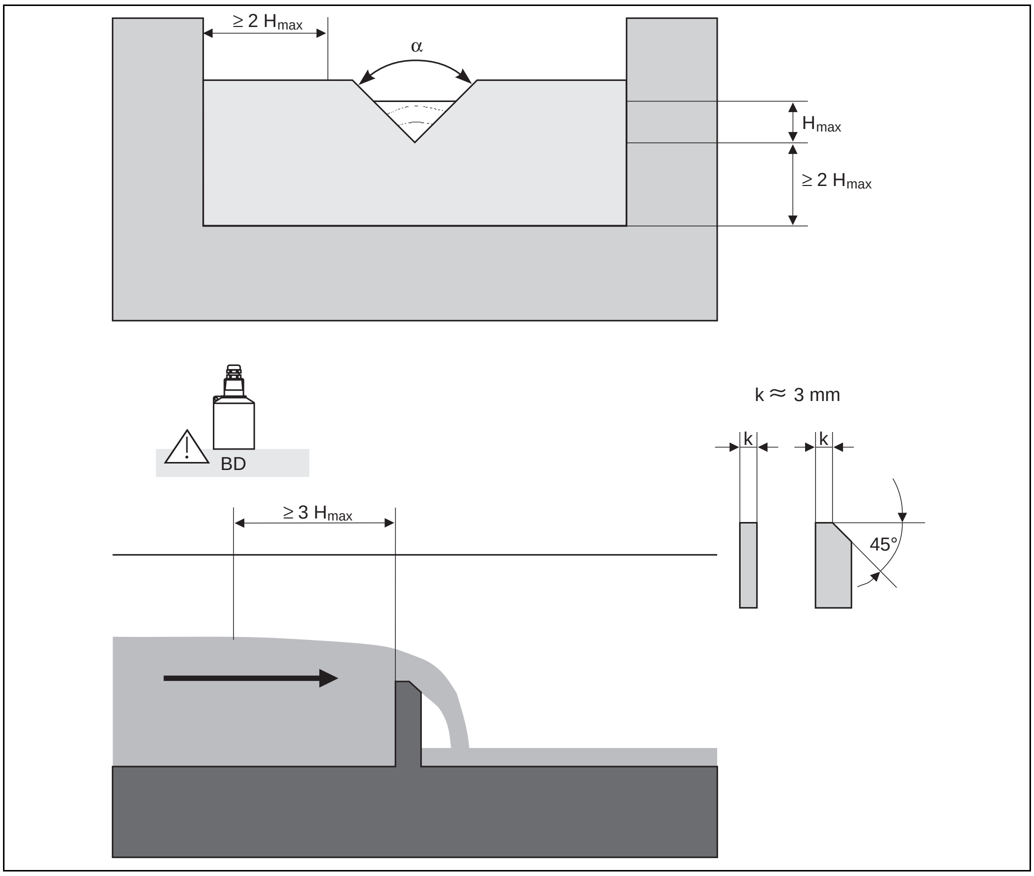
L00-FMU90xxx-05-00-00-xx-010

Type of weir	B	H_{max}	Q_{max} [m^3/h]
Trap.W T0/3H	1000 (39.4)	300 (11.8)	1049
Trap.W T0/T5	1000 (39.4)	1500 (59.1)	11733

mm (in)

Note!
- In the "width" parameter, the width of the weir can be adjusted. The corresponding change of the flow curve is automatically performed by the Prosonic S.
- After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.11 Triangular weirs



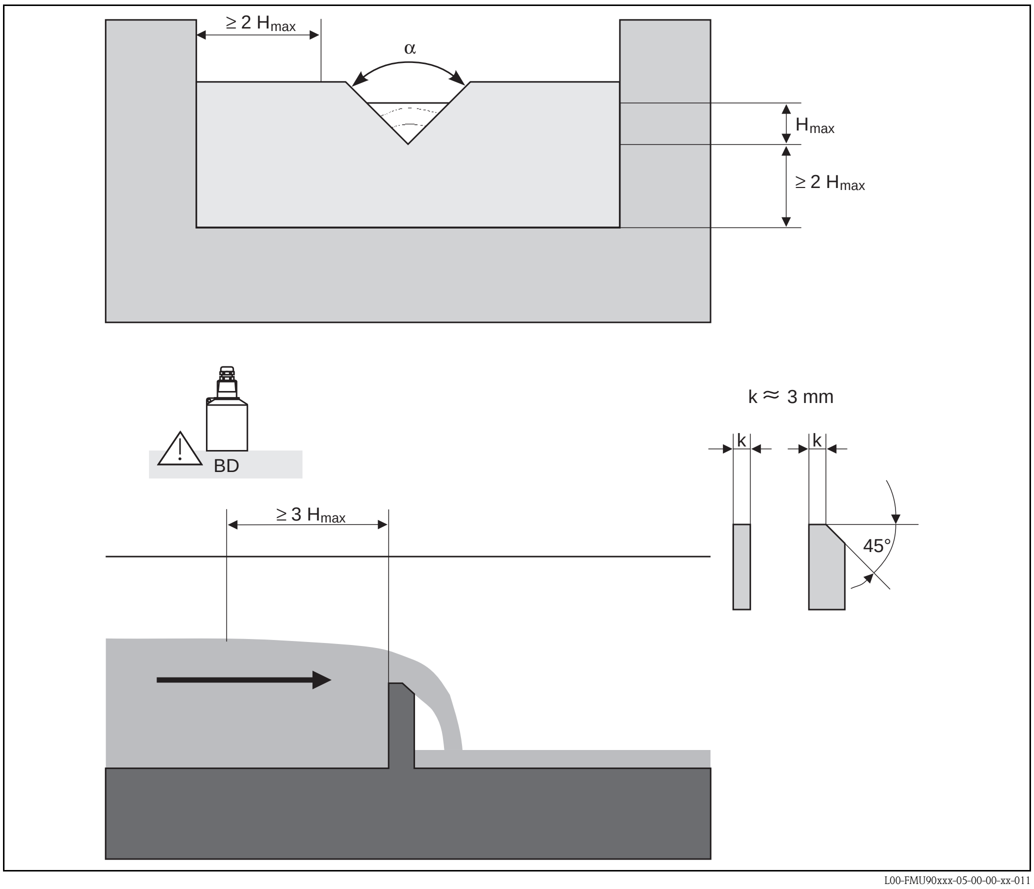
L00-FMU90xxx-05-00-00-xx-011

Type of weir	α	H_{max}	Q_{max} [m³/h]
V-Weir 22.5	22.5°	600 (23.6)	276.0
V-Weir 30	30°	600 (23.6)	371.2
V-Weir 45	45°	600 (23.6)	574.1
V-Weir 60	60°	600 (23.6)	799.8
V-Weir 90	90°	600 (23.6)	1385

mm (in)

Note!
After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.12 British standard triangular weirs (BS 3680)

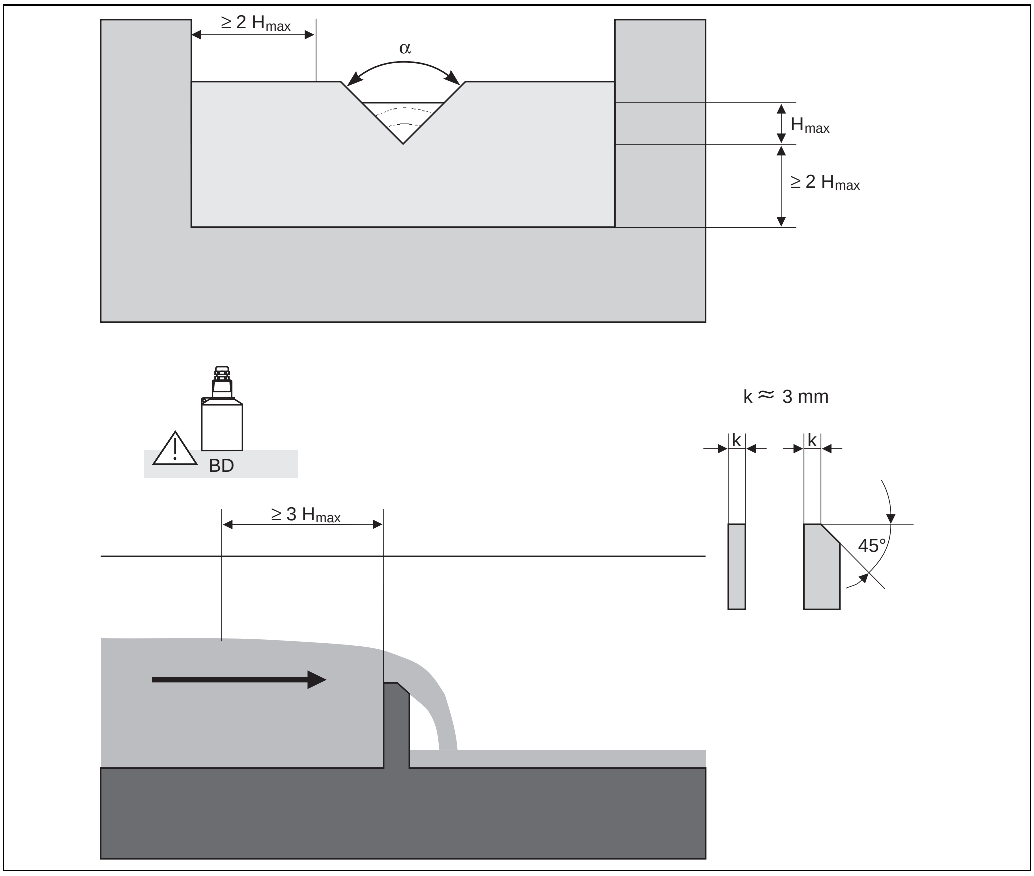


Type of weir	α	H_{max}	Q_{max} [m³/h]
BST V-Weir 22.5 (1/4 90°)	1/4 90 °	390 (15.4)	120.1
BST V-Weir 45 (1/2 90 °)	1/2 90 °	390 (15.4)	237.0
BST V-Weir 90	90°	390 (15.4)	473.2

mm (in)

Note!
After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.1.13 Triangular weirs according to the French standard NFX



L00-FMU90xxx-05-00-00-xx-011

Type of weir	α	H_{max}	Q_{max} [m^3/h]
NFX V-Weir 30	30°	600 (23.6)	375.9
NFX V-Weir 45	45°	600 (23.6)	573.1
NFX V-Weir 60	60°	600 (23.6)	793.1
NFX V-Weir 90	90°	600 (23.6)	1376.7

mm (in)

Note!
After selecting the type of weir, Q_{max} can be adjusted to the flow conditions. Q_{max} defines the flow at which the output current is 20 mA.

15.2 The formula for flow calculation

If you have selected the "formula" linearization type, the flow calculation is performed according to:

$Q = C\ (h^{\alpha} + \gamma h^{\beta})$

where:
- Q: the flow in m^3/h
- C: a scaling parameter
- h: the upstream level
- α,β: the flow exponents
- γ: a weighting constant

Appropriate values of α, β, γ and C for the different types of flumes and weirs can be taken from the following tables.

Khafagi-Venturi flumes					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
QV 302	40,09	1,500	2,500	0,0013140	0,0095299
QV 303	104,3	1,500	2,500	0,0004301	0,0238249
QV 304	231,5	1,500	2,500	0,0003225	0,0317665
QV 305	323,0	1,500	2,500	0,0002580	0,0397081
QV 306	414,0	1,500	2,500	0,0002150	0,0476497
QV 308	1024	1,500	2,500	0,0001613	0,0635329
QV 310	1982	1,500	2,500	0,0001290	0,0794162
QV 313	3308	1,500	2,500	0,0000992	0,1032410
QV 316	6181	1,500	2,500	0,0000806	0,1270659

ISO-Venturi flumes					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
ISO 415	42,5	1,500	2,100	0,0009336	0,0146865
ISO 425	130,3	1,500	1,600	0,0959719	0,0214406
ISO 430	322,2	1,500	2,000	0,0032155	0,0379104
ISO 440	893,6	1,600	1,700	-0,2582633	0,0590888
ISO 450	1318,9	1,600	1,800	-0,0895791	0,0553654
ISO 480	1862,5	1,600	1,800	-0,0928186	0,0795737

British standard Venturi flumes (BS 3680)					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
BST Venturi 4"	36,25	1,500	1,000	0,0000000	0,019732
BST Venturi 7"	90,44	1,500	1,000	0,0000000	0,034532
BST Venturi 12"	371,2	1,500	1,000	0,0000000	0,059201
BST Venturi 18"	925,7	1,500	1,000	0,0000000	0,088021
BST Venturi 30"	3603	1,500	1,000	0,0000000	0,148003

Parshall flumes					
Type	**Q_{max} [m³/h]**	α	β	γ	**C**
Parshall 1"	15,23	1,550	1,000	0,0000000	0,0048651
Parshall 2"	30,46	1,550	1,000	0,0000000	0,0097302
Parshall 3"	203,8	1,547	1,000	0,0000000	0,0144964
Parshall 6"	430,5	1,580	1,000	0,0000000	0,0249795
Parshall 9"	950,5	1,530	1,000	0,0000000	0,0495407
Parshall 1 ft	1704	1,522	1,000	0,0000000	0,0675749
Parshall 1,5 ft	2595	1,538	1,000	0,0000000	0,0924837
Parshall 2 ft	3498	1,550	1,000	0,0000000	0,1151107
Parshall 3 ft	5328	1,566	1,000	0,0000000	0,1575984
Parshall 4 ft	7185	1,578	1,000	0,0000000	0,1962034
Parshall 5 ft	9058	1,587	1,000	0,0000000	0,2329573
Parshall 6 ft	10951	1,595	1,000	0,0000000	0,2670383
Parshall 8 ft	14767	1,607	1,000	0,0000000	0,3324357

Palmer-Bowlus flumes					
Type	**Q_{max} [m³/h]**	α	β	γ	**C**
Palmer-Bowlus 6"	37,94	0,200	2,000	0,01176	0,22063
Palmer-Bowlus 8"	68,62	0,200	2,000	0,00661	0,45306
Palmer-Bowlus 10"	150,55	0,200	2,000	0,00512	0,65826
Palmer-Bowlus 12"	215,83	0,200	2,000	0,0033	1,11787
Palmer-Bowlus 15"	376,97	0,200	2,000	0,00213	1,93489
Palmer-Bowlus 18"	499,86	0,200	2,000	0,00152	2,96269
Palmer-Bowlus 21"	871,05	0,200	2,000	0,00113	4,29769
Palmer-Bowlus 24"	1075,94	0,200	2,000	0,00091	5,73322
Palmer-Bowlus 27"	1625,58	0,200	2,000	0,00073	7,51238
Palmer-Bowlus 30"	2136,47	0,200	2,000	0,00061	9,57225

Rectangular weirs					
Type	**Q_{max} [m³/h]**	α	β	γ	**C**
RectWT0/5H	2418	1,500	1,000	0,0000000	0,21632686
RectWT0/T5	12567	1,500	1,000	0,0000000	0,21632686

Constricted rectangular weirs					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
RectWThr 2H	51,18	1,500	1	0,0000000	0,038931336
RectWThr 3H	108,4	1,500	1	0,0000000	0,059018248
RectWThr 4H	289,5	1,500	1	0,0000000	0,077862671
RectWThr 5H	434,6	1,500	1	0,0000000	0,097949584
RectWThr 6H	613,3	1,500	1	0,0000000	0,118036497
RectWThr 8H	1493	1,500	1	0,0000000	0,156346588
RectWThr T0	2861	1,500	1	0,0000000	0,194656679
RectWThr T5	6061	1,500	1	0,0000000	0,3106200
RectWThr 2T	13352	1,500	1	0,0000000	0,4141600

Rectangular weirs according to French standard NFX					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
NFX Rect T0/5H	2427,3	1,400	2,000	0,0107097	0,2801013
NFX Rect T0/T5	12582,5	1,500	0,000	0,0000000	0,1951248

Constricted rectangular weirs according to French standard NFX					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
NFX RectWThr 2H	53,5	1,500	1,600	-0,1428487	0,0528094
NFX RectWThr 3H	111,7	1,500	1,600	-0,1115842	0,0744722
NFX RectWThr 4H	299,1	1,500	1,600	-0,0975777	0,0966477
NFX RectWThr 5H	445,8	1,500	1,600	-0,0884398	0,1187524
NFX RectWThr 6H	626,2	1,500	1,600	-0,0816976	0,1407481
NFX RectWThr 8H	1527,8	1,500	1,600	-0,0634245	0,1810272
NFX RectWThr T0	2933,8	1,500	1,600	-0,0671398	0,2285268

Trapezoidal weirs					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
Trap.W T0/3H	1049	1,500	1,000	0,0000000	0,2067454
Trap.W T0/T5	11733	1,500	1,000	0,0000000	0,2067454

Triangular weirs					
Type	**Q_{max} [m^3/h]**	α	β	γ	**C**
V-Weir 22,5	276,0	2,500	1,000	0,0000000	0,0000313
V-Weir 30	371,2	2,500	1,000	0,0000000	0,0000421
V-Weir 45	574,1	2,500	1,000	0,0000000	0,0000651
V-Weir 60	799,8	2,500	1,000	0,0000000	0,0000907
V-Weir 90	1385	2,500	1,000	0,0000000	0,0001571

British standard triangular weirs (BS 3680)					
Type	**Q_{max} [m³/h]**	α	β	γ	**C**
BST V-Weir 22,5	120,1	2,314	2,649,000	0,1430720	0,0000590
BST -Weir 45	237,3	2,340	2,610	0,2659230	0,0000880
BST V-Weir 90	473,2	2,314	2,650	0,1904230	0,0001980

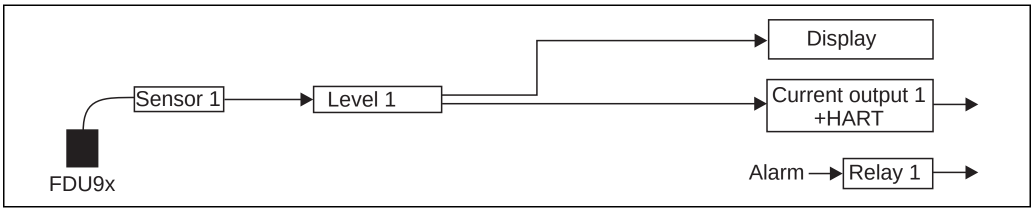
Triangular weirs according to French standard NFX					
Type	**Q_{max} [m³/h]**	α	β	γ	**C**
NFX V-Weir 30	375,9	2,400	2,800	0,0241095	0,0000616
NFX V-Weir 45	573,1	2,476	0,000	0,0000000	0,0000757
NFX V-Weir 60	793,1	2,486	0,000	0,0000000	0,0000983
NFX V-Weir 90	1376,7	2,491	0,000	0,0000000	0,0001653

15.3 Default block configuration

The default block configuration depends on the instrument version and the selected operating mode:

15.3.1 Operating mode = "level"

1 sensor input / 1 current output
(FMU90 - *****1*1**)**



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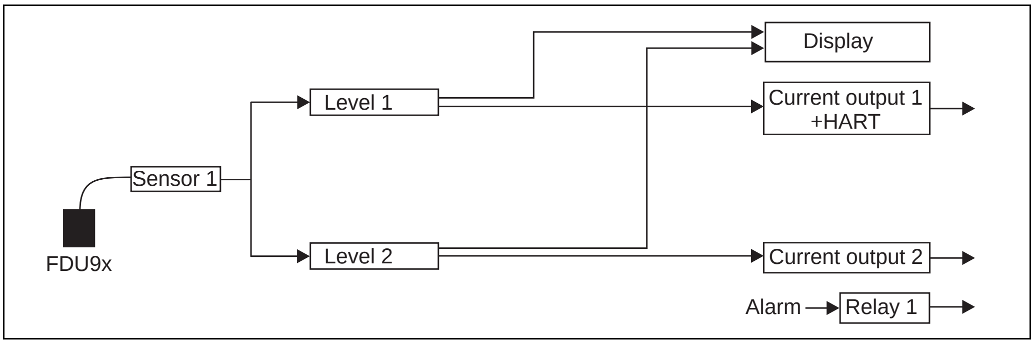
1 sensor input / 2 current outputs
(FMU90 - *****1*2**)**



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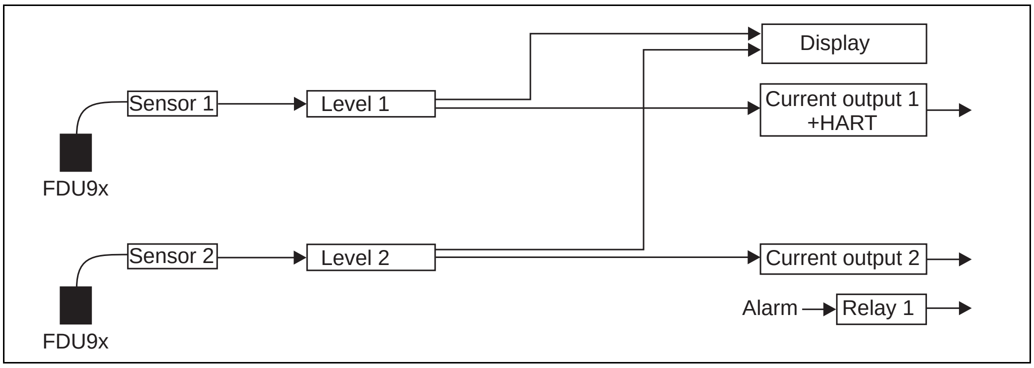
2 sensor inputs / 2 current outputs
(FMU90 - *****2*2**)**



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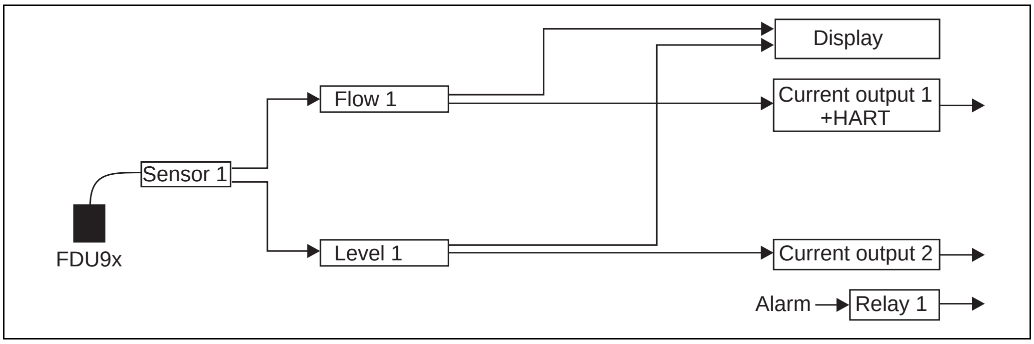
15.3.2 Operating mode = "level + flow"

1 sensor input / 2 current outputs
(FMU90 - *****1*2**)**



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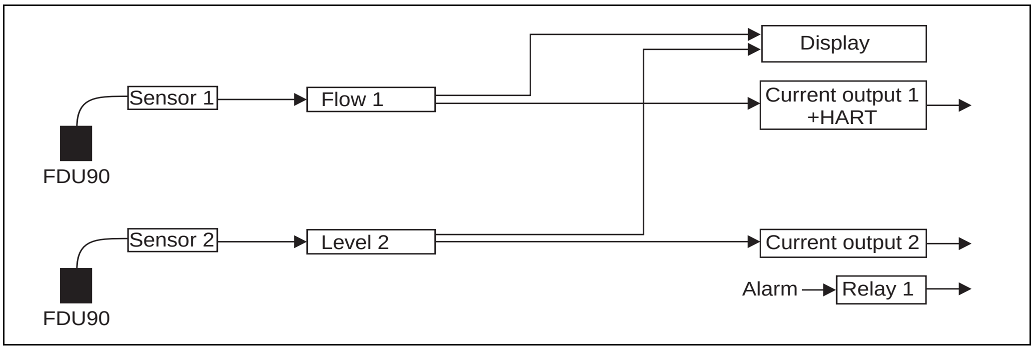
2 sensor inputs / 2 current outputs
(FMU90 - *****2*2**)**



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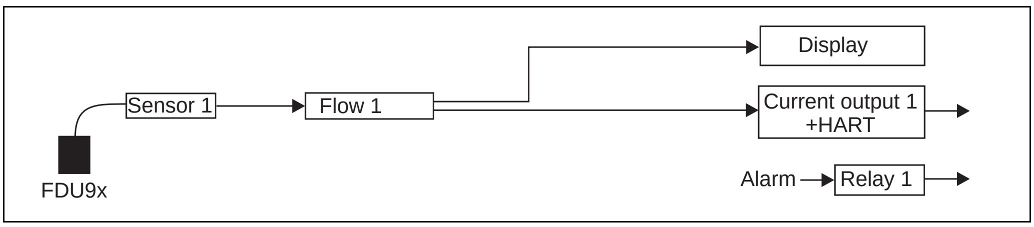
15.3.3 Operating mode = "flow"

1 sensor input / 1 current output
(FMU90 - *****1*1**)**



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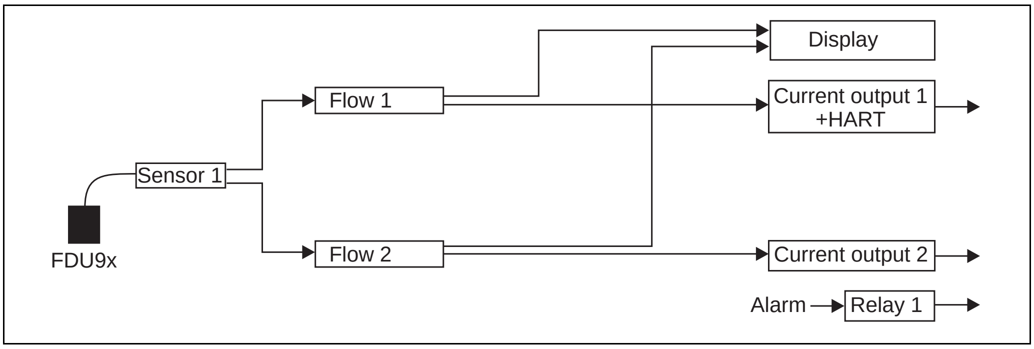
1 sensor input / 2 current outputs (FMU90 - *****1*2****)



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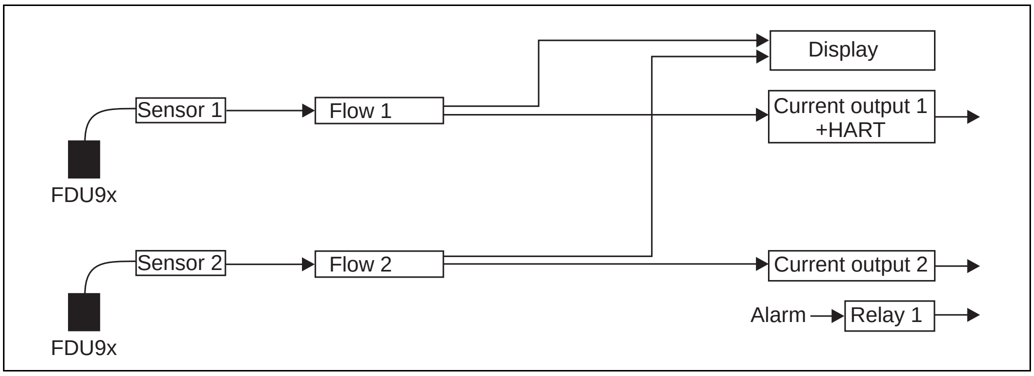
2 sensor inputs / 2 current outputs (FMU90 - *****2*2****)



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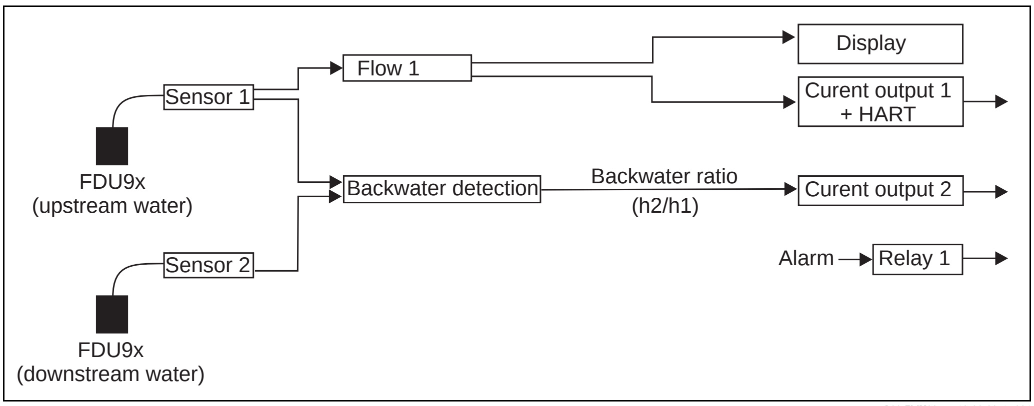
15.3.4 Operating mode = "flow + backwater"

2 sensor inputs / 2 current outputs



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Catalog Number 5860018

Hach sc100™ Controller

USER MANUAL

March 2007, Edition 6

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Section 1 Specifications

Specifications are subject to change without notice.

Component Description	Microprocessor-controlled measuring unit with measured value display, temperature display, and menu-driven system
Controller Operating Temperature	–20 to 60 °C (–4 to 140 °F); 95% relative humidity, non-condensing with sensor/network card load <7 W; –20 to 40 °C (–4 to 104 °F) with sensor /network card load <25 W
Controller Storage Temperature	–20 to 70 °C (–4 to 158 °F); 95% relative humidity, non-condensing
Enclosure	NEMA 4X/IP66 metal enclosure with a corrosion-resistant finish
Power Requirements	**AC Powered sc100 model:** 100–230 VAC ±10%, 50/60 Hz; Power 15 W with 7 W sensor/network card load, 37 W with 25 W sensor/network card load
	24 VDCpowered sc100 model: 24 VDC –15%, +20%; Power 16W with 7W sensor/network card load, 34 W with 25 W sensor/network card load
Pollution Degree/ Installation Category	II; II
Outputs	Two (Analog (4–20 mA)) outputs, maximum impedance 500 ohm. Optional digital network connection. IrDA digital connection.
Relays	Three SPDT, user-configured contacts rated 100–230 VAC, 5 Amp resistive maximum for the ac powered sc100 and 24 VDC, 5A resistive maximum for the dc powered sc100.
Controller Dimensions	½ DIN—144 x 144 x 150 mm (5.7 x 5.7 x 5.9 inches)
Controller Weight	1.6 kg (3.5 lb)
Certifications	CE approved (with all sensor types) Listed for use in general locations to UL and CSA safety standards by ETL (with all sensor types) Listed for use in Class I, Division 2 hazardous locations to FM & CSA safety standards by ETL (with specified sensor types, per Control Drawing 58600-78

Section 2 General Information

2.1 Safety Information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

2.1.1 Use of Hazard Information

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

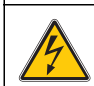
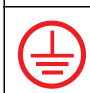
CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

Important Note: *Information the requires special emphasis.*

Note: *Information that supplements points in the main text.*

2.1.2 Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.

2.2 General Product Information

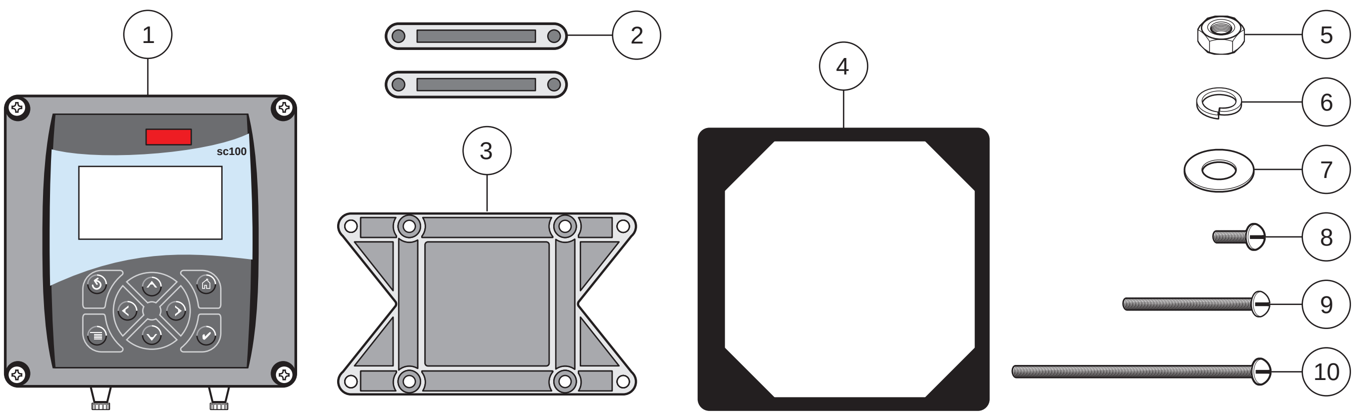
The controller enclosure is NEMA4X/IP66-rated and has a corrosion-resistant finish designed to withstand corrosive environmental constituents such as salt spray and hydrogen sulfide. The controller display shows the current reading plus a secondary measurement such as temperature if connected to a single sensor, or two readings with their corresponding secondary measurement readings when two sensors are connected.

Installation instructions for the controller are presented in this manual. If a system with a sensor and a controller has been purchased, complete information for installation and operation is also presented in the sensor system manual.

DANGER
Only qualified personnel should conduct the installation tasks described in this section of the manual. This equipment is suitable for use in non-hazardous locations or Class 1, Division 2, Groups A, B, C, D Hazardous Locations with specified sensors and options when installed per the Hazardous Location Installation Control Drawing on page 8. Always refer to the Control Drawing and applicable electrical code regulations for proper installation instructions.

DANGER
Explosion hazard. Substitution of components may impair suitability for Class 1, Division 2. Do not replace any component unless power has been switched off and the area is known to be non-hazardous.

Figure 1 Components of a Basic System

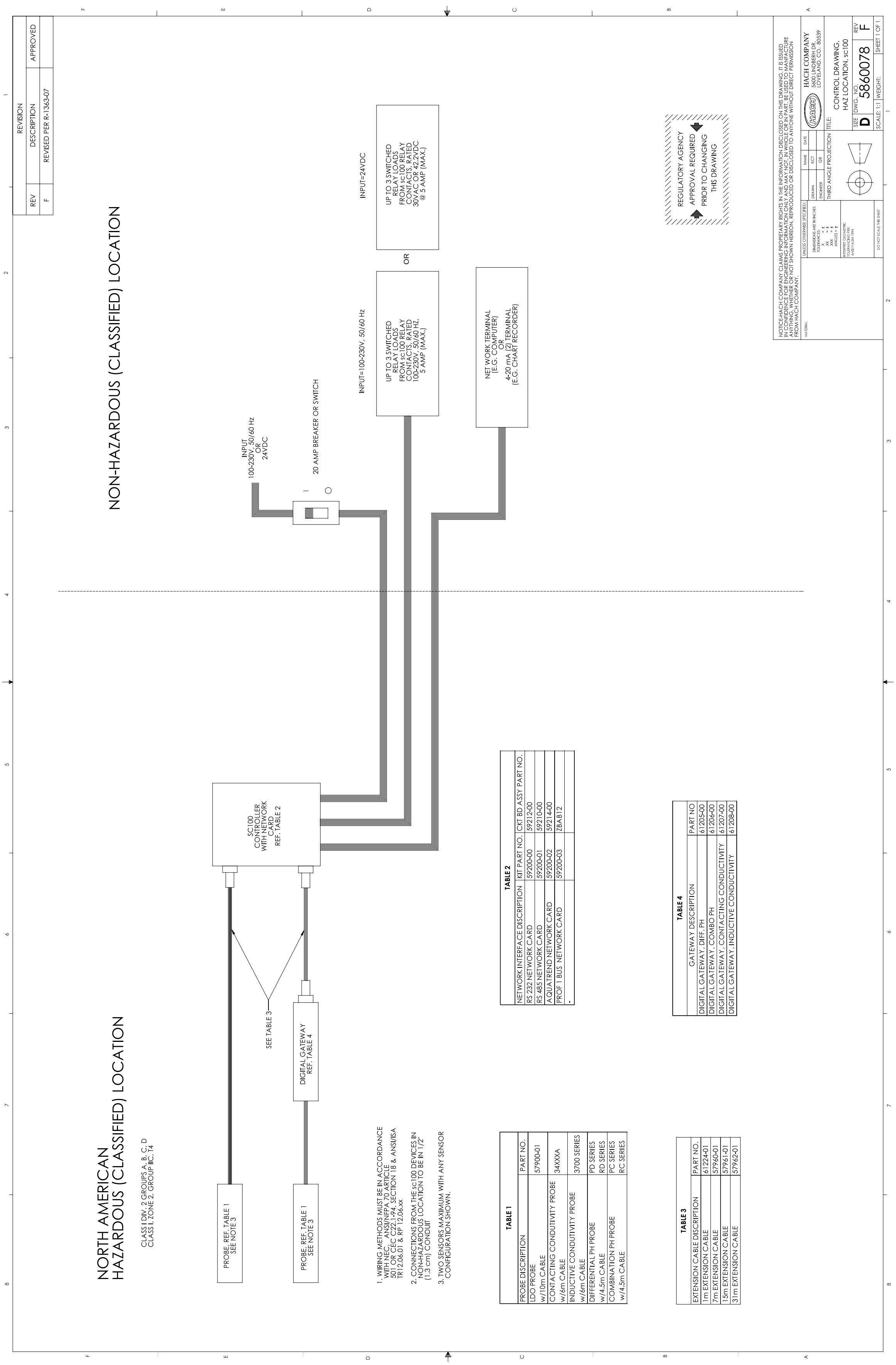


1. Controller	**6.** Lock washer, ¼-inch I.D. (4), Cat. No. 8H1336
2. Mounting foot for panel mounting (2), Cat. No. 1000B4F3222	**7.** Flat washer, ¼-inch I.D. (4), Cat. No. 8H1346
3. Bracket for panel & pipe mounting, Cat. No. 1000C4F3217-101	**8.** Pan head screws (4), M6 x 1.0 x 20 mm, Cat. No. 5867400
4. Gasket for panel mounting, Neoprene, Cat. No. 1000A4F3249-101	**9.** Pan head screws (4), M6 x 1.0 x 100 mm, Cat. No. 5867500
5. Hex nut, M6 (4), Cat. No. 5867300	**10.** Pan head screws (4), M6 x 1.0 x 150 mm, Cat. No. 5867600

Table 1 Customer-supplied Items

Item
14-AWG wire for electrical power connections in conduit or 115 or 230 V ac power cord plus a NEMA 4X-rated strain relief
High-quality, shielded instrumentation cable for connecting the analog outputs plus a NEMA 4X-rated strain relief.
Mounting hardware for the sensor (available from the manufacturer, order separately). See the sensor manual.
Sun shield for mounting configurations where the sun strikes the front of the display.
Common hand tools

Figure 2 Hazardous Location Installation Control Drawing



3.1 Mechanical Installation

Install in an environment that is protected from corrosive fluids.

3.1.1 Controller Dimension Illustrations

Figure 3 Controller Dimensions

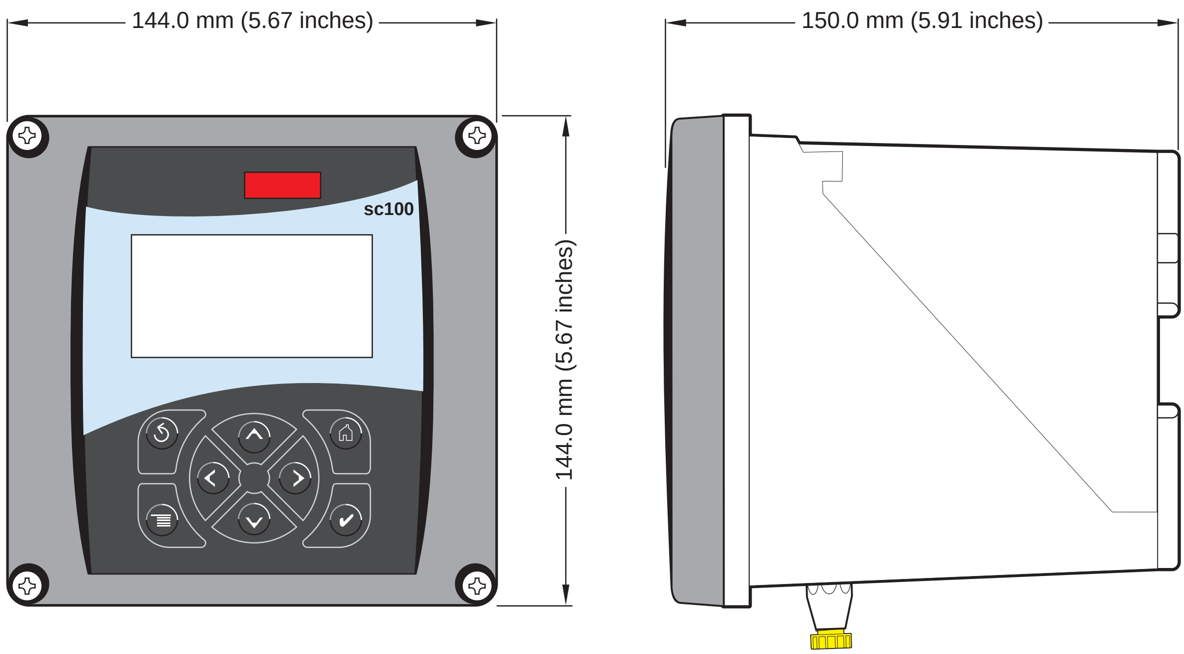


Figure 4 Controller Mounting Dimensions

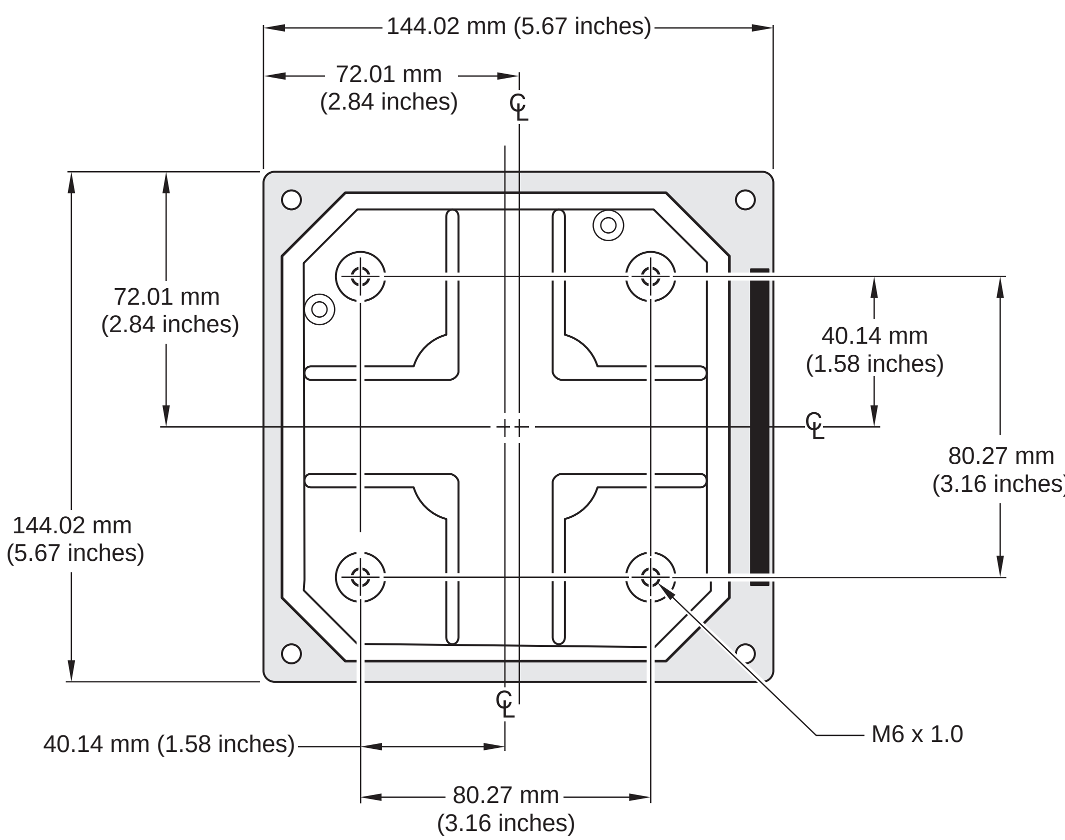


Figure 5 Panel Mount Cut-out Dimensions

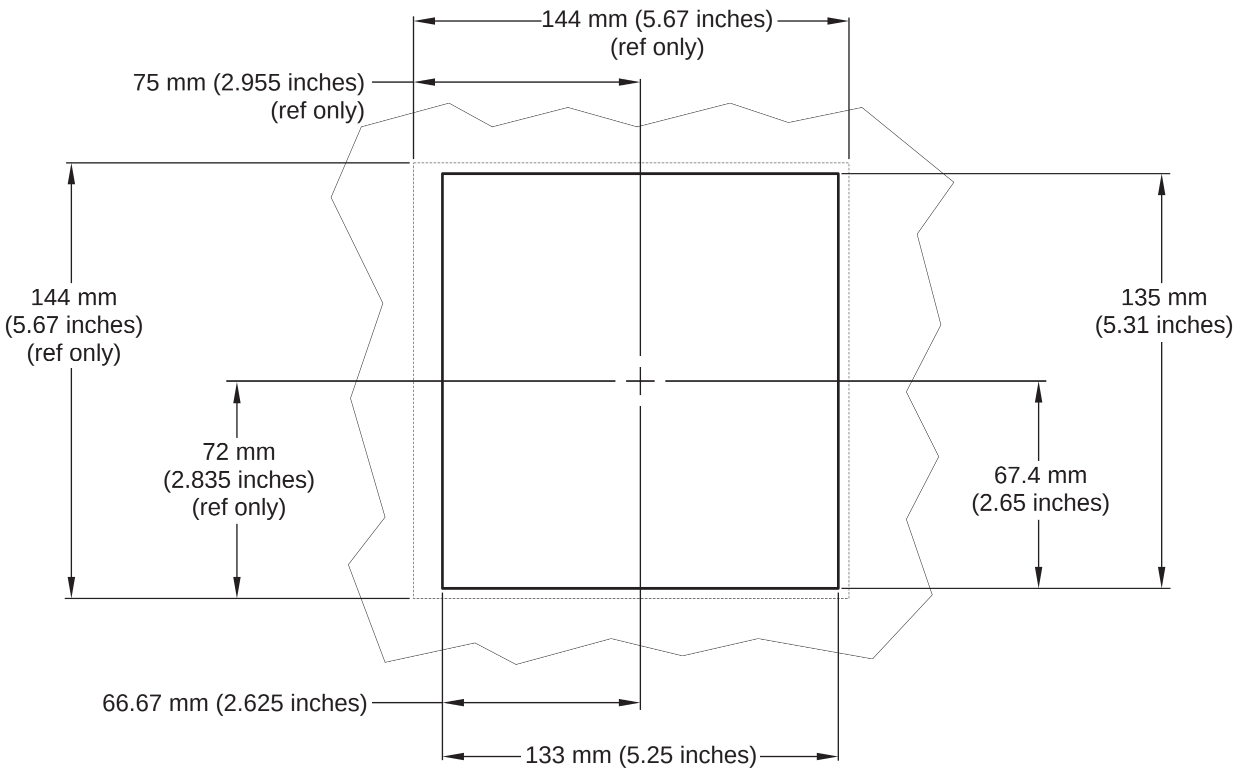
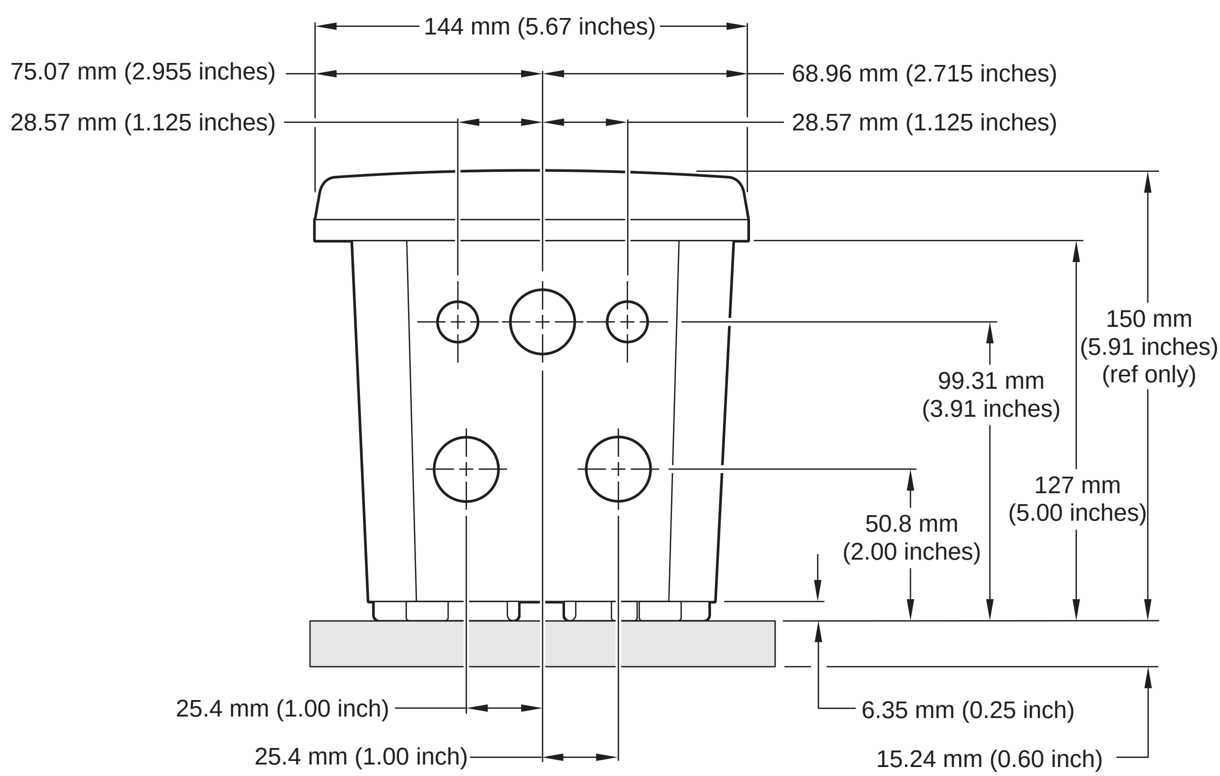


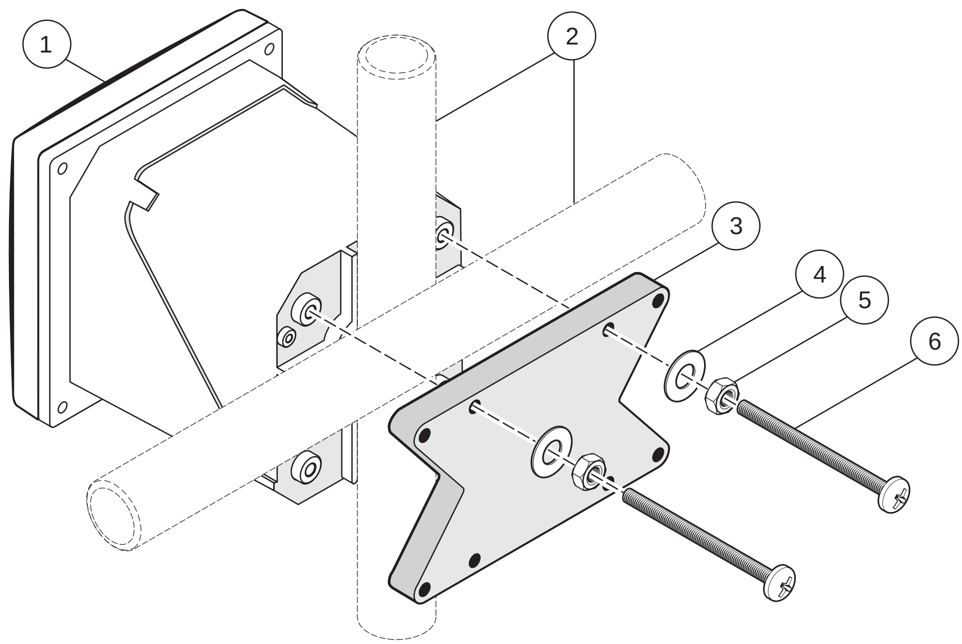
Figure 6 Conduit Hole Dimensions



3.1.2 Mounting the Controller

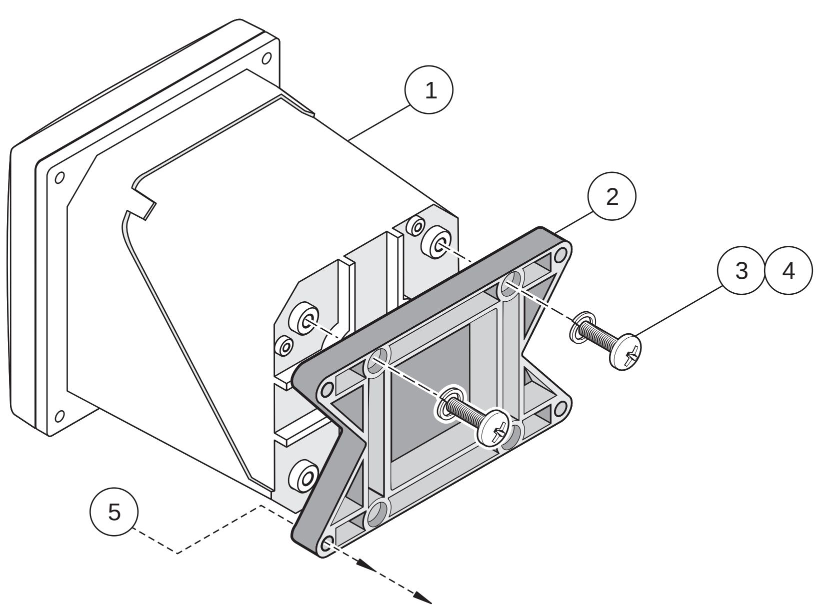
Attach the controller to a rail or wall or mount it in a panel. Supplied mounting hardware is shown in Figure 7, Figure 8, and Figure 9.

Figure 7 Vertical or Horizontal Pipe Mounting the Controller



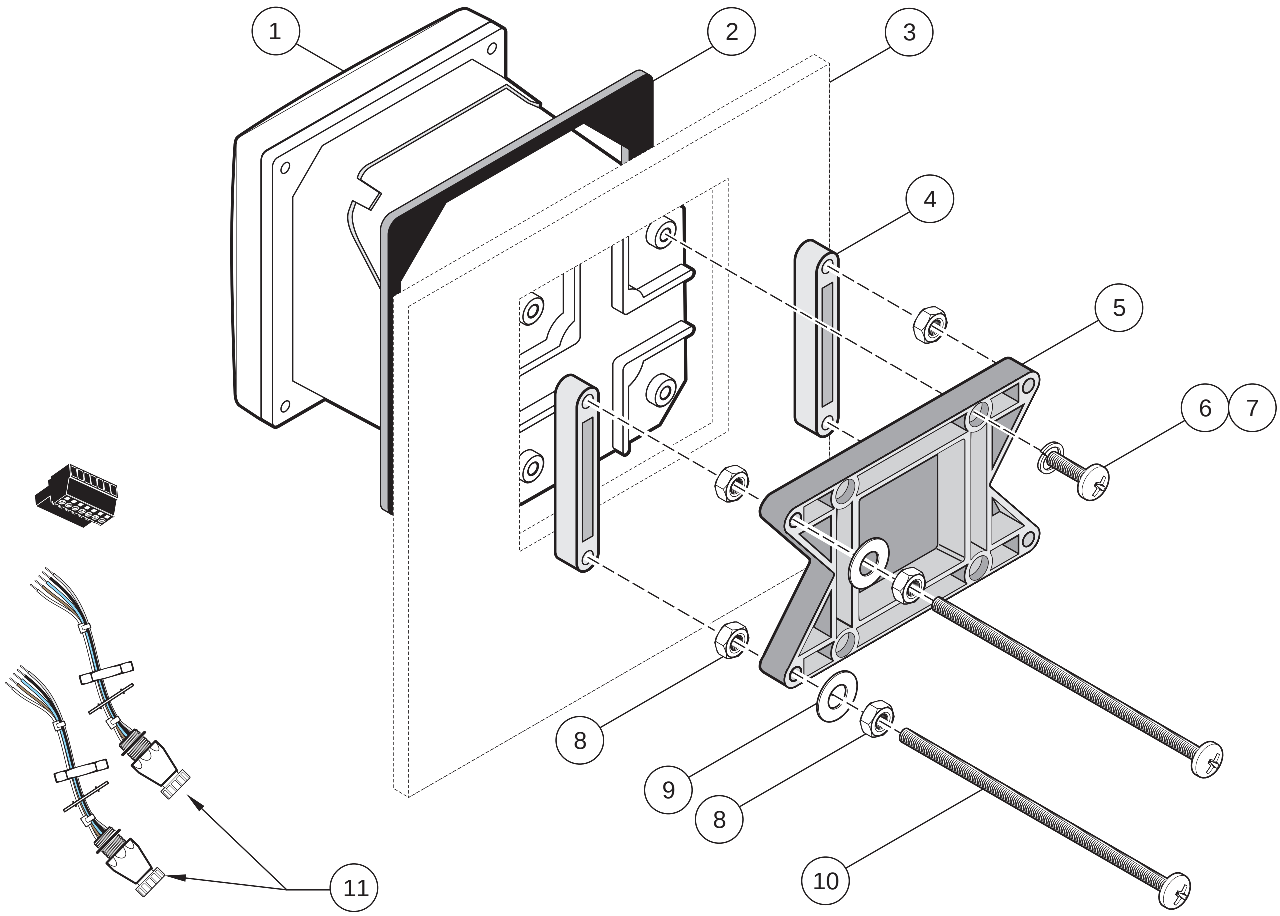
1.	Controller	**4.**	Flat washer, ¼-inch I.D. (4), Cat. No. 8H1346
2.	Pipe (vertical or horizontal)	**5.**	Hex nut, M6 (4), Cat. No. 5867300
3.	Bracket, pipe mounting, Cat. No. 1000C4F3217-101	**6.**	Pan head screw, M6 x 1.0 x 100 mm (4), Cat. No. 5867400

Figure 8 Wall Mounting the Controller



1.	Controller	**4.**	Pan head screw, M6 x 1.0 x 20 mm (4), Cat. No. 5867400
2.	Bracket, Cat. No. 1000C4F3217-101	**5.**	Customer-supplied hardware for wall mounting
3.	Lock washer, ¼-inch I.D., Cat. No. 8H1336		

Figure 9 Panel Mounting the Controller



1. Controller	**7.** Lock washer, ¼-inch I.D., (4) Cat. No. 8H1336
2. Gasket, Neoprene, panel mount, Cat. No. 1000A4F3249-101	**8.** Hex nut (4), Cat. No. 5867300
3. Panel (maximum thickness is 9.5 mm (3/8 inch))	**9.** Flat washer (4), Cat. No. 8H1346
4. Mounting Foot (2), Cat. No. 1000B4F3222	**10.** Pan head screw, M6 x 1.0 x 150 mm (4), Cat. No. 5867600
5. Mounting bracket, controller, Cat. No. 1000C4F3217-101	**11.** It may be necessary to remove the sensor connectors. see procedure below.
6. Pan head screw (4), Cat. No. 5867400	

To remove the sensor connectors before inserting the controller enclosure into the panel cut-out:

1. Disconnect the wires at terminal block J5, see Figure 19 on page 22.
2. Loosen and remove the nut securing the sensor connector inside the enclosure. Remove the sensor connector and wires. Repeat step 1 and 2 for the other sensor connector.
3. After the controller is in place in the panel, reinstall the sensor connectors and reconnect the wiring to terminal J5 as shown in Figure 19 on page 22.

3.2 Wiring Safety Information

When making any wiring connections to the sc100 Controller, the following warnings and must be adhered to, as well as, any warnings and notes found throughout the individual installation sections. For more safety information refer to Safety Information on page 5.

DANGER
Always disconnect power to the instrument when any making electrical connections.

3.2.1 Electrostatic Discharge (ESD) Considerations

Important Note: *To minimize hazards and ESD risks, maintenance procedures not requiring power to the analyzer should be performed with power removed.*

Delicate internal electronic components can be damaged by static electricity, resulting in degraded instrument performance or eventual failure.

The manufacturer recommends taking the following steps to prevent ESD damage to your instrument:

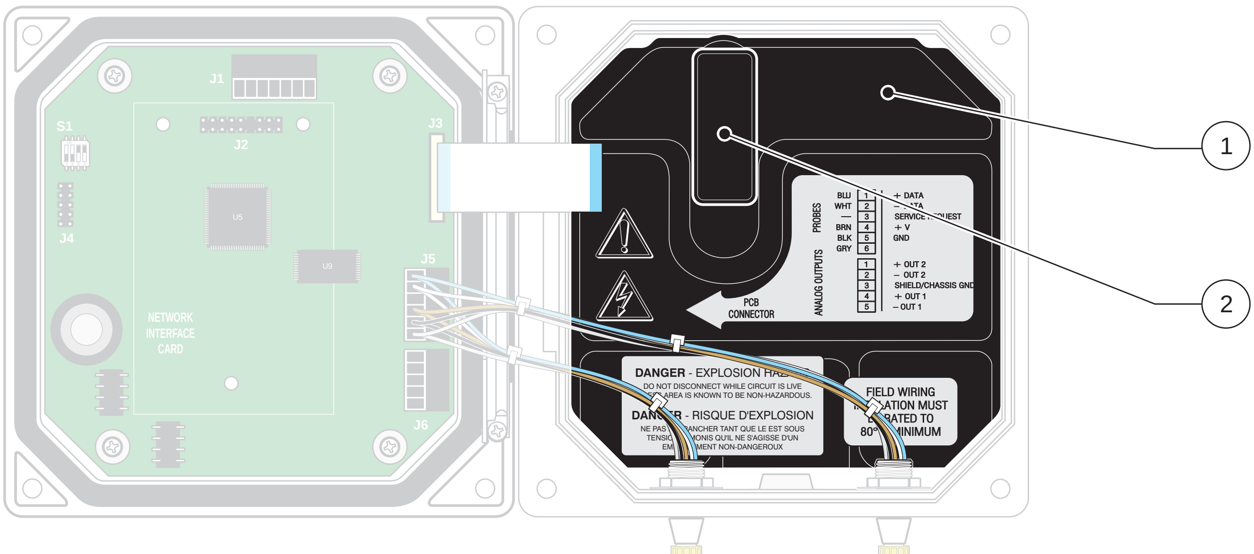
- Before touching any instrument electronic components (such as printed circuit cards and the components on them) discharge static electricity from your body. This can be accomplished by touching an earth-grounded metal surface such as the chassis of an instrument, or a metal conduit or pipe.
- To reduce static build-up, avoid excessive movement. Transport static-sensitive components in anti-static containers or packaging.
- To discharge static electricity from your body and keep it discharged, wear a wrist strap connected by a wire to earth ground.
- Handle all static-sensitive components in a static-safe area. If possible, use anti-static floor pads and work bench pads.

3.3 Electrical Installation

DANGER
This equipment is suitable for use in non-hazardous locations or Class 1, Division 2, Groups A, B, C, D Hazardous Locations with specified sensors and options when installed per the Hazardous Location Installation Control Drawing on page 8. Always refer to the Control Drawing and applicable electrical code regulations for proper installation instructions.

High-voltage wiring for the controller is conducted behind the high voltage barrier in the controller enclosure. The barrier must remain in place unless a qualified installation technician is installing wiring for power, alarms, or relays. See Figure 10 for barrier removal information.

Figure 10 Removing Voltage Barrier



1. High voltage barrier	**2.** Unsnap the barrier latch then pull out to remove the barrier.

3.3.1 Installation in Conduit

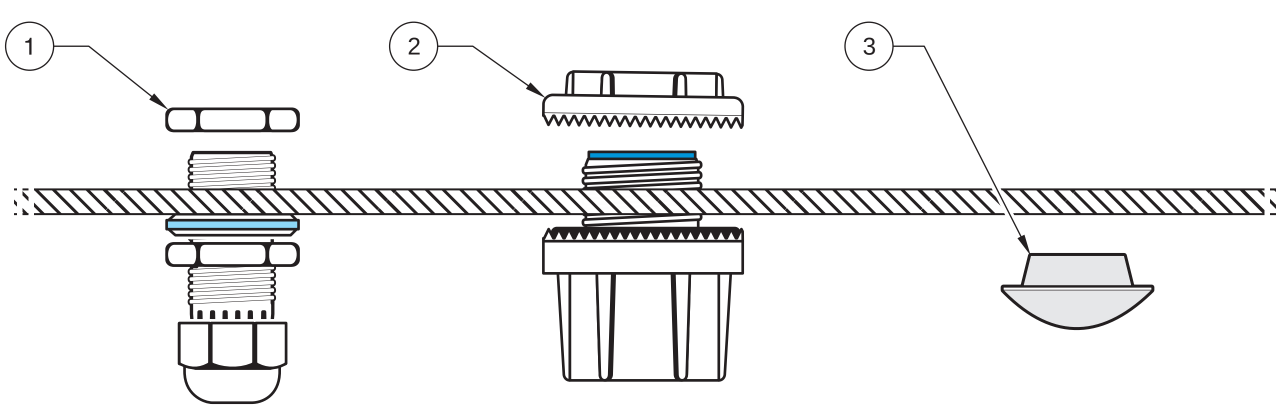
In hard-wired electrical applications, the power and safety ground service drops for the instrument must be 18 to 12 AWG. See Figure 11 on page 14 for strain relief and conduit opening sealing plug information. See section 3.3.3 on page 15 for wiring information.

3.3.2 Installation Using a Power Cord

DANGER
Use of a power cord is not acceptable in Class 1, Division 2 Hazardous Location Installation (see Hazardous Location Installation Control Drawing on page 8).

A sealing-type strain relief to maintain the NEMA 4X/IP66 environmental rating and a power cord less than 3 meters (10 feet) in length with three 18-gauge conductors (including a safety ground wire) can be used, see Replacement Parts and Accessories on page 41. See Figure 11 on page 14 for strain relief and conduit opening sealing plug assembly. See section 3.3.3 on page 15 for wiring information.

Figure 11 Using the Optional Strain Relief and Conduit Plug



1. Power cord strain relief	**2.** Conduit strain relief	**3.** Conduit opening sealing plug

3.3.3 Wiring for Power at the Controller

DANGER
Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been switched off or the area is known to be non-hazardous.

DANGER
Do not connect AC power to a sc100 24 VDC powered model.

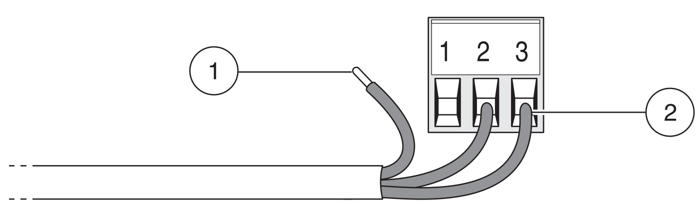
The sc100 can be purchased as either an 100–230 VAC powered model or a 24 VDC powered model. Follow the appropriate wiring instructions per the purchased model.

Important Note: *A protective earth (PE) ground connection is required by the sc100 for* ***both*** *100–230 VAC and 24 VDC wiring applications. Failure to connect a good PE ground connection can result in shock hazards and poor performance due to electromagnetic interferences. ALWAYS connect a good PE ground to the sc100 terminal.*

The controller can be wired for line power by hard-wiring in conduit or wiring to a power cord. Regardless of the wire used, the connections are made at the same terminals. A local disconnect designed to meet local electrical code is required and must be identified for all types of installation. See Figure 14 and Figure 15 on page 17 for suggested local disconnect configurations.

1. Obtain appropriate fittings with NEMA 4X/IP66 environmental rating.
2. Loosen the screws using a phillips-head screwdriver and open the hinged controller cover.
3. Remove the high-voltage barrier (see Figure 10 on page 14).
4. Insert the wires through the strain relief fitting or conduit hub located in the right-rear access hole in the bottom of the enclosure. Tighten the strain relief if used, to secure the cord.
5. Properly prepare each wire (Figure 12) and insert each wire into the terminal according to Table 2 or Table 3. Tug gently after each insertion to ensure the connection is secure.
6. Seal any unused openings in the controller box with conduit opening sealing plugs.
7. Reinstall the high-voltage barrier and latch to secure.

Figure 12 Proper Wire Preparation and Insertion



1. Strip ¼-inch of insulation.	**2.** Seat insulation against connector with no bare wire exposed.

Table 2 AC Power Wiring Information (sc100 AC powered model only)

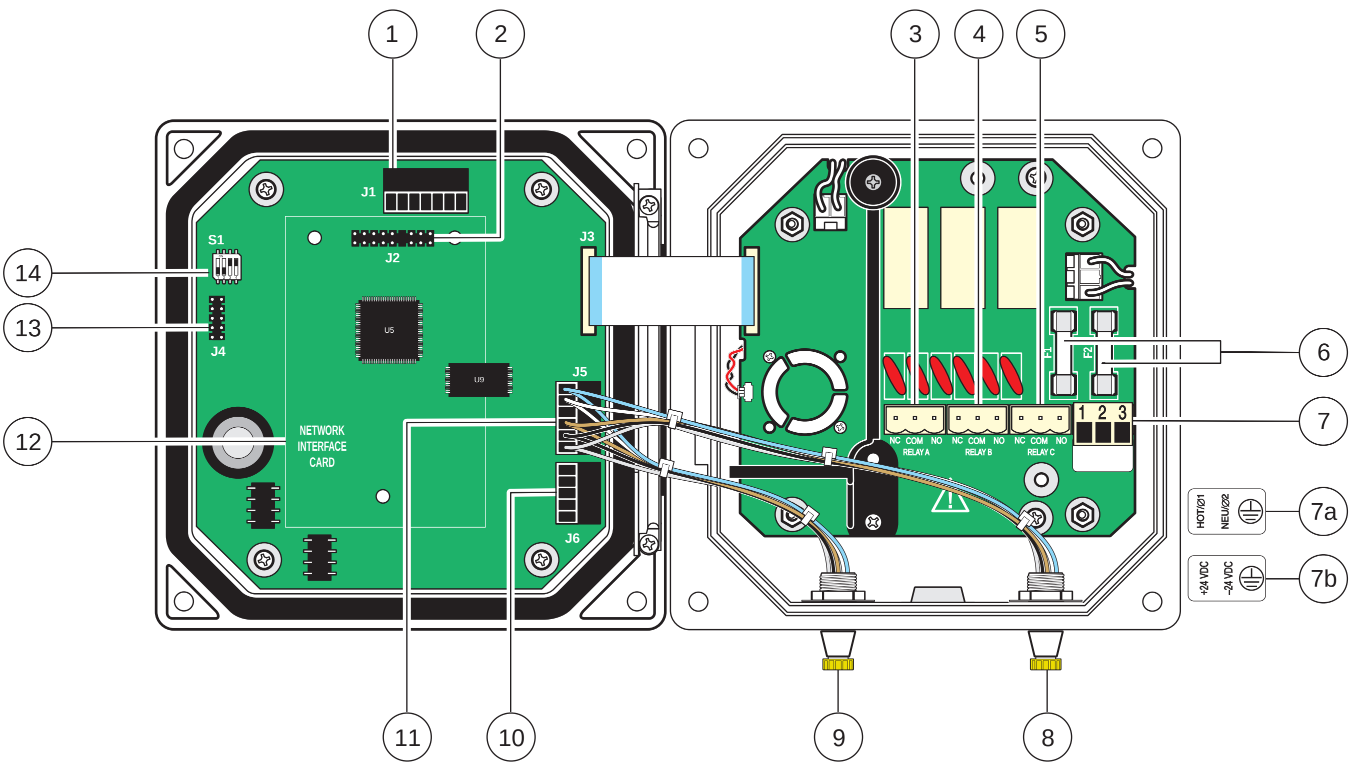
Terminal Number	Terminal Description	Wire Color Code for North America	Wire Color Code for Europe
1	Hot (L1)	Black	Brown
2	Neutral (N)	White	Blue
3	Protective Earth (PE)	Green	Green w/yellow tracer

Table 3 DC Power Wiring Information (sc100 24 VDC powered model only)

Terminal Number	Terminal Description	Wire Color Code for North America	Wire Color for Europe
1	+24 V dc	Red	Red
2	24 V dc return	Black	Black
3	Protective Earth (PE)	Green	Green w/yellow tracer

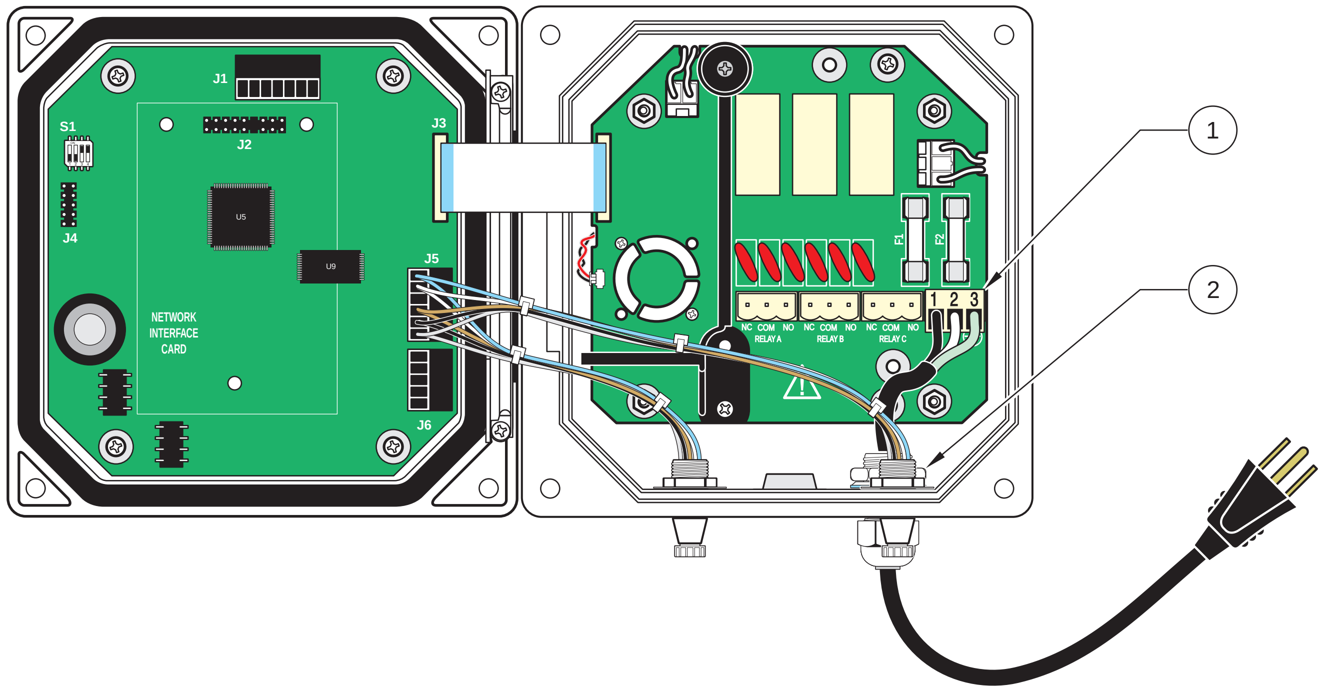
The DC power source that supplies power to the 24 VDC powered sc100 must maintain voltage regulation within the specified 24 VDC –15% +20% voltage limits. The DC power source must also provide adequate protection against surges and line transients.

Figure 13 sc100 Wiring Connections



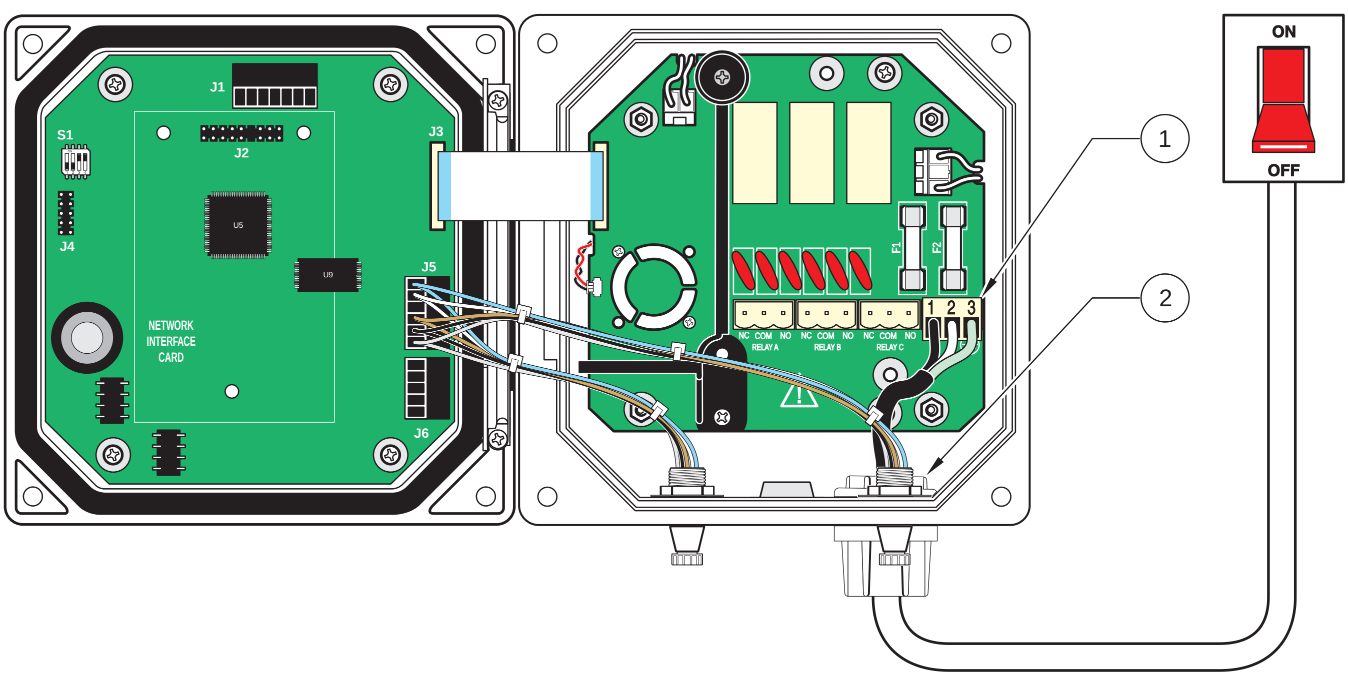
1. J1—Network connector	**8.** Sensor connector
2. J2—Header for optional network interface card	**9.** Sensor connector
3. J5—Relay A connector	**10.** J6—Analog output (4–20 mA) connector
4. J6—Relay B connector	**11.** J5—Sensor connector for hard-wiring
5. J7—Relay C connector	**12.** Position for network interface card
6. Fuses (F1, F2)	**13.** Service port
7. J8—Power connections	**14.** Sensor terminator selector/service port configuration
a. AC Power connection (AC powered sc100 model only)	
b. DC Power connection (24 VDC sc100 model only)	

Figure 14 Local Disconnect for Power Cord



1. Power terminal	**2.** Power cord strain relief

Figure 15 Local Disconnect for Hard-wired Line Power



1. Power terminal	**2.** Conduit strain relief

3.4 Alarms and Relays

DANGER
Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been switched off or the area is known to be non-hazardous.

DANGER
For Class 1, Division 2 Hazardous Location installations, refer to the Control Drawing (Figure 2 on page 8) for permanent connection requirements for the alarm relays.

DANGER
Exposure to some chemicals may degrade the sealing properties of materials used in the following devices: Relays K1, K2, and K3. Periodic inspection of these devices is recommended to check for degradation.

The controller is equipped with three unpowered relays rated 100–230 VAC, 50/60 Hz, 5 amp resistive maximum. See the sensor manual for relay setup details.

3.4.1 Connecting the Relays

DANGER
Relay loads must be resistive. User must externally limit current to the relays to 5 Amps by use of a fuse or breaker.

DANGER
Power and relay terminals are designed for only single wire termination. Do not use more than one wire in each terminal.

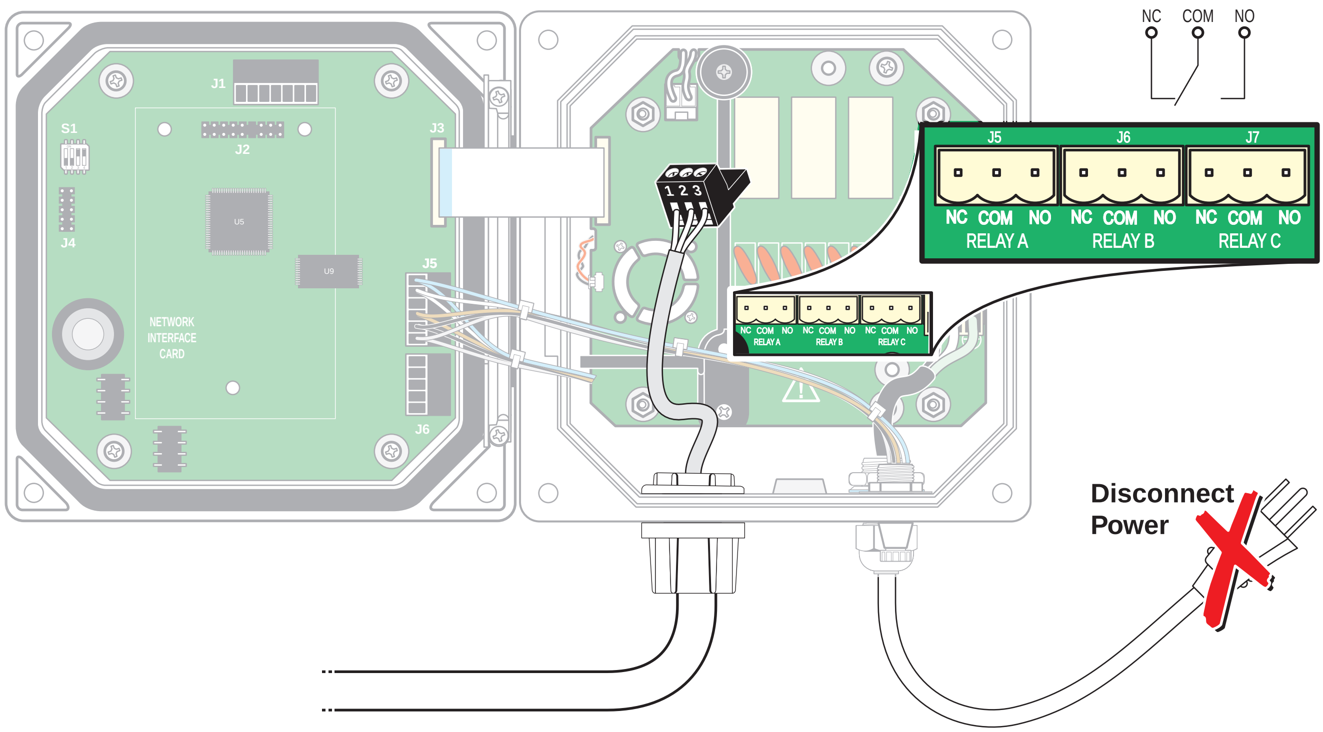
The relay connector accepts 18–12 AWG wire (as determined by load application). Wire gauge less than 18 AWG is not recommended.

The Normally Open (NO) and Common (COM) relay contacts will be connected when an alarm or other condition is active. The Normally Closed (NC) and Common relay contacts will be connected when an alarm or other condition is inactive or when power is removed from the controller.

AC Line (100–230 V) Powered sc100's
AC line powered sc100 controllers contain three relays designed for connection to AC MAINS circuits (i.e., voltages greater than 30V-RMS, 42.2V-PEAK or 60 V dc). Refer to Figure 16 for connection information. The relay wiring compartment is not designed for voltage connections below these levels. Relays must not be powered from the same wiring used to power the controller.

24 VDC Powered sc100
The 24 VDC sc100 controller contains three relays designed for connection to LOW voltage circuits (i.e., voltages less than 30V-RMS, 42.2V-PEAK or 60 V dc). Refer to Figure 16 for connection information. The wiring compartment is not designed for voltage connections above these levels. Relay must not be powered from the same wiring used to power the controller.

Figure 16 Alarm and Relay Connections



3.4.2 Connecting the Analog Outputs

DANGER
Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been switched off or the area is known to be non-hazardous.

DANGER
For Class 1, Division 2 Hazardous Location installations, refer to the Control Drawing (Figure 2 on page 8) for permanent connection requirements for the analog output.

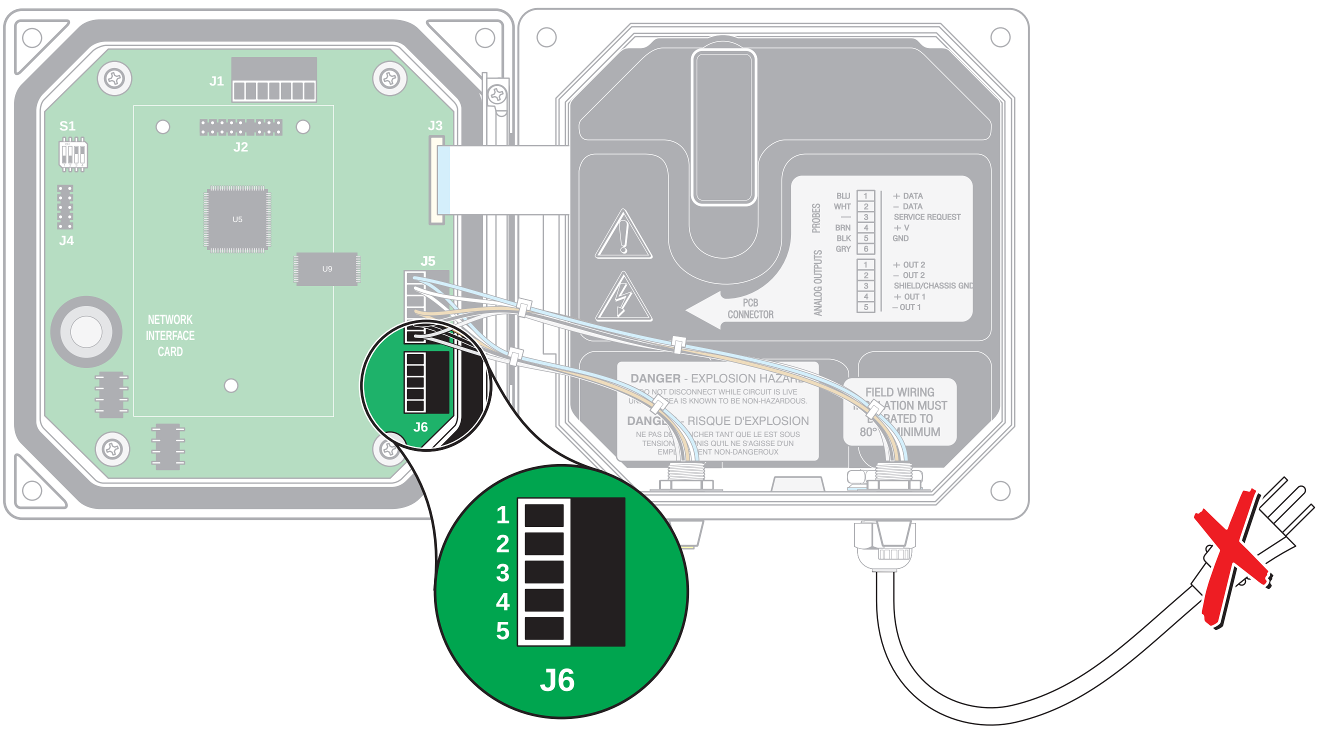
Two isolated analog outputs (1 and 2) are provided, see Figure 17. Each output can be set to 0–20 or 4–20 mA, and can be assigned to represent the measured parameter or secondary measurement such as temperature. Make connections with twisted-pair shielded wire and connect the shield at the controlled component end or at the control loop end. **Do not connect the shield at both ends of the cable.** Use of non-shielded cable may result in radio frequency emission or susceptibility levels higher than allowed. Maximum loop resistance is 500 ohm. Refer to the sensor manual for output software setup.

Make wiring connections at the analyzer end as shown in Table 4 and Figure 17.

Table 4 Output Connections at Terminal Block J6

Recorder Wires	Circuit Board Position
Output 2 +	1
Output 2 –	2
Shield	3
Output 1 +	4
Output 1 –	5

Figure 17 Analog Output Connections



3.5 Connecting/Wiring the sc Sensor

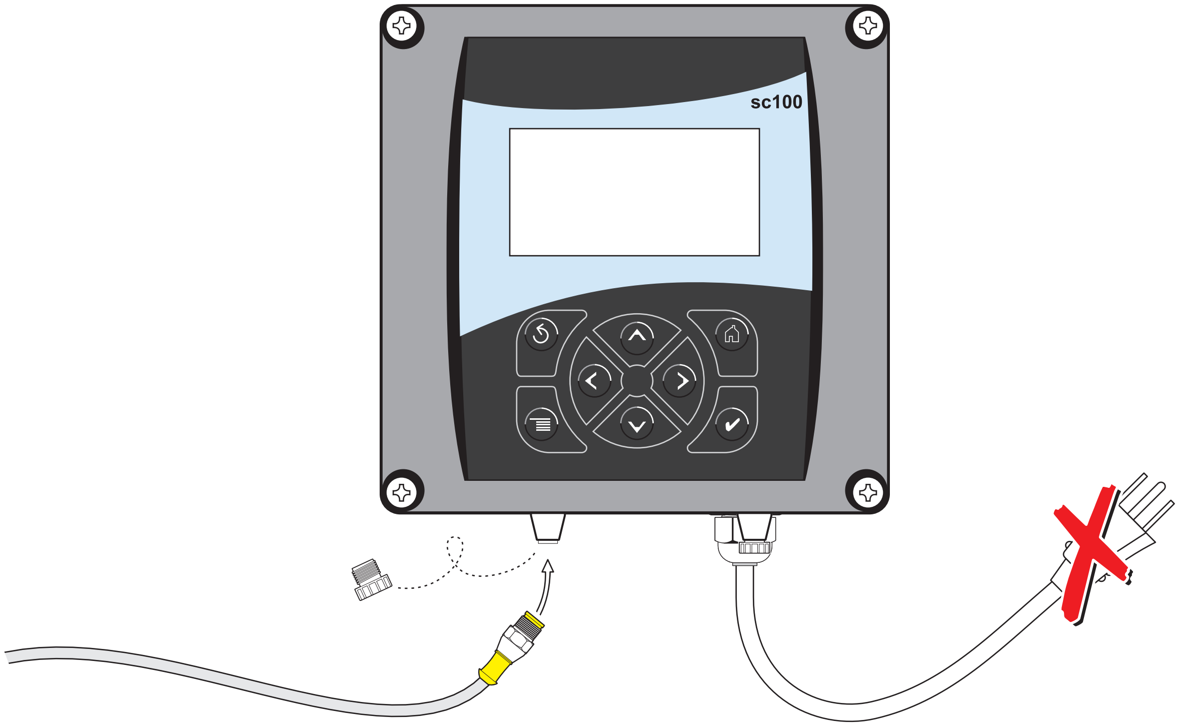
DANGER
For Class 1, Division 2 Hazardous Location installations, refer to the Control Drawing (Figure 2 on page 8) for sensor and optional equipment connection requirements.

3.5.1 Connecting the sc Sensor in a Non-hazardous Location

3.5.1.1 Attaching a sc Sensor with a Quick-connect Fitting

The sensor cable is supplied with a keyed quick-connect fitting for easy attachment to the controller, see Figure 18. Retain the connector cap to seal the connector opening in case the sensor must be removed. Optional extension cables may be purchased to extend the sensor cable length. If the total cable length exceeds 100 m (300 ft), a termination box must be installed. When used with the termination box, the maximum cable length is 1000 m (3000 ft). See the Replacement Parts section in the sensor manual for part number information.

Figure 18 Attaching the Sensor using the Quick-connect Fitting



3.5.1.2 Hard-wiring a sc Sensor to the Controller

1. Open the controller cover.
2. Disconnect and remove the existing wires between the quick connect and terminal block J5, see Figure 19.
3. Remove the quick connect fitting and wires and install the threaded plug on the opening to maintain the environmental rating.
4. Strip the insulation on the cable back 1-inch. Strip ¼-inch of each individual wire end.
5. Pass the cable through conduit and a conduit hub or a strain relief fitting and an available access hole in the controller enclosure. Tighten the fitting.
6. Wire as shown in Table 5.
7. Close and secure the cover.

Figure 19 Hard-wiring the sensor

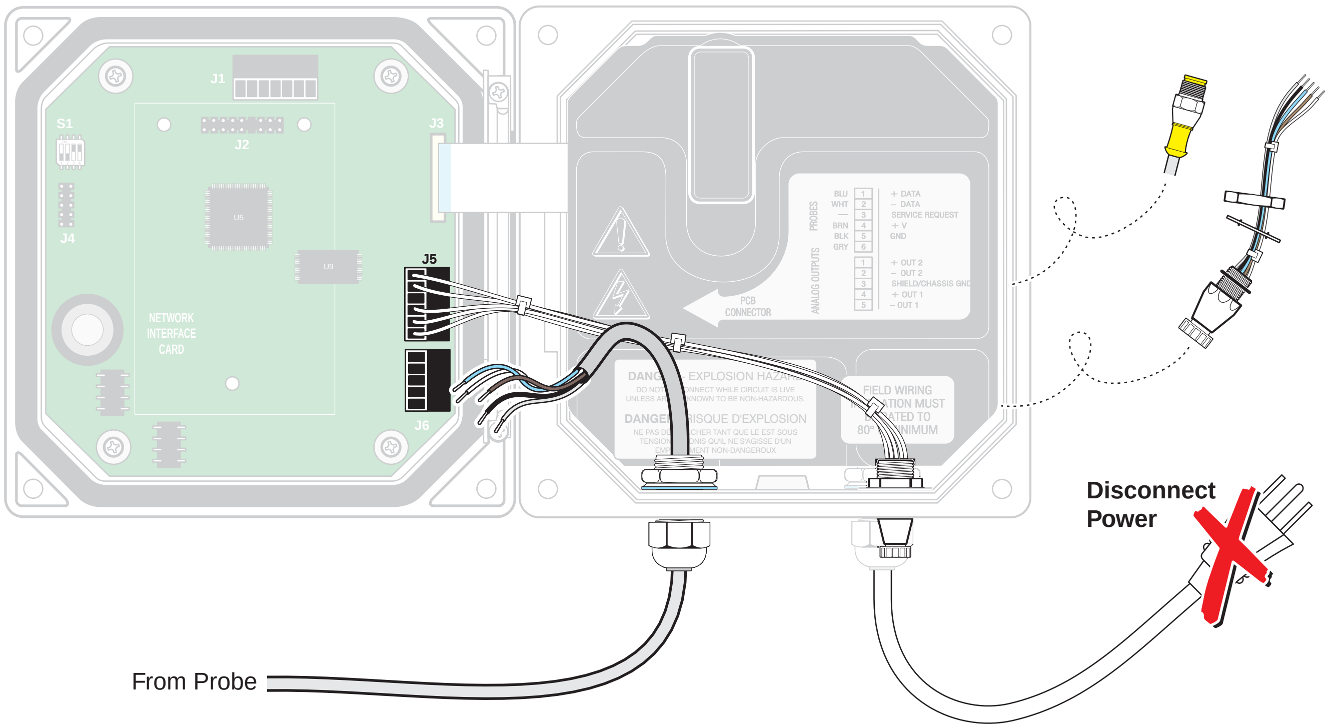


Table 5 Wiring the Sensor at Terminal Block J5

Terminal Number	Terminal Designation	Wire Color
1	Data (+)	Blue
2	Data (–)	White
3	Service Request	No Connection
4	+12 V dc	Brown
5	Circuit Common	Black
6	Shield	Shield (grey wire in existing quick disconnect fitting)

3.5.2 Connecting the sc Sensor to a Controller in a Hazardous Location

DANGER
For Class 1, Division 2 Hazardous Location installations, refer to the Control Drawing (Figure 2 on page 8) for sensor and optional equipment connection requirements.

DANGER
Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been switched off or the area is known to be non-hazardous.

3.5.2.1 Attaching a sc Sensor with a Quick-connect FItting in a Hazardous Location

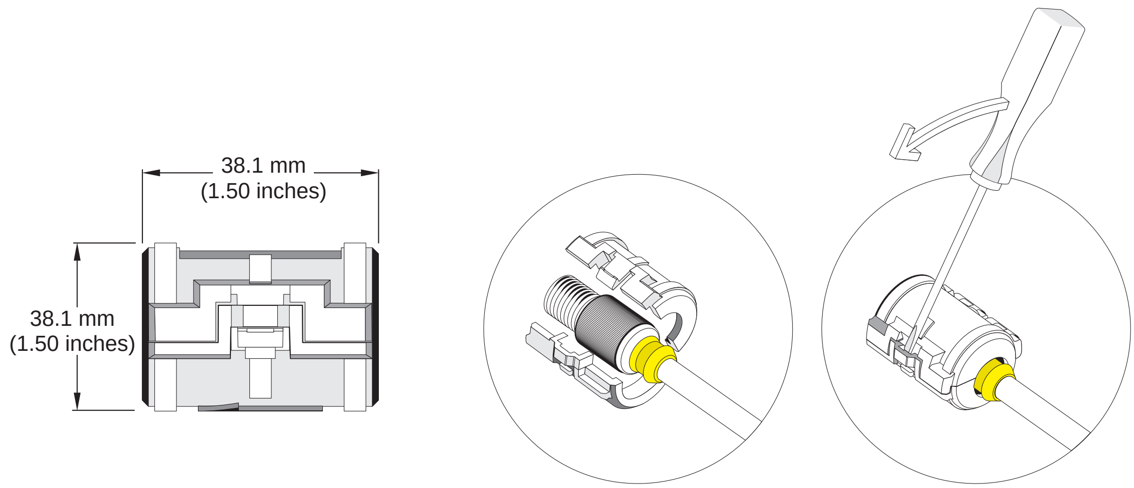
The sensor cable is supplied with a keyed quick-connect fitting for easy attachment to the controller, see Figure 18. For hazardous locations, a connector safety lock **must** be installed. Retain the connector cap to seal the connector opening in case the sensor must be removed. Optional extension cables may be purchased to extend the sensor cable length (up to a maximum length of 1000 m (3000 ft).

1. Remove the connector cap from sc100 controller. Retain the connector cap to seal the connector opening in case the sensor must be removed.

2. Connect the sensor connector to the plug on the sc100.

3. Install a connector safety lock (Figure 20). Align the lock over the connector and squeeze the two halves together to lock. To remove the connector safety lock by inserting a small flat-bladed screwdriver into the locking groove. Pivot the screwdriver away from the groove and separate the two halves (Figure 20).

Figure 20 Installing the Connector Safety Lock



3.6 Wiring the Digital Gateway

DANGER
For Class 1, Division 2 Hazardous Location installations, refer to the Control Drawing (Figure 2 on page 8) for sensor and optional equipment connection requirements.

The digital gateway is designed to provide a digital interface to the sc100 controller (or other appropriate digital controller). The non-sensor end is connected to the controller as described in section 3.5.1 on page 20 for non-hazardous locations and section 3.5.2 on page 22 for hazardous locations.

3.7 Connecting the Optional Digital Output

DANGER
Explosion hazard. Do not connect or disconnect electrical components or circuits to the equipment unless power has been switched off or the area is known to be non-hazardous.

DANGER
For Class 1, Division 2 Hazardous Location installations refer to the Control Drawing (Figure 2 on page 8) for permanent connection requirements for the Digital Outputs. Installation of communication protocols other than those specified in the Control Drawing are not allowed for Class 1, Division 2 Hazardous Locations.

At this time, the manufacturer supports Modbus RS485, Modbus RS232, and Profibus DP communication protocols. The optional digital output card is installed in the location indicated in Figure 22 on page 25. Terminal block J1 provides user connection to the optional network card. The terminal connection is based on the selected network card. Refer to the instructions supplied with the network card for more details.

Note: *The sc100/1720E system also supports the AquaTrend Network.*

Surge Protection Recommendation for Profibus DP

Many industrial environments are vulnerable to power transients and lightning. Water and wastewater plants are frequent targets of lightning. Lightning generated fields and power surges can cause instrument failures at these facilities. Surge protectors limit the magnitude of over-voltage transients and protect equipment from damage. To be effective on Data lines, at a minimum, a surge protector should provide two stages of protection with sub-nanosecond response time. Data line surge protection should be installed on a Profibus DP network where it might be susceptible to lightning or transients. The purpose of the surge protector is to protect the equipment that it is located next to, not the network cable.

For the best performance/protection connect the surge protector as close as possible to the device to be protected and connect the device (instrument) ground connection through the surge protector's ground to the local protective earth ground. Contact your local Profibus network component supplier for their recommendation as to which surge protectors may be best for your system.

Table 6 Digital Output Terminal Assignments

Terminal Number	AquaTrend Network[1]	Modbus RS485 2-wire	Modbus RS485 4-wire	Modbus RS232	Profibus DP
1	Network A	D+	RD+	Rx	A1– (out)
2	Network B	D–	RD–	No connection	B1+ (out)
3	Network A	No connection	TD+	Tx	A2– (in)
4	Network B	No connection	TD–	No connection	B2+ (in)
5	No connection	Common	Common	Common	Common
6	No connection	No connection	No connection	No connection	No connection
7	Shield	Shield	Shield	Shield	Shield

[1] The AquaTrend Network only applies to sc100/1720E systems

Figure 21 RS232 Connection to Customer-supplied Computer 9-pin D Subminiature Connector

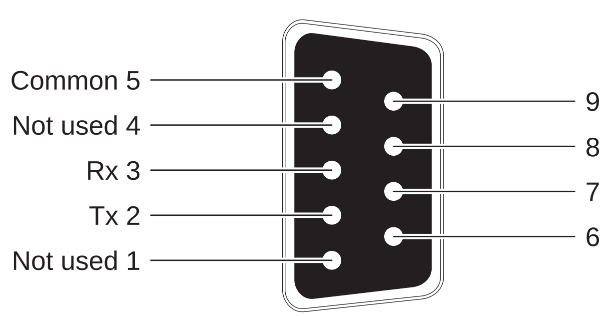
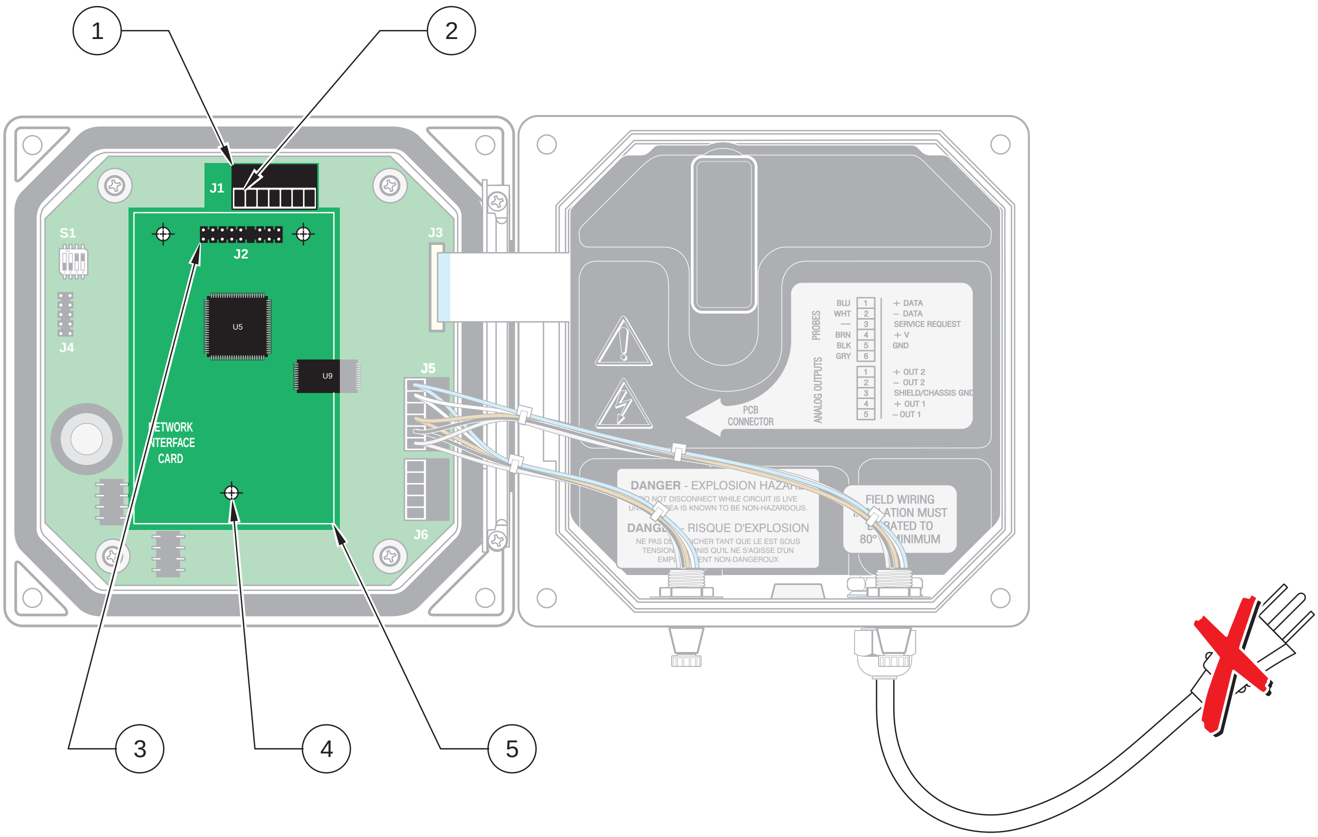


Figure 22 Network Card Position in the Controller

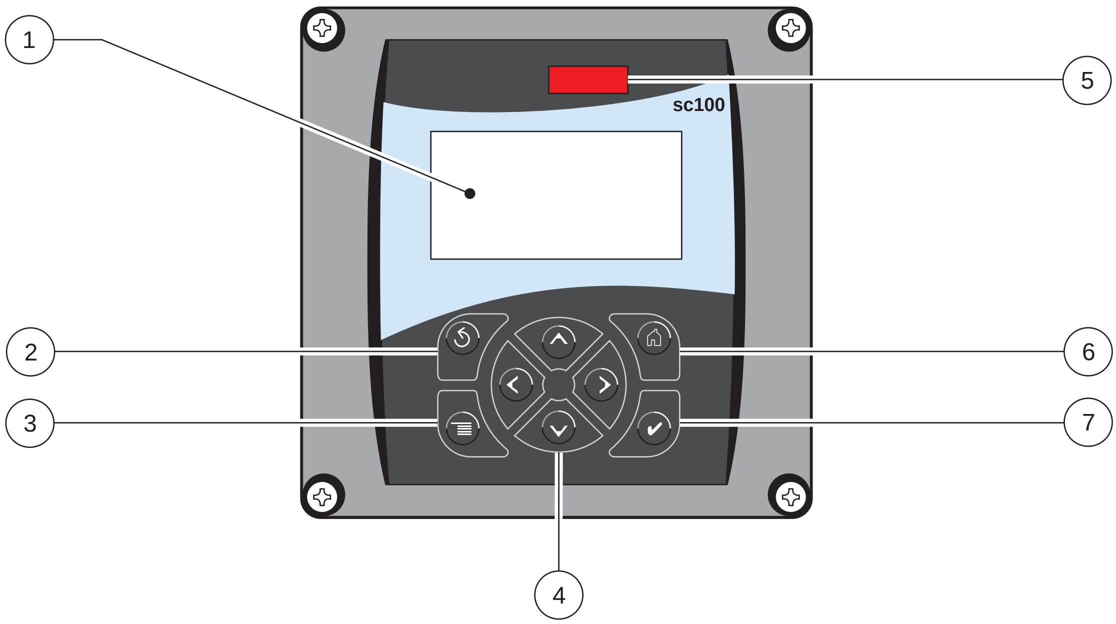


1.	J2—Network card header	**4.**	Mounting hole (3)
2.	J2 Pin 1	**5.**	Network card placement
3.	J1 Terminal		

4.1 Using the Keypad

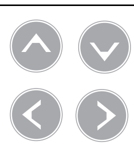
The front of the controller is shown in Figure 23. The keypad consists of the eight keys described in Table 7.

Figure 23 Front of the Controller



1. Instrument display	**5.** IrDA Port
2. **BACK** key	**6.** **HOME** key
3. **MENU** key	**7.** **ENTER** key
4. **RIGHT**, **LEFT**, **UP**, and **DOWN** keys	

Table 7 Controller Key Functions/Features

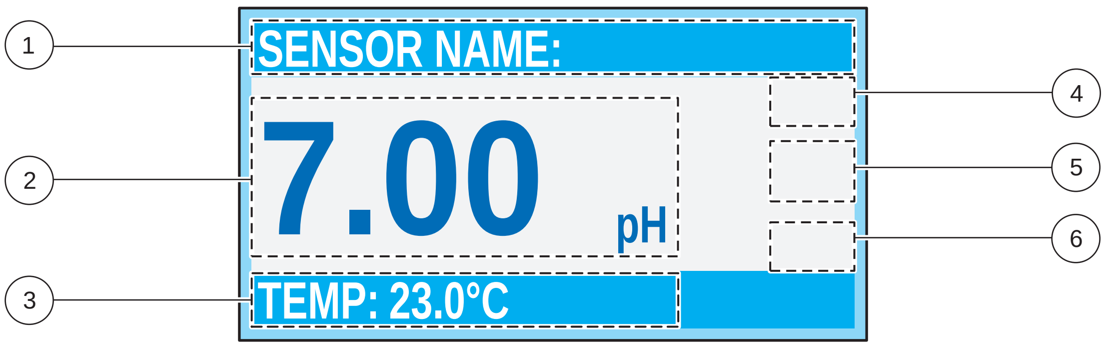
Number	Key	Function
2		Moves back one level in the menu structure.
3		Moves to the main menu from other menus. This key is not active in menus where a selection or other input must be made.
4		Navigates through the menus, changes settings, and increments and decrements digits.
6		Moves to the Main Measurement screen from any other screen. This key is not active in menus where a selection or other input must be made.
7		Accepts an input value, updates, or accepts displayed menu options.

4.2 Controller Display Features

When a sensor is connected and the controller is in measurement mode, the controller automatically identifies the connected sensors and displays associated measurements.

The display will flash on startup, when a sensor error has occurred, when the hold outputs function has been activated, and when a sensor is being calibrated. An active system warning will cause the warning icon (a triangle with an exclamation point inside) to be displayed on the right side of the display. See Figure 24.

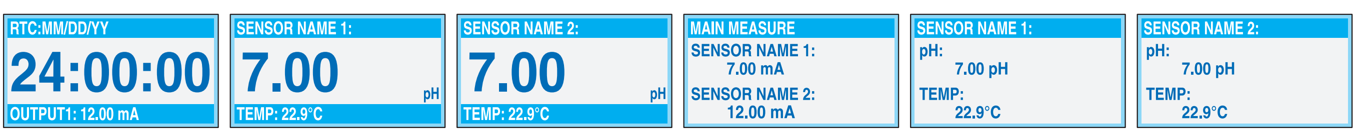
Figure 24 Display Example



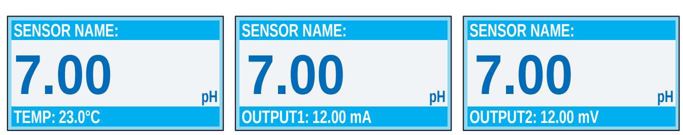
1. Status bar. Indicates the sensor name and status of relays. The relay letter is displayed when the relay is energized.	**4.** Parameter
2. Main measurement	**5.** Warning icon area
3. Secondary measurement (if applicable)	**6.** Measurement units

4.2.1 Important Key Presses

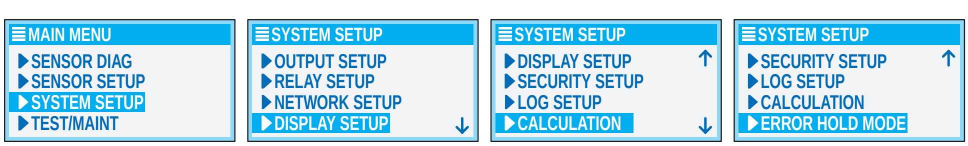
- Press **HOME** then **RIGHT** or **LEFT** to display two readings when two sensors are connected. Continue to press **RIGHT** or **LEFT** to toggle through the available display options:



- Press **UP** and **DOWN** to toggle the status bar at the bottom of the measurement display to display the secondary measurement (temperature) and output information.



- When in Menu mode, an arrow may appear on the right side of the display to indicate that more menus are available. Press **UP** or **DOWN** (corresponding to the arrow direction) to display additional menus.



4.2.2 Software Text Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
Adj	Adjust	P/F	Pass/Fail
Cal	Calibration	Pass	Password
Cont	Continue	Preped	Prepared
Dflt	Default	SN	Serial Number
Diag	Diagnostic	Std	Standard
Freq	Frequency	Temp	Temperature
Int	Internal	Vers	Version
Meas	Measurement	Xfer	Transfer

4.3 System Setup

4.3.1 Adjusting Display Contrast

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	↓	SYSTEM SETUP	enter
3	↓	DISPLAY SETUP	enter
4	—	ADJUST CONTRAST	enter
5	↑ ↓	(+0–50)	enter
6	menu home	Main Menu or Main Measurement Screen	—

4.3.2 Specifying the Displayed Language

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	↓	SYSTEM SETUP	enter
3	↓	DISPLAY SETUP	enter
4	↓	LANGUAGE	enter
5	↑ ↓	Select the language from displayed options.	enter
6	menu home	Main Menu or Main Measurement Screen	—

4.3.3 Setting the Time and Date

4.3.3.1 Setting the Time (24-hr format)

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	▼	SYSTEM SETUP	enter
3	▼	DISPLAY SETUP	enter
4	▼	SET DATE/TIME	enter
5	▼	Highlight TIME	enter
6	◄ ►	Select the character to edit.	enter
	▲ ▼	Scroll to appropriate number.	
7	menu home	Main Menu or Main Measurement Screen	—

4.3.3.2 Setting the Date Format and Date

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	menu	SYSTEM SETUP	enter
3	▼	DISPLAY SETUP	enter
4	▼	SET DATE/TIME	enter
5	—	Highlight DATE FORMAT	enter
6	▲ ▼	Choose the appropriate date format from the displayed options.	enter
7	▼	Highlight DATE	enter
8	◄ ►	Select the character to edit.	—
	▲ ▼	Scroll to the appropriate number.	enter
9	menu home	Main Menu or Main Measurement Screen	—

4.4 Setting up System Security

The passcode feature of the sc100 restricts unauthorized access to configuration and calibration settings. The passcode is factory set to **sc100** (the five digits must be followed by a space to remove the trailing asterisk). The following two options are available:

Disabled: All configuration settings and calibrations can be changed. This is the default.

Enabled: Certain calibration and Test/Maint settings/operations cannot be accessed without the passcode. If the passcode is enabled, it may be edited (section 4.4.2). The passcode can include up to six digits (alpha and/or numeric and available characters). If the instrument is reset using the Configure/Default Setup menu selection, the passcode will return to the factory default. If a passcode is forgotten, obtain the Master passcode from the Technical Consulting Services Department, see Section 9 on page 46.

4.4.1 Setting the Passcode

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	↓	SYSTEM SETUP	enter
3	↓	SECURITY SETUP	enter
4	—	SET PASSCODE	enter
5	↓	Highlight ENABLE	enter
6	menu home	Main Menu or Main Measurement Screen	—

4.4.2 Editing the Passcode

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	↓	SYSTEM SETUP	enter
3	↓	Highlight SECURITY SETUP	enter
4	↓	ENTER PASSCODE	enter
5	↓	EDIT PASSCODE	enter
6	← →	EDIT PASSCODE select character (shown in brackets)	—
	↑ ↓	EDIT PASSCODE move to the next character	enter
7	menu home	Main Menu or Main Measurement Screen	—

4.5 Output Options

Refer to the System Setup on page 29 for more information on the output options menu. The analyzer provides two isolated analog outputs (Output 1 and Output 2).

4.5.1 Navigating to the Output Options Menu

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	↓	SYSTEM SETUP	enter
3	↓	OUTPUT SETUP	enter
4	↓	SELECT OUTPUT	enter
5	↑ ↓	Customize the options, refer to System Setup on page 29.	enter
6	menu home	Main Menu or Main Measurement Screen when Output options are configured.	—

4.5.2 Hold/Transfer Outputs

During normal measurement operation, the analog outputs can be held at the last measured value or transferred to a preset value.

4.5.2.1 Hold/Transfer Outputs until Release

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2	↓	TEST/MAINT	enter
3	↓	HOLD OUTPUTS	enter
4	↓	SET OUTMODE	enter
5	↓	Select HOLD OUTPUTS or XFER OUTPUTS	enter
6	↓	SET CHANNELS	enter
7	↑ ↓	Select ALL or one of the connected sensors.	—
8	↓	ACTIVATION	enter
9	↓	Select LAUNCH	enter
10	menu home	Main Menu or Main Measurement Screen	reading will flash

During calibration, analog outputs can remain active, held, or transferred to a preset mA value.

4.5.3 Release Outputs

Step	Select	Menu Level	Confirm
1	menu	MAIN MENU	—
2		TEST/MAINT	enter
3		HOLD OUTPUTS	enter
4		ACTIVATION	enter
5		RELEASE	enter
6	menu home	Main Menu or Main Measurement Screen	—

4.6 Relay Options

Refer to System Setup on page 29 for more information on the relay options menu.

4.6.1 Navigating to the Relay Options Menu

Step	Select	Menu Level/Instructions	Confirm
1	menu	MAIN MENU	—
2		SYSTEM SETUP	enter
3		RELAY SETUP	enter
4		SELECT RELAY	enter
5		Customize the options, refer to System Setup on page 29.	enter
6	menu home	Main Menu or Main Measurement Screen when Relay options are configured.	—

4.7 Data Event Logging Options

The sc100 provides three data logs (one for each sensor and one for calculated values) and three event logs (one for each sensor and one for the controller). The data logs store the measurement data at selected intervals. The event log stores a variety of events that occur on the devices such as configuration changes, alarms, and warning conditions. The data logs are stored in a packed binary format and the event logs are stored in a CSV format. The logs can be downloaded through the digital network port, the IrDA port, or through the service port using the service cable LZX887.

4.8 Digital Network Options

The sc100 provides two digital communication methods with the controller (the digital network port and the IrDA port). Either of the digital ports can be used to access setup data, measurement data, or data/event logs. For the features available for each individual digital network port, refer to the instruction sheet supplied with the selected network card.

4.9 System Setup Menu

OUTPUT SETUP (see section 4.5.1 on page 32 for expanded menu information)

SELECT OUTPUT 1 OR 2

SELECT SOURCE

Press **ENTER** to access a list of all connected sensors and select the sensor that will drive the output.

SET PARAMETER

Press **ENTER** to select from the displayed parameters. Highlight the appropriate displayed parameter and press **ENTER.**

SET FUNCTION

Select LINEAR CONTROL for current output to track the measurement valve. Select PID CONTROL for the sc100 to operate as a PID controller.

SET TRANSFER

Each analog output is normally active, responding to the measured value of its assigned parameter. However, during calibration, each output can be transferred to this preset transfer value.

SET FILTER

Average measurements over time (0–999 seconds). Default is 0 seconds. The higher the value, the longer the sensor signal response time will be to a change in the actual process value.

SCALE 0 mA/4 mA

Select 0 mA or 4 mA for minimum current (outputs will be set to 0–20 mA or 4–20 mA).

ACTIVATE

Dependent on Function selected previously. See section 4.5.1 on page 32 for additional information.

FUNCTION set to LINEAR CONTROL

If LINEAR CONTROL was selected in SET FUNCTION, set the low and the high values for the current output here.

FUNCTION set to PID CONTROL

1. SET MODE: AUTO or MANUAL
2. PHASE: DIRECT or REVERSE controller operation.
3. SET SETPOINT: enter the setpoint the PID control will control the process to.
4. PROP BAND: control the proportional band for the PID control.
5. INTEGRAL: control the integral action time period in minutes.
6. DERIVATIVE: control the settings for the rate control.

4.9 System Setup Menu (continued)

RELAY SETUP
Select Relay A, B, or C
SELECT SOURCE
. Select from none, a connected sensor, or the real time clock (RTC)
SET PARAMETER
Press **ENTER** to select from the displayed parameters.
SET FUNCTION
Source set to sensor
Alarm: Operates relays in response to the measured parameter. Contains separate High and Low Alarm points, deadbands, and ON/OFF delay.
Feeder Control: Operates in response to the measured parameter. Can be set for phasing, setpoint, deadband, overfeed timer, and ON/OFF delay.
Event Control: Controls a cleaning system (or equivalent) on a timed basis.
Warning: Activated when the analyzer detects a sensor warning.
PMW Control: Allows the relay to provide a duty cycled output.
Freq Control: Allows the relay to cycle at a frequency between the minimum pulse per minute and maximum pulse per minute.
Source set to RTC
Timer: Sets the timer for a cleaning system (or equivalent). Controls the output hold, interval, duration, and off delay.
SET TRANSFER
Sets the relay to Energize or De-energize (user-selectable). Normally, each control or alarm relay is active, responding to the measured value of its assigned parameter. During calibration, however, the relay can be transferred to a preset on/off state to suit the application requirements. Select Energize or De-energize and press **ENTER**.
FAILSAFE
Allows the user to create a state where the normal condition is energized. The relay is de-energized when an error condition is experienced. Select YES (Energized) or NO (De-energized) and press **ENTER**. YES sets the relay normal condition to energized resulting in the relay becoming de-energized when an error condition is experienced.
ACTIVATION
Function set to ALARM
LOW ALARM—Sets the value where the relay will turn on in response to decreasing measured value. For example, if the low alarm is set for 1.0 and the measured value drops to 0.9, the relay will be activated.
HIGH ALARM—Sets the value where the relay will turn on in response to increasing measured value. For example, if the high alarm is set for 1.0 and the measured value increases to 1.1, the relay will be activated.
LOW DEADBAND—Sets the range where the relay remains on after the measured value increases above the low alarm value. Default is 5% of the range. For example, if the low alarm is set for 1.0 and the low deadband is set for 0.5, then the relay remains on between 1.0 and 1.5.
HIGH DEADBAND—Sets the range where the relay remains on after the measured value decreases below the high alarm value. Default is 5% of the range. For example, if the high alarm is set for 4.0 and the high deadband is set for 0.5, then the relay remains on between 3.5 and 4.0.
OFF DELAY—Sets a time (0–300 seconds) to delay the relay from normally turning off.
ON DELAY—Sets a time (0–300 seconds) to delay the relay from normally turning on.
LOW ALARM—Sets the value where the relay will turn on in response to decreasing measured value. For example, if the low alarm is set for 1.0 and the measured value drops to 0.9, the relay will be activated.

4.9 System Setup Menu (continued)

Function set to FEEDER CONTROL
PHASE—"High" phase assigns the relay setpoint to respond to an increasing measured value; conversely, a "Low" phase assigns the relay setpoint to respond to a decreasing measured value.
SET SETPOINT—Sets the value where the relay will turn on.
DEADBAND—Sets the range where the relay remains on after the measured value decreases below the setpoint value (high phase relay) or increases above the setpoint value (low phase relay).
OVERFEED TIMER—Sets the time (0–999.9 minutes) to limit how long the relay can remain on.
OFF DELAY—Sets a time (0–999 seconds) to delay the relay from normally turning off.
ON DELAY—Sets a time (0–999 seconds) to delay the relay from normally turning on.
Function set to EVENT CONTROL
SET SETPOINT—Sets the value where the relay will turn on.
DEADBAND—Sets the range where the relay remains on after the measured value decreases below the setpoint value (high phase relay) or increases above the setpoint value (low phase relay).
OnMax TIMER—Sets the time (0–999 minutes) to limit the time the relay can remain on.
OffMax TIMER—Sets a time (0–999 minutes) to delay the relay from normally turning off.
OnMin TIMER—Sets the time (0–999 minutes) to limit the time the relay can remain on.
OffMin TIMER—Sets the time (0–999 minutes) to limit the time the relay can remain off.
Function set to TIMER (RTC selected in SELECT SOURCE)
HOLD OUTPUTS—Set OUTMODE to select output hold operation and select channels that cause the outputs to be held.
INTERVAL—Set the off time for the relay.
DURATION—Set the on time for the relay.
OFF DELAY—Set the time for additional hold/output time after the relay has been turned off.
Function set to WARNING CONTROL
WARNING LEVEL—Set the warning level that will trigger a relay. Range: 0–32. For example: If warnings 1–9 are active on the instrument, set the warning level to 0 to allow all warnings to trigger the relay; set the warning level to 5 to allow warnings 6 and above to trigger the relay. Set the warning level to 9 or greater to not trigger the relay on any warning.
Function set to PMW CONTROL
SET MODE—Auto or Manual
PHASE—Direct or Reverse
SET SETPOINT—Control Setpoint
DEAD ZONE—Zone around setpoint where output is off
PERIOD—3–60 second PMW period
MIN WIDTH—Minimum pulse width in 0.1 seconds
MAX WIDTH—Maximum pulse width in 0.1 seconds
PROP BAND—Proportional control band
INTEGRAL—Integral control setting (minutes)
Function set to FREQ CONTROL
SET MODE—Auto or Manual
PHASE—Direct or Reverse
SET SETPOINT—Control Setpoint
DEAD ZONE—Zone around setpoint where output is off
MIN WIDTH—0.001–200 pulses per minute
MAX WIDTH—0.001–200 pulses per minute
PROP BAND—Proportional control band (this is outside of the dead zone)
INTEGRAL—Integral control setting (minutes)

4.9 System Setup Menu (continued)

NETWORK SETUP (this menu appears only if a network card is installed in the controller)		
	SET MODE	
		Auto or Manual
	MODBUS ADDRESS	
		Highlight sc100 Analyzer, or either connected sensor then press **ENTER**. Choose a number between 1 and 247 as the address (each source must have a different address) then press **ENTER**.
	BAUD RATE	
		Select a baud rate of 9600, 19200, 38.4K, 57.6K, or 115.2K. Default: 19200
	STOP BITS	
		Select 1 or 2 stop bits. Default: 1
	MODBUS MODE	
		Select RTU or ASCI. Default: RTU
	DATA ORDER	
		Select Normal or Swapped. Default: Swapped
DISPLAY SETUP		
	ADJUST CONTRAST	
		Use the **UP** and **DOWN** keys to increase or decrease the contrast, see section 4.3.1 on page 29.
	LANGUAGE	
		The default is English. Choose Spanish, German, or French to allow all menus to appear in the selected language.
	SET DATE/TIME	
		Select the date format and to set the date and time (24-hour (military) format), see section 4.3.3 on page 30.
SECURITY SETUP (Enter a 6-digit passcode)		
	SET PASSCODE	
		DIISABLE
		Disables system security. See section 4.4 on page 31.
		ENABLE
		Enables system security. See section 4.4 on page 31.
LOG SETUP		
	DATALOG SETUP	
		Setup datalogging of displayed sensor measurements
CALCULATION		
	SET VARIABLE X	
		Select the sensor corresponding to the variable set as “X”.
	SET VARIABLE Y	
		Select the sensor corresponding to the variable set as “Y”.
	SET PARAMETER	
		Select the parameter to be associated with the variable.
	SET FORMULA	
		Select the formula of the calculation to be performed on “X” and “Y”.

4.9 System Setup Menu (continued)

ERROR HOLD MODE

- **HOLD OUTPUTS**
  - Holds outputs when unable to communicate with the sensor.
- **XFER OUTPUTS**
  - Goes to transfer state when unable to communicate with the sensor.

4.10 Test/Maint Menu

STATUS

- Indicates the status of each relay and indicates which sensors are connected to the controller.

OUTPUT CAL

- **SELECT OUTPUT 1 OR 2**
  - Calibrate Analog Output by specifying values to correspond to 4 mA and 20 mA using the **UP** and **DOWN** arrow keys.

HOLD OUTPUTS

- **SET OUTMODE**
  - Choose Hold Outputs or Xfer Outputs
- **SET CHANNELS**
  - Choose any individual attached sensor or all attached sensors to be held or transferred.
- **ACTIVATION**
  - Select Launch or Release.

OVERFEED RESET

- Reset the overfeed time out.

TEST OUTPUT

- **SELECT OUTPUT 1 OR 2**
  - Set the analog output to a desired current level. Range: 0–20

TEST RELAY

- **SELECT RELAY A, B, OR C**
  - Energize or de-energize the selected relay.

RESET CONFIG

- Reset to default configuration

SIMULATION

- **SELECT SOURCE, SET PARAMETER, SET SIM VALUE**
  - Simulate sensor measurement value for testing the outputs and relays.

SCAN SENSORS

- Manually scans for sensors to determine if sensors have been added or removed.

MODBUS STATS

- Indicates the communication statistics for use with an external network.

CODE VERSION

- Indicates the controller software version.

Section 5 Maintenance

DANGER
Only qualified personnel should conduct the tasks described in this section of the manual.

DANGER
Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

DANGER
Explosion hazard. Substitution of components may impair suitability for Class 1, Division 2.

5.1 Cleaning the Controller

With the enclosure securely closed, wipe the exterior with a damp cloth.

5.2 Fuse Replacement

The instrument contains two mains fuses. Failed fuses are an indication that an equipment problem could exist. Problem resolution and fuse replacement should be performed only by qualified service personnel. Refer to Figure 25 and the following steps to replace the fuses:

1. Disconnect power to the controller (including power to relays and other components, if powered).

2. Open the hinged controller cover by completely loosening all four captive screws in the cover.

3. Remove the high voltage barrier; pull out on the lever of the captive fastener then pull straight out on the barrier. Set the barrier aside for reinstallation.

4. Remove the fuses and install new fuses of the same type and rating:

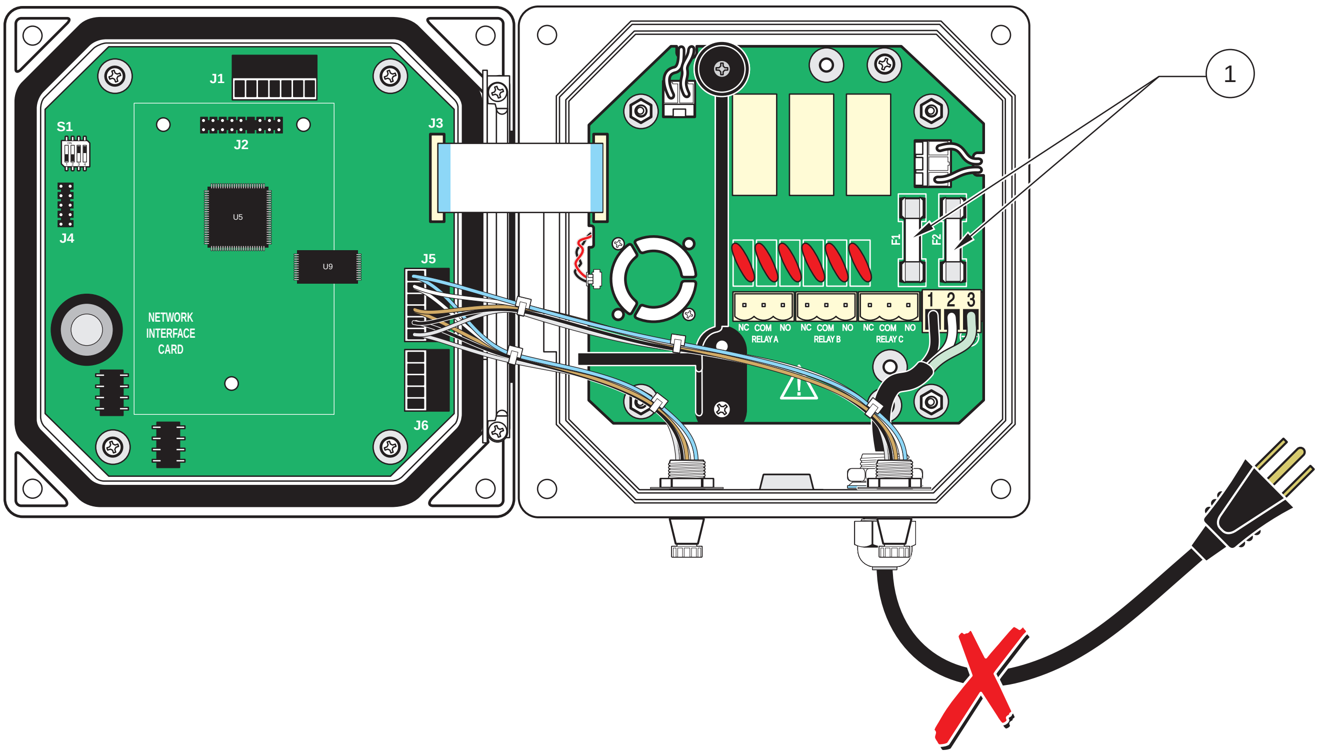
- ac Powered sc100: T, 1.6 A, 250 V, slow blow
- 24 V dc powered sc100: T, 3 A, 250V, slow blow

5. Reinstall the high voltage barrier.

6. Close the controller cover and hand-tighten the four screws.

7. Reconnect power to the instrument.

Figure 25 Fuse Replacement



1.	Fuses F1 and F2. AC powered, T, 1.6A, 250V, slow blow DC powered, T, 3A, 250V, slow blow

Section 6 Replacement Parts and Accessories

6.1 Replacement Items

Description	Quantity	Catalog Number
Controller Installation Kit	each	58672-00
Fuse, T, 3A, 250V, slow blow	each	41060
Fuse, T, 1.6 A, 250 V, slow blow	each	52083-00
Instruction manual, English	each	58600-18

6.2 Accessories

Description	Quantity	Catalog Number
Digital output card for Modbus RS232 communication	each	59200-00
Digital output card for Modbus RS485 communication	each	59200-01
Locknut	each	1059612
Plug, conduit opening	each	58687-00
Power cord with strain relief, 115 V	each	54488-00
Power cord with strain relief, 230 V	each	54489-00
Sealing Washer	each	1033814
Strain relief, Heyco	each	4379400
Sun Shield	each	58690-00

Section 7 Compliance Information

Hach Co. certifies this instrument was tested thoroughly, inspected, and found to meet its published specifications when it was shipped from the factory.

The **Model sc100** has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

FM 3600/3611 Class I, Division 2 (ETL Listing I.D. # 65454)
UL 61010A-1 (ETL Listing # 65454)
CSA C22.2 No. 1010.1 & No. 213-M1987 Class I, Division 2 (ETLc Certification I.D. # 65454)
Certified by Hach Co. to EN 61010-1 Amds. 1 & 2 (IEC1010-1) per 73/23/EEC, supporting test records by Intertek Testing Services.

Immunity

This equipment was tested for Industrial level EMC per:

EN 61326 (EMC Requirements for Electrical Equipment for Measurement, Control and Laboratory Use) **per 89/336/EEC EMC:** Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electrostatic Discharge Immunity (Criteria B)
IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electromagnetic Field Immunity (Criteria A)
IEC 1000-4-4:1995 (EN 61000-4-4:1995) Electrical Fast Transients/Burst (Criteria B)
IEC 1000-4-5:1995 (EN 61000-4-5:1995) Surge (Criteria B)
IEC 1000-4-6:1996 (EN 61000-4-6:1996) Conducted Disturbances Induced by RF Fields (Criteria A)
IEC 1000-4-11:1994 (EN 61000-4-11:1994) Voltage Dip/Short Interruptions (Criteria B)

Additional Immunity Standard/s include:
ENV 50204:1996 Radiated Electromagnetic Field from Digital Telephones (Criteria A)

Emissions

This equipment was tested for Radio Frequency Emissions as follows:

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Class “A” emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

Standards include:
EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

Additional Emissions Standard/s include:
EN 55011 (CISPR 11), Class “A” emission limits

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-causing Equipment Regulations.
Cet appareil numèrique de la classe A respecte toutes les exigences du Rëglement sur le matÈriel brouilleur du Canada.

FCC PART 15, Class “A” Limits

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the Model sc100 Controller from its power source to verify that it is or is not the source of the interference.
2. If the Model sc100 Controller is connected into the same outlet as the device with which it is interfering, try another outlet.
3. Move the Model sc100 Controller away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Section 8 How to Order

U.S.A. Customers

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH (800-227-4224)

By Fax:
(970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Ordering information by e-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send an e-mail to: intl@hach.com or contact:

Hach Company World Headquarters; Loveland, Colorado, U.S.A.
Telephone: (970) 669-3050; Fax: (970) 669-2932

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you.

Call 1-800-227-4224 or e-mail techhelp@hach.com

Section 9 Repair Service

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Service Center serving your location.

In the United States:
Hach Company
Ames Service
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
FAX: (515) 232-3835

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Latin America, the Caribbean, the Far East,
Indian Subcontinent, Africa, Europe, or the Middle East:
Hach Company World Headquarters,
P.O. Box 389
Loveland, Colorado, 80539-0389 U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

Section 10 Limited Warranty

Hach Company warrants its products to the original purchaser against any defects that are due to faulty material or workmanship for a period of one year from date of shipment unless otherwise noted in the product manual.

In the event that a defect is discovered during the warranty period, Hach Company agrees that, at its option, it will repair or replace the defective product or refund the purchase price excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact Hach Company or your distributor to initiate warranty support. Products may not be returned without authorization from Hach Company.

Limitations

This warranty does not cover:

- Damage caused by acts of God, natural disaster, labor unrest, acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction
- Damage caused by misuse, neglect, accident or improper application or installation
- Damage caused by any repair or attempted repair not authorized by Hach Company
- Any product not used in accordance with the instructions furnished by Hach Company
- Freight charges to return merchandise to Hach Company
- Freight charges on expedited or express shipment of warranted parts or product
- Travel fees associated with on-site warranty repair

This warranty contains the sole express warranty made by Hach Company in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Hach Company.

Limitation of Remedies

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, in no event shall Hach Company be liable for any incidental or consequential damages of any kind for breach of warranty or negligence.

Appendix A Modbus Protocol

A.1 Introduction

Modbus was developed as a PLC communication protocol by Modicon in the late 1970s. Because Modbus is a well-defined and published standard, Modbus has become one of the best known protocols for interfacing digital equipment to PLCs.

Modbus uses a master/slave data exchange technique. The master (typically a PLC) generates queries to individual slaves. The slaves, in turn, reply back with a response to the master. A Modbus message contains the information required to send a query or request, including the slave address, function code, data, and a checksum.

The format of a Modbus message is shown below:

Address	Function	Data	Checksum
1 byte	1 byte	Variable number of bytes	2 bytes

A.2 Query Message

A query message is generated by the master to request data from a slave. It contains a function code that specifies the type and amount of data requested. A read digital input register function code (02), for example, instructs the slave to read digital inputs and return the value in a response message.

The following message instructs slave 1 to read two bits starting at offset 0.

Address	Function	Data		Checksum
		Start Register	Number of Points	
01	02	00 00	00 02	F9 CB

Note that the above values are hexadecimal bytes, not ASCII characters.

A.3 Response Message

A response message is generated by the slave in response to a query message from the master. The response to read digital input register function code (02), for example, returns the value of the requested digital inputs. The original slave address and function code is also returned to validate the response.

The following response is generated from the previous query if discrete input 1 is OFF (0) and discrete input 2 is ON (1).

Address	Function	Data		Checksum
		Byte Count	Digital Input Bits	
01	02	01	02	20 49

Again note that the above values are hexadecimal bytes, not ASCII characters.

A.4 Modbus Message Detail

The various fields within a Modbus message are described in more detail below.

Address
The address field is a single byte. This byte ranges in value from 1 to 247.

Function Codes
The function code is a single byte. Several function code values exist in Modbus. The ones supported by the sc100/Digital Sensor System are described below.

Function Code	Description	Data Type	Absolute Address	Relative Address
03	Read Holding Registers	Word (16 bits)	40001 to 49999	0 to 9998
06	Write Holding Register	Word (16 bits)	40001 to 49999	0 to 9998
08	Loopback Test	n/a	n/a	n/a
17	Report Slave ID	n/a	n/a	n/a

Only the relative address is specified in a message. The relative address is automatically added to the absolute address for that function code. If a read holding register message, for example, specifies relative address 0, the value in absolute address 40001 would be returned.

Data
The data field consists of a series of bytes. The number of bytes varies in length depending on the function code. Typical query message data consists of the relative address to be read by the slave. Typical response message data consists of actual data read by the slave.

Checksum
The checksum is two bytes which are appended to every message. These bytes ensure the data packet was transmitted with no errors. The algorithm which is applied to RTU messages is a 16 bit Cyclic Redundancy Check (CRC). The algorithm which is applied to ASCII messages is an 8 bit Longitudinal Redundancy Check (LRC).

ASCII / RTU Data Format
Modbus supports both ASCII and RTU data formats. RTU uses binary (non-printable) characters, and is used for normal operation. ASCII uses 7 bit printable characters, and is typically only used for debugging purposes.

The following tables show the same message in RTU and ASCII formats.

Table 8 RTU Message

Address	Function	Data		Checksum
		Start Register	Number of Points	
01	02	00 00	00 02	F9 CB

Table 9 ASCII Message

Colon	Address	Function	Data		Checksum	CR LF
			Start Register	Number of Points		
3A	30 31	30 32	30 30 30 30	30 30 30 32	46 42	0D 0A

Exception Codes
An illegal request will generate a Modbus Exception Code. The most common code is caused by reading data from an unused register. An exception response message consists of the slave address, the function code with the high order bit set, the exception code, and a CRC. In the following response message, the slave reported exception code 02, indicating an illegal data address.

Address	Function	Data	Checksum
01	81	02	C1 91

More Information
More information about the Modbus Protocol can be found on the Modbus-IDA website at www.modbus-ida.org.

A.5 Floating Point Measurements

Floating point measurements are available from the sc100/Digital Sensor system. Each floating point number is a 32-bit IEEE-754 value, occupying two 16-bit registers (back-to-back); this has one sign bit, eight exponent bits and 23 mantissa bits, and is stored in Motorola (big-endian) order.

A.5.1 Big-endian and Little-endian

Big-endian and little-endian are terms that describe the order in which a sequence of bytes are stored in the computer memory. Big-endian is an order in which the "big end" (most significant value) is stored first (lowest storage address). Little-endian is an order in which the "little end" (least significant value in the sequence) is stored first. For example, in a big-endian computer, the two bytes required for the hexadecimal number 4F52 would be stored as 4F52 in storage (if 4F is stored at storage address 1000, for example, 52 will be at address 1001). In a little-endian system, it would be stored as 524F (52 at address 1000, 4F at 1001).

The sc100/Digital Sensor registers are big-endian byte order within a register and little-endian word order for multi-registers Floats.

A.5.2 Changing the “endian” Order

The default "endian" order is little-endian word order for multi-registers Floats (SWAPPED order). The order can be changed in the NETWORK SETUP menu to NORMAL order (big-endian word order for multi-registers Floats).

A.6 Modbus Troubleshooting

Table 10 Troubleshooting

Problem	Possible Causes	Solution
No Modus Response	Baud rate, or stop bits does not match settings of Modbus master	Verify sc100 settings match the Modbus master settings.Verify Modbus master Parity setting is set to None.
	Bad RS232 or RS485 cable	Replace/Repair cable
	No or improper network biasing and termination.	Check all network devices for termination or biasing settings. Only the ends of the network should have termination turned on and only one point on the network should be providing biasing.
	Slave Address incorrect or duplicate address of another bus device.	Verify all addresses are unique and between 1 and 247.
Modbus Exception Response	Register not supported	Verify register is supported
	Data Type incorrect	Verify the requested register(s) Data Type matches the Modbus Master Request e.g. do not access a Slave Float value with a 2 byte Integer request. When requesting a Float (2 registers/4 bytes), both registers must be requested at the same time.

Table 11 sc100 Modbus Registers

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Measurements	Calculated Value	40001	Float	2	R	Value calculated from two sensor measurements
Setup	Language	40003	Unsigned Integer	1	R/W	Current System Language
Setup	Date Format	40004	Unsigned Integer	1	R/W	Current Data Display Format (0 = DD/MM/YY; 1 = MM/DD/YY; 2 = DD-MM-YY; 3 = MM-DD-YY)
Setup	Error Hold Mode	40005	Unsigned Integer	1	R/W	Error Mode Hold State (0 = Hold outputs; 1 = Transfer outputs to predefined value)
Setup/Analog Output 1	Source	40006	Unsigned Integer	1	R/W	Selects data source for this output (0 = None; 2 = sensor; 4 = Calculation)
Setup/Analog Output 1	Sensor Select	40007	Unsigned Integer	1	R/W	Selects sensor source when Source = Sensor (0 = sensor1; 1 = sensor2)
Setup/Analog Output 1	Measuremen t Select	40008	Unsigned Integer	1	R/W	Selects measurement on the sensor (0 = Meas1.. 3 = Meas4)
Setup/Analog Output 1	Type	40009	Unsigned Integer	1	R/W	Selects output type (0 = Linear output; 1 = PID control)
Setup/Analog Output 1	Transfer Value	40010	Float	2	R/W	Sets the transfer value
Setup/Analog Output 1	Filter	40012	Unsigned Integer	1	R/W	Sets the output filter value in seconds (0 to 120 sec.)
Setup/Analog Output 1	0mA - 4mA Select	40013	Unsigned Integer	1	R/W	Selects 0mA/4mA for min output (0 = 0mA; 1 = 4mA)
Setup/Analog Output 1/Linear	Min Setting	40014	Float	2	R/W	Sets the min output value
Setup/Analog Output 1/Linear	Max Setting	40016	Float	2	R/W	Sets the max output value

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Setup/Analog Output 1/PID	PID Mode	40018	Unsigned Integer	1	R/W	Sets the PID mode (0 = auto; 1 = manual)
Setup/Analog Output 1/PID	PID Manual Set	40019	Float	2	R/W	Sets the PID manual output value (0.0 to 100.0%)
Setup/Analog Output 1/PID	PID Setpoint	40021	Float	2	R/W	Sets the PID setpoint
Setup/Analog Output 1/PID	PID Phase	40023	Unsigned Integer	1	R/W	Sets the PID phase (0 = Direct; 1 = Reverse)
Setup/Analog Output 1/PID	PID Proportional Band	40024	Float	2	R/W	Sets the PID proportional band
Setup/Analog Output 1/PID	PID Integral Time	40026	Unsigned Integer	1	R/W	Sets the PID integral time (min)
Setup/Analog Output 1/PID	PID Derivative Time	40027	Unsigned Integer	1	R/W	Sets the PID derivative time (min)
Setup/Analog Output 2	Source	40028	Unsigned Integer	1	R/W	Selects data source for this output (0 = None; 2 = Sensor; 4 = Calculation)
Setup/Analog Output 2	Sensor Select	40029	Unsigned Integer	1	R/W	Selects sensor source when Source = Sensor (0 = Sensor1; 1 = Sensor2)
Setup/Analog Output 2	Measurement Select	40030	Unsigned Integer	1	R/W	Selects measurement on the Sensor (0 = Meas1 .. 3 = Meas4)
Setup/Analog Output 2	Type	40031	Unsigned Integer	1	R/W	Selects output type (0 = Linear output; 1 = PID control)
Setup/Analog Output 2	Transfer Value	40032	Float	2	R/W	Sets the transfer value
Setup/Analog Output 2	Filter	40034	Unsigned Integer	1	R/W	Sets the output filter value in seconds (0 to 120 sec)
Setup/Analog Output 2	0mA - 4mA Select	40035	Unsigned Integer	1	R/W	Selects 0mA/4mA for min output (0 = 0mA; 1 = 4mA)
Setup/Analog Output 2/Linear	Min Setting	40036	Float	2	R/W	Sets the min output value
Setup/Analog Output 2/Linear	Max Setting	40038	Float	2	R/W	Sets the max output value
Setup/Analog Output 2/PID	Mode	40040	Unsigned Integer	1	R/W	Sets the PID mode (0 = auto; 1 = manual)
Setup/Analog Output 2/PID	Manual Set	40041	Float	2	R/W	Sets the PID manual output value (0.0 to 100.0%)
Setup/Analog Output 2/PID	Setpoint	40043	Float	2	R/W	Sets the PID setpoint
Setup/Analog Output 2/PID	Phase	40045	Unsigned Integer	1	R/W	Sets the PID phase (0 = Direct; 1 = Reverse)
Setup/Analog Output 2/PID	Proportional Band	40046	Float	2	R/W	Sets the PID proportional band
Setup/Analog Output 2/PID	Integral Time	40048	Unsigned Integer	1	R/W	Sets the PID integral time (min)
Setup/Analog Output 2/PID	Derivative Time	40049	Unsigned Integer	1	R/W	Sets the PID derivative time (min)

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Setup/Relay 1	Source	40050	Unsigned Integer	1	R/W	Selects data source for this relay (0 = None; 1 = Real Time Clock; 2 = Sensor; 4 = Calculation)
Setup/Relay 1	Sensor Select	40051	Unsigned Integer	1	R/W	Selects Sensor source when Source = Sensor (0 = Sensor1; 1 = Sensor2)
Setup/Relay 1	Measurement Select	40052	Unsigned Integer	1	R/W	Selects measurement on the Sensor (0 = Meas1 .. 3 = Meas4)
Setup/Relay 1	Type	40053	Unsigned Integer	1	R/W	Selects the relay type (0 = Alarm; 1 = Control; 2 = Status; 3 = Timer; 4 = Event)
Setup/Relay 1	Transfer Setting	40054	Unsigned Integer	1	R/W	Selects the transfer value for the relays (0 = De-energized; 1 = Energized)
Setup/Relay 1/Alarm	High Alarm	40055	Float	2	R/W	Sets the high alarm setpoint
Setup/Relay 1/Alarm	Low Alarm	40057	Float	2	R/W	Sets the low alarm setpoint
Setup/Relay 1/Alarm	High Deadband	40059	Float	2	R/W	Sets the high alarm deadband
Setup/Relay 1/Alarm	Low Deadband	40061	Float	2	R/W	Sets the low alarm deadband
Setup/Relay 1/Alarm	On Delay	40063	Unsigned Integer	1	R/W	Sets the on delay time
Setup/Relay 1/Alarm	Off Delay	40064	Unsigned Integer	1	R/W	Sets the off delay time
Setup/Relay 1/Control	Setpoint	40065	Float	2	R/W	Sets the controller setpoint
Setup/Relay 1/Control	Phase	40067	Unsigned Integer	1	R/W	Sets the controller phase (0 = Low; 1 = High)
Setup/Relay 1/Control	Deadband	40068	Float	2	R/W	Sets the controller deadband
Setup/Relay 1/Control	Overfeed Timer	40070	Unsigned Integer	1	R/W	Sets the overfeed timer value (mins)
Setup/Relay 1/Control	On Delay	40071	Unsigned Integer	1	R/W	Sets the on delay time (sec)
Setup/Relay 1/Control	Off Delay	40072	Unsigned Integer	1	R/W	Sets the off delay time (sec)
Setup/Relay 1/Control	Reset Overfeed Timer	40073	Unsigned Integer	1	R/W	Resets the overfeed timer
Setup/Relay 1/Event	Setpoint	40074	Float	2	R/W	Sets the event setpoint
Setup/Relay 1/Event	Phase	40076	Unsigned Integer	1	R/W	Sets the event phase (0 = Low; 1 = High)
Setup/Relay 1/Event	Deadband	40077	Float	2	R/W	Sets the event deadband
Setup/Relay 1/Event	On Max Time	40079	Unsigned Integer	1	R/W	Sets the max on time (mins)
Setup/Relay 1/Event	On Min Time	40080	Unsigned Integer	1	R/W	Sets the min on time (mins)
Setup/Relay 1/Event	Off Max Time	40081	Unsigned Integer	1	R/W	Sets the max off time (mins)
Setup/Relay 1/Event	Off Min Time	40082	Unsigned Integer	1	R/W	Sets the min off time (mins)

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Setup/Relay 1/Timer	Hold Type	40083	Unsigned Integer	1	R/W	Sets which Sensor outputs are affected during timer on time (0 = None; 2 = Selected Sensor; 13 = All Sensors)
Setup/Relay 1/Timer	Sensor Select	40084	Unsigned Integer	1	R/W	Selects which Sensor outputs are being held/transferred during the timers on time (this is used when Hold type is set for single Sensor)
Setup/Relay 1/Timer	Hold Mode	40085	Unsigned Integer	1	R/W	Selects hold outputs vs. set transfer value during timers on time
Setup/Relay 1/Timer	Duration Time	40086	Unsigned Integer	1	R/W	Sets the timer on duration time (sec)
Setup/Relay 1/Timer	Period Time	40087	Unsigned Integer	1	R/W	Sets the period between timer on events (mins)
Setup/Relay 1/Timer	Off Delay	40088	Unsigned Integer	1	R/W	Sets the time the affected Sensor outputs are held/transferred after the timer turns off (sec)
Setup/Relay 1/Status	Level	40089	Unsigned Integer	1	R/W	Sets the status level which will trigger the relay
Setup/Relay 2	Source	40090	Unsigned Integer	1	R/W	Selects data source for this relay (0 = None; 1 = Real Time Clock; 2 = Sensor; 4 = Calculation)
Setup/Relay 2	Sensor Select	40091	Unsigned Integer	1	R/W	Selects Sensor source when Source = Sensor (0 = Sensor1; 1 = Sensor2)
Setup/Relay 2	Measurement Select	40092	Unsigned Integer	1	R/W	Selects measurement on the Sensor (0 = Meas1 .. 3 = Meas4)
Setup/Relay 2	Type	40093	Unsigned Integer	1	R/W	Selects the relay type (0 = Alarm; 1 = Control; 2 = Status; 3 = Timer; 4 = Event)
Setup/Relay 2	Transfer Setting	40094	Unsigned Integer	1	R/W	Selects the transfer value for the relays (0 = De-energized; 1 = Energized)
Setup/Relay 2/Alarm	High Alarm	40095	Float	2	R/W	Sets the high alarm setpoint
Setup/Relay 2/Alarm	Low Alarm	40097	Float	2	R/W	Sets the low alarm setpoint
Setup/Relay 2/Alarm	High Deadband	40099	Float	2	R/W	Sets the high alarm deadband
Setup/Relay 2/Alarm	Low Deadband	40101	Float	2	R/W	Sets the low alarm deadband
Setup/Relay 2/Alarm	On Delay	40103	Unsigned Integer	1	R/W	Sets the on delay time
Setup/Relay 2/Alarm	Off Delay	40104	Unsigned Integer	1	R/W	Sets the off delay time
Setup/Relay 2/Control	Setpoint	40105	Float	2	R/W	Sets the controller setpoint
Setup/Relay 2/Control	Phase	40107	Unsigned Integer	1	R/W	Sets the controller phase (0 = Low; 1 = High)
Setup/Relay 2/Control	Deadband	40108	Float	2	R/W	Sets the controller deadband
Setup/Relay 2/Control	Overfeed Timer	40110	Unsigned Integer	1	R/W	Sets the overfeed timer value (mins)
Setup/Relay 2/Control	On Delay	40111	Unsigned Integer	1	R/W	Sets the on delay time (sec)
Setup/Relay 2/Control	Off Delay	40112	Unsigned Integer	1	R/W	Sets the off delay time (sec)

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Setup/Relay 2/Control	Reset Overfeed Timer	40113	Unsigned Integer	1	R/W	Resets the overfeed timer
Setup/Relay 2/Event	Setpoint	40114	Float	2	R/W	Sets the event setpoint
Setup/Relay 2/Event	Phase	40116	Unsigned Integer	1	R/W	Sets the event phase (0 = Low; 1 = High)
Setup/Relay 2/Event	Deadband	40117	Float	2	R/W	Sets the event deadband
Setup/Relay 2/Event	On Max Time	40119	Unsigned Integer	1	R/W	Sets the max on time (mins)
Setup/Relay 2/Event	On Min Time	40120	Unsigned Integer	1	R/W	Sets the min on time (mins)
Setup/Relay 2/Event	Off Max Time	40121	Unsigned Integer	1	R/W	Sets the max off time (mins)
Setup/Relay 2/Event	Off Min Time	40122	Unsigned Integer	1	R/W	Sets the min off time (mins)
Setup/Relay 2/Timer	Hold Type	40123	Unsigned Integer	1	R/W	Sets which Sensor outputs are affected during timer on time (0 = None; 2 = Selected Sensor; 13 = All Sensors)
Setup/Relay 2/Timer	Sensor Select	40124	Unsigned Integer	1	R/W	Selects which Sensor outputs are being held/transferred during the timers on time (this is used when Hold type is set for single Sensor)
Setup/Relay 2/Timer	Hold Mode	40125	Unsigned Integer	1	R/W	Selects hold outputs vs. set transfer value during timers on time
Setup/Relay 2/Timer	Duration Time	40126	Unsigned Integer	1	R/W	Sets the timer on duration time (sec)
Setup/Relay 2/Timer	Period Time	40127	Unsigned Integer	1	R/W	Sets the period between timer on events (mins)
Setup/Relay 2/Timer	Off Delay	40128	Unsigned Integer	1	R/W	Sets the time the affected Sensor outputs are held/transferred after the timer turns off (sec)
Setup/Relay 2/Status	Level	40129	Unsigned Integer	1	R/W	Sets the status level which will trigger the relay
Setup/Relay 3	Source	40130	Unsigned Integer	1	R/W	Selects data source for this relay (0 = None; 1 = Real Time Clock; 2 = Sensor; 4 = Calculation)
Setup/Relay 3	Sensor Select	40131	Unsigned Integer	1	R/W	Selects Sensor source when Source = Sensor (0 = Sensor1; 1 = Sensor2)
Setup/Relay 3	Measurement Select	40132	Unsigned Integer	1	R/W	Selects measurement on the Sensor (0 = Meas1 .. 3 = Meas4)
Setup/Relay 3	Type	40133	Unsigned Integer	1	R/W	Selects the relay type (0 = Alarm; 1 = Control; 2 = Status; 3 = Timer; 4 = Event)
Setup/Relay 3	Transfer Setting	40134	Unsigned Integer	1	R/W	Selects the transfer value for the relays (0 = De-energized; 1 = Energized)
Setup/Relay 3/Alarm	High Alarm	40135	Float	2	R/W	Sets the high alarm setpoint
Setup/Relay 3/Alarm	Low Alarm	40137	Float	2	R/W	Sets the low alarm setpoint
Setup/Relay 3/Alarm	High Deadband	40139	Float	2	R/W	Sets the high alarm deadband

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Setup/Relay 3/Alarm	Low Deadband	40141	Float	2	R/W	Sets the low alarm deadband
Setup/Relay 3/Alarm	On Delay	40143	Unsigned Integer	1	R/W	Sets the on delay time
Setup/Relay 3/Alarm	Off Delay	40144	Unsigned Integer	1	R/W	Sets the off delay time
Setup/Relay 3/Control	Setpoint	40145	Float	2	R/W	Sets the controller setpoint
Setup/Relay 3/Control	Phase	40147	Unsigned Integer	1	R/W	Sets the controller phase (0 = Low; 1 = High)
Setup/Relay 3/Control	Deadband	40148	Float	2	R/W	Sets the controller deadband
Setup/Relay 3/Control	Overfeed Timer	40150	Unsigned Integer	1	R/W	Sets the overfeed timer value (mins)
Setup/Relay 3/Control	On Delay	40151	Unsigned Integer	1	R/W	Sets the on delay time (sec)
Setup/Relay 3/Control	Off Delay	40152	Unsigned Integer	1	R/W	Sets the off delay time (sec)
Setup/Relay 3/Control	Reset Overfeed Timer	40153	Unsigned Integer	1	R/W	Resets the overfeed timer
Setup/Relay 3/Event	Setpoint	40154	Float	2	R/W	Sets the event setpoint
Setup/Relay 3/Event	Phase	40156	Unsigned Integer	1	R/W	Sets the event phase (0 = Low; 1 = High)
Setup/Relay 3/Event	Deadband	40157	Float	2	R/W	Sets the event deadband
Setup/Relay 3/Event	On Max Time	40159	Unsigned Integer	1	R/W	Sets the max on time (mins)
Setup/Relay 3/Event	On Min Time	40160	Unsigned Integer	1	R/W	Sets the min on time (mins)
Setup/Relay 3/Event	Off Max Time	40161	Unsigned Integer	1	R/W	Sets the max off time (mins)
Setup/Relay 3/Event	Off Min Time	40162	Unsigned Integer	1	R/W	Sets the min off time (mins)
Setup/Relay 3/Timer	Hold Type	40163	Unsigned Integer	1	R/W	Sets which Sensor outputs are affected during timer on time (0 = None; 2 = Selected Sensor; 13 = All Sensors)
Setup/Relay 3/Timer	Sensor Select	40164	Unsigned Integer	1	R/W	Selects which Sensor outputs are being held/transferred during the timers on time (this is used when Hold type is set for single Sensor)
Setup/Relay 3/Timer	Hold Mode	40165	Unsigned Integer	1	R/W	Selects hold outputs vs. set transfer value during timers on time
Setup/Relay 3/Timer	Duration Time	40166	Unsigned Integer	1	R/W	Sets the timer on duration time (sec)
Setup/Relay 3/Timer	Period Time	40167	Unsigned Integer	1	R/W	Sets the period between timer on events (mins)
Setup/Relay 3/Timer	Off Delay	40168	Unsigned Integer	1	R/W	Sets the time the affected Sensor outputs are held/transferred after the timer turns off (sec)
Setup/Relay 3/Status	Level	40169	Unsigned Integer	1	R/W	Sets the status level which will trigger the relay

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Comm/Net Card	Mode	40170	Unsigned Integer	1	R/W	Sets the Modbus mode (0 = RTU; 1 = ASCII)
Comm/Net Card	Baud	40171	Unsigned Integer	1	R/W	Sets the Modbus baud rate (0 = 9600; 1 = 19200; 2 = 38400; 3 = 57600; 4 = 115200)
Comm/Net Card	Stop Bits	40172	Unsigned Integer	1	R/W	Sets the number of stop bits (1,2)
Comm/Net Card	Data Order	40173	Unsigned Integer	1	R/W	Sets the register data order for floats (0 = Normal; 1 = Reversed)
Comm/Net Card	Min Response Time	40174	Unsigned Integer	1	R/W	Sets the minimum response time (0 to 30 sec)
Comm/Net Card	Max Response Time	40175	Unsigned Integer	1	R/W	Sets the maximum response time (100 to 1000 sec)
Comm/Net Card/Addresses	sc100	40176	Unsigned Integer	1	R/W	Sets the sc100 Modbus Address
Comm/Net Card/Addresses	Sensor 1	40177	Unsigned Integer	1	R/W	Sets the Sensor 1 Modbus Address
Comm/Net Card/Addresses	Sensor 2	40178	Unsigned Integer	1	R/W	Sets the Sensor 2 Modbus Address
Comm/Net Card/Stats	Good Messages	40179	Unsigned Integer	2	R/W	Number of good messages
Comm/Net Card/Stats	Bad Messages	40181	Unsigned Integer	2	R/W	Number of failed messages
Comm/Net Card/Stats	% Good Mesg	40183	Float	2	R/W	% of good messages
Comm/Service Port	Mode	40185	Unsigned Integer	1	R/W	Sets the Modbus mode (0 = RTU; 1 = ASCII)
Comm/Service Port	Baud	40186	Unsigned Integer	1	R/W	Sets the Modbus baud rate (0 = 9600; 1 = 19200; 2 = 38400; 3 = 57600; 4 = 115200)
Comm/Service Port	Stop Bits	40187	Unsigned Integer	1	R/W	Sets the number of stop bits (1,2)
Comm/Service Port	Data Order	40188	Unsigned Integer	1	R/W	Sets the register data order for floats (0 = Normal; 1 = Reversed)
Comm/Service Port	Min Response Time	40189	Unsigned Integer	1	R/W	Sets the minimum response time (0 to 30 sec)
Comm/Service Port	Max Response Time	40190	Unsigned Integer	1	R/W	Sets the maximum response time (100 to 1000 sec)
Comm/Service Port/Addresses	sc100	40191	Unsigned Integer	1	R/W	Sets the sc100 Modbus Address
Comm/Service Port/Addresses	Sensor 1	40192	Unsigned Integer	1	R/W	Sets the Sensor 1 Modbus Address
Comm/Service Port/Addresses	Sensor 2	40193	Unsigned Integer	1	R/W	Sets the Sensor 2 Modbus Address
Comm/Service Port/Stats	Good Messages	40194	Unsigned Integer	2	R/W	Number of good messages

Table 11 sc100 Modbus Registers (continued)

Group Name	Tag Name	Register #	Data Type	Length	R/W	Description
Comm/Service Port/Stats	Bad Messages	40196	Unsigned Integer	2	R/W	Number of failed messages
Comm/Service Port/Stats	% Good Mesg	40198	Float	2	R/W	% of good messages
Comm/Sensor/ Sensor1 Stats	Good Messages	40200	Unsigned Integer	2	R/W	Number of good messages
Comm/Sensor/ Sensor1 Stats	Bad Messages	40202	Unsigned Integer	2	R/W	Number of failed messages
Comm/Sensor/ Sensor1 Stats	% Good Mesg	40204	Float	2	R/W	% of good messages
Comm/Sensor/ Sensor2 Stats	Good Messages	40206	Unsigned Integer	2	R/W	Number of good messages
Comm/Sensor/ Sensor2 Stats	Bad Messages	40208	Unsigned Integer	2	R/W	Number of failed messages
Comm/Sensor/ Sensor2 Stats	% Good Mesg	40210	Float	2	R/W	% of good messages
Calibration	Output1 4mA count	40212	Unsigned Integer	1	R/W	Calibration counts for the 4mA output 1
Calibration	Output1 20mA count	40213	Unsigned Integer	1	R/W	Calibration counts for the 20mA output 1
Calibration	Output2 4mA count	40214	Unsigned Integer	1	R/W	Calibration counts for the 4mA output 2
Calibration	Output2 20mA count	40215	Unsigned Integer	1	R/W	Calibration counts for the 20mA output 2

Davey® Repair or Replacement Guarantee

In the unlikely event in Australia or New Zealand that this Davey product develops any malfunction within two years of the date of original purchase due to faulty materials or manufacture, Davey will at our option repair or replace it for you free of charge, subject to the conditions below.

Should you experience any difficulties with your Davey product, we suggest in the first instance that you contact the Davey Dealer from which you purchased the Davey product. Alternatively you can phone our Customer Service line on 1300 367 866 in Australia, or 0800 654 333 in New Zealand, or send a written letter to Davey at the address listed below. On receipt of your claim, Davey will seek to resolve your difficulties or, if the product is faulty or defective, advise you on how to have your Davey product repaired, obtain a replacement or a refund.

Your Davey two Year Guarantee naturally does not cover normal wear or tear, replacement of product consumables (i.e. mechanical seals, bearings or capacitors), loss or damage resulting from misuse or negligent handling, improper use for which the product was not designed or advertised, failure to properly follow the provided installation and operating instructions, failure to carry out maintenance, corrosive or abrasive water or other liquid, lightning or high voltage spikes, or unauthorized persons attempting repairs. Where applicable, your Davey product must only be connected to the voltage shown on the nameplate.

Your Davey two Year Guarantee does not cover freight or any other costs incurred in making a claim. Please retain your receipt as proof of purchase; you **MUST** provide evidence of the date of original purchase when claiming under the Davey two Year Guarantee.

Davey shall not be liable for any loss of profits or any consequential, indirect or special loss, damage or injury of any kind whatsoever arising directly or indirectly from Davey products. This limitation does not apply to any liability of Davey for failure to comply with a consumer guarantee applicable to your Davey product under the Australian or New Zealand legislation and does not affect any rights or remedies that may be available to you under the Australian or New Zealand Consumer Legislation.

In Australia, you are entitled to a replacement or refund for a major failure and for compensation for any other reasonably foreseeable loss or damage. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

Should your Davey product require repair or service after the guarantee period; contact your nearest Davey Dealer or phone the Davey Customer Service Centre on the number listed below.

For a complete list of Davey Dealers visit our website (davey.com.au) or call:

AUSTRALIA

Customer Service Centre
6 Lakeview Drive,
Scoresby, Australia 3179
Ph: 1300 367 866
Fax: 1300 369 119
Website: davey.com.au

NEW ZEALAND

Customer Service Centre
7 Rockridge Avenue,
Penrose, Auckland 1061
Ph: 0800 654 333
Fax: 09 527 7654
Website: daveynz.co.nz

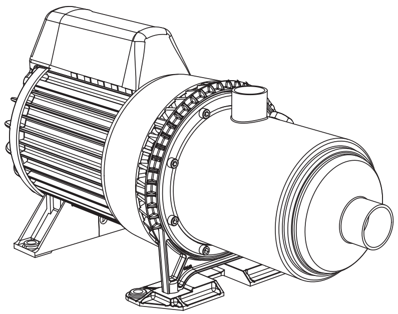
Davey Water Products Pty Ltd
Member of the GUD Group
ABN 18 066 327 517

P/N 400559-6 supersedes P/N 400559-5

*** Installation and operating instructions are included with the product when purchased new. They may also be found on our website.**

DEPEND ON DAVEY
WATER PRODUCTS

Installation and Operating Instructions for HM Series Electric Pumps



PLEASE READ IMPORTANT CAREFULLY

NOTE: Prior to installation remove the red transport plugs & associated seals from the suction and/or discharge ports.

WARNING : The pump and associated pipework operate under pressure. Under no circumstances should the pump or associated pipework be disassembled unless the internal pressure of the unit has been relieved. Failure to observe this warning will expose persons to the possibility of personal injury and may also result in damage to the pump, pipework or other property.

WARNING: Failure to follow these instructions and comply with all applicable codes may cause serious bodily injury and/or property damage.

Please pass these instructions on to the operator of this equipment.

Prior to using this pump you must ensure that:

- The pump is installed in a safe and dry environment
- The pump enclosure has adequate drainage in the event of leakage
- Any transport plugs are removed
- The pipe-work is correctly sealed and supported
- The pump is primed correctly
- The power supply is correctly connected
- All steps have been taken for safe operation

Appropriate details for all of these items are contained in the following Installation and Operating Instructions. Read these in their entirety before switching on this pump. If you are uncertain as to any of these Installation and Operating Instructions please contact your Davey dealer or the appropriate Davey office as listed on the back of this document.

Congratulations on your purchase of a high quality, Australian built Davey multistage pump. All components have been designed and manufactured to give trouble free, reliable operation.

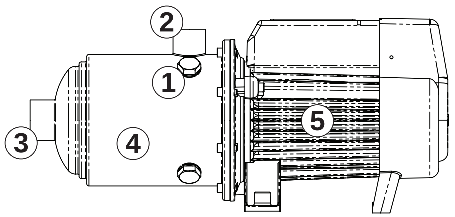
Before installing your new pump, please read all instructions carefully as failures caused by incorrect installation or operation are not covered by the guarantee. Your HM Electric Pump is designed to handle clean water. The pump should not be used for any other purpose without specific referral to Davey. The use of the pump to pump flammable, corrosive and other materials of a hazardous nature is specifically excluded.

General

Applications

Pumps for clear liquids, free of abrasives in residential, agricultural, industrial, and other applications.

In accordance with AS 3350.2.41 we are obliged to inform you that this pump is not to be used by children or infirm persons and must not be used as a toy by children.



1. Priming Plug
2. Discharge Outlet (1” BSPF)
3. Suction Inlet ($1^1/_4$” BSPF)
4. Pump Body
5. Motor

Specifications

Max. service pressure:	1000kPa
Max. inlet pressure:	600kPa
Liquid temperate range:	-15 to +105^{o}C
Ambient temperature:	0 to 50^{o}C
Suction head:	depends on NPSH of pump

***NOTE "MOTOR PROTECTION DEVICE" :**
For protection, the Davey pump motor is fitted with an automatic reset thermal overload, constant tripping of this overload indicates a problem e.g. low voltage at pump, excessive temperature (above 50°C) in pump enclosure.

WARNING: Automatic reset thermal overloads will allow the pump to restart without warning. Always disconnect the pump motor from the electrical supply before maintenance or repairs.

WARNING: When servicing or attending pump, always ensure power is switched off and lead unplugged. Electrical connections should be serviced only by qualified persons.

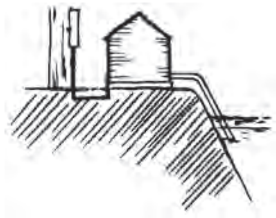
Care should also be taken when servicing or disassembling pump to avoid possible injury from hot pressurised water. Unplug pump, relieve pressure by opening a tap on the discharge side of the pump and allow any hot water in the pump to cool before attempting to dismantle.

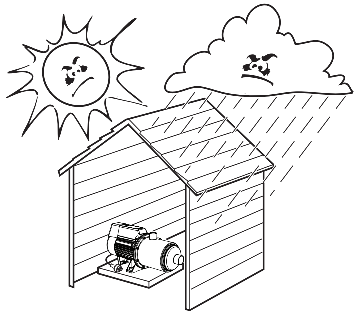
IMPORTANT:
DO NOT USE petroleum based fluids or solvents (e.g. Oils, Kerosene, Turpentine, Thinners, etc) on the plastic pump components or seal components.

WARNING: Do not use hydrocarbon based or hydrocarbon propelled sprays around the electrical components of this pump.

Choosing a Site

Choose a site with a firm base as close to the water source as possible with correct power supply. Make sure your pump is always connected to an adequate, reliable source of clean water.





Housing your Davey Pump

To protect your pump from the weather, make sure the pump house is both water proof, frost free and has adequate ventilation.
The pump should be mounted on a firm base allowing for drainage, to avoid damage to flooring etc., that over time may occur from leaking pipe joints or pump seals. Do not mount the pump vertically. Never place flammable materials on or near your pump.

Power Connection

Connect lead to power supply designated on pump label, do not use long extension leads as they cause substantial voltage drop, poor pump performance and may cause motor overload.

The electrical connections and checks must be made by a qualified electrician and comply with applicable local standards. Poor installation or poor power supply may even result in electrical fires!

NOTE:
1. **Ensure motor is connected to power supply specified on nameplate.**
2. **Avoid long extension leads as they can cause substantial voltage drop and operating problems.**
3. **Although the Davey electric motor is specifically engineered to perform on a range of power supply voltages, malfunctions or failure caused by adverse voltage supply conditions are not covered under guarantee.**

In accordance with AS 3350.2.41 we are obliged to inform you that this pump is not to be used by children or infirm persons and must not be used as a toy by children.

Single Phase
The single phase models which are supplied with a 10 amp plug may be plugged into a standard 10amp outlet. Model with the special 15 amp power plug may only be used with the appropriate 15 amp 220/250V power outlet (15 amp power outlets are usually specially provided by an electrician).
Always ensure that the earth conductor in the lead is connected to a good earth.

All single phase Models have automatic re-set thermal overload protection built in, i.e. should overload on motor cause thermal to open circuit and switch motor off, it will automatically re-set and switch motor on when motor has cooled down sufficiently, usually within a few minutes.

WARNING: Automatic reset thermal overloads will allow the pump to restart without warning. ALWAYS disconnect the pump motor from the electrical supply before maintenance or repairs.

Note:
1. Long extension leads should be avoided as they often have insufficient current carrying capacity to run electric motors, hence they can cause substantial voltage drop and operating problems.
2. Minimum voltage at the electric motor must not fall below 216.
3. If the electrical fittings in your country make it necessary to remove the plug from the lead fixed to the motor care should be taken to ensure that the earth conductor green/yellow in the lead is properly connected to a good earth. This work must only be undertaken by an authorised electrician.

Three Phase

Some HM models are also available as 3 phase model for 50Hz, nominal 415volt power supply. A recommended wiring diagram can be found inside the capacitor cover (see figure one below). Three phase units must be wired in by an authorised electrician in conjunction with a contactor which has “quicktrip” (M10) overloads set at nameplate current.

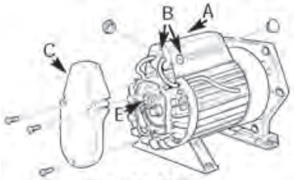


Figure One

Davey recommend the use of overloads which also have the ability to detect “single phasing” or “dropped phase” conditions in the power supply.

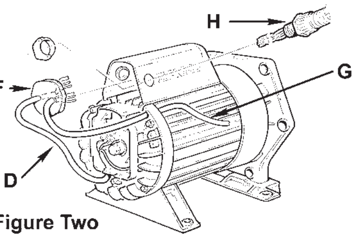


Figure Two

Three phase models with output power of below 1.4kW have been designed to provide cable entry on the right hand side when viewed from the non-drive or fan end of the motor. A terminal block is provided under the capacitor cover. Note: Three phase motors do not have capacitors fitted in the capacitor cover.

Access to the terminal block is achieved by removal of the fan cowl - see Figure A. Before prising the fan cowl ensure the retaining screw has been removed.

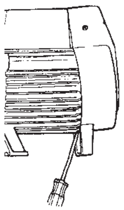


Figure A

The capacitor cover screw is then removed, allowing the cover to be lifted (Figure B). Once the wiring has been completed and checked, ensure the supply cable is run along the cable access, the capacitor cover will clamp the supply cable once it is re-installed. Replace the fan cowl and ensure the fan cowl retaining screw is re-installed correctly.

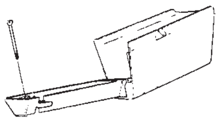


Figure B

WARNING:
DO NOT RUN DRY.
DO NOT RUN WITH LOSS OF PRIME.
DO NOT PUMP WATER CONTAINING ABRASIVE MATERIALS.

Trouble Shooting Check List

MOTOR OPERATING BUT NOT PUMPING
1. Suction line and pump body not filled with water.
2. Leaking foot valve.
3. Air leaks in suction lines or suction pipe not under water.
4. Air trapped in suction lines (also possible with flooded suction) due to uneven rise in piping (eliminate humps and hollows).
5. No water at source or water level too low.
6. Valve on suction or delivery lines closed.

MOTOR NOT RUNNING
1. Power not connected.
2. Supply voltage too low.
3. Overload tripped.
4. Motor not free to turn e.g. a blocked impeller.
5. Internal motor fault.

MOTOR RUNS FOR SOME TIME THEN STOPS - RESTARTS AUTOMATICALLY AFTER SHORT TIME

Overload tripping in motor
- low voltage at motor terminals
- motor in direct sunshine or in “hot box”
- motor not free to turn (eg: blocked)

Priming and Operation

The pump body and suction line should be filled by pouring water into the priming plug hole adjacent to the outlet. Screw on the priming plug, close the discharge valve two thirds and switch pump on. Gradually open the discharge valve and the pipeline fills.

In high suction lift conditions, the pump may make a noise similar to it pumping sand or gravel; this will usually be cavitation occurring. Reduce flow until the cavitation noise stops. Once the discharge pipeline fills you can open the valve. If the cavitation noise returns, close the discharge valve slightly until it stops.

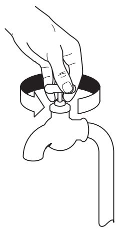
In the case of installations where there is a positive suction pressure (flooded suction) remove the pump's priming plug and slowly open the gate valve in the suction piping to allow water to enter the pump from the suction line until all air is expelled. Replace the priming plug and fully open the gate valve in the suction line and switch the pump on.

Prime should be established almost immediately, however, it may be necessary to re-prime several times on some installations before fully established optimum pump performance is obtained.

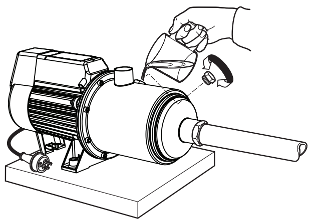
Do not run pump dry or allow to run continuously in a loss of prime condition. If this pump is allowed to pump water containing sand or other abrasive material, the effective life of the pump will be shortened.

If pump runs but will not pump water, check for the following:
1. Suction line and pump body not filled with water.
2. Leaking foot valve.
3. Air leaks in suction lines.
4. Air trapped in suction line (even on flooded suction) possibly when there is an uneven rise in the piping from water to pump (eliminate "humps and hollows")

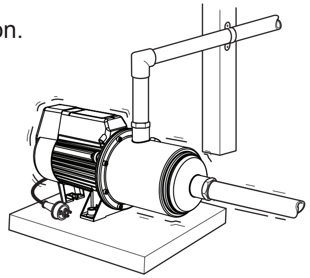
1. Ensure outlet nearest to pump is open.



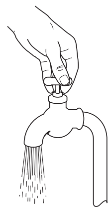
2. Fill pump body and suction line through priming plug hole located above suction inlet and replace plug.



3. Switch on.



4. Prime should establish almost immediately with a strong flow of water, however, in some installations it may be necessary to repeat the above operation to remove all air from the system.



Three phase models with output power of 1.4kW and over have been designed to allow for connection either side of the Capacitor Cover (marked "A" in figure one) on the motor. (NOTE: Three phase motors do not have capacitors fitted in the Capacitor Cover).
This is achieved by way of either of the two 19mm access holes (marked "B" in figure one). The access holes are designed to accept most standard cable grommets. The unused hole can be sealed by inserting the plug enclosed with the pump. To connect a three phase Pressure Pump start by removing the Terminal Cover ("C")
In accordance with AS 3350.2.41 we are obliged to inform you that this pump is not to be used by children or infirm persons and must not be used as a toy by children.

A short four core flex ("D") is fitted from the motor terminals ("E"). This lead is inserted through the blanking grommet ("F").
Pressure switch or other control leads ("G") can be fitted as well. Incoming power ("H") can be fitted through the preferred access hole, and terminated as shown in Figure Three. A termination kit is available if required.

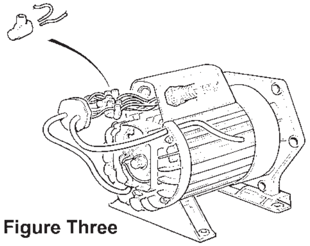


Figure Three

Insert the blanking grommet ("F") into the capacitor cover ("A"). Fix the short lead ("D") into the path provided in the non-drive endshield and replace the terminal cover ("C").

IMPORTANT NOTE: THREE PHASE MODELS ONLY

Before finalising wiring connections, check that motor rotates in direction of arrow (clockwise when shaft is viewed from wiring connection end except HM270 models which rotate anti-clockwise). To alter rotation, change any two power leads at motor terminals.

When the unit is connected and operating the phase balance should be checked. This should be within 5% variation. "Rolling" the leads may help to improve a small unbalance, but major phase unbalance will usually be attributed to an input power unbalance. This must be addressed before the pump is used.

Power connections and wiring must be carried out by an Authorised Electrician.

Note: Minimum three phase voltage supply at the motor must not fall below 374 volts, otherwise motor damage may result which is not claimable under Guarantee.

WARNING: Some insects, such as small ants, find electrical devices attractive for various reasons. If your pump enclosure is susceptible to insect infestation you should implement a suitable pest control plan.

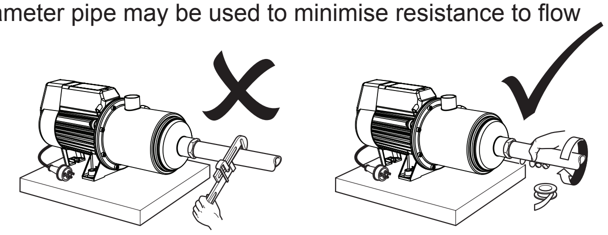
IP55 Compliant Connection

For some installations, such as wet areas in dairies, the pump is required to be IP55 compliant. The HM pump is IP55 compliant (models over 1.05kW are IP56).

Pipe Connections

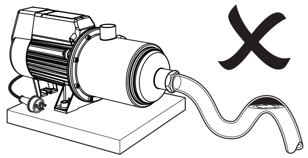
DO NOT USE THREAD SEALING COMPOUNDS, HEMP OR PIPE DOPE!

For best performance use P.V.C. or polythene pipe at least the same diameter as the pump's inlet. Larger diameter pipe may be used to minimise resistance to flow when pumping longer distances.



Use unions at pipe connections to enable easy removal and servicing. Use sufficient tape to ensure airtight seal and hand tighten only, do not screw connections all the way into suction port.
To prevent strain on pump thread always support heavy inlet and outlet pipes.
Lay suction pipe at a constant gradient to avoid air pockets which may reduce pump efficiency.

NOTE: Suction leaks are the largest cause of poor pump performance and are difficult to detect. Ensure all connections are completely sealed using thread tape only. DO NOT USE SEALING COMPOUNDS OR PIPE DOPE.

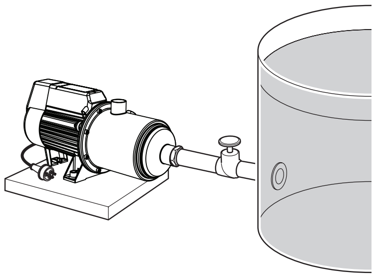


Connection to your Water Source

ABOVE GROUND WATER SOURCES

Installations with flooded suction require a gate valve so water supply can be turned off for pump removal and servicing.

Install a one-way check valve in the suction pipeline to avoid water draining back past the pump while not in operation and causing possible pump damage.



BELOW GROUND WATER SOURCES

NOTE: HM models require a foot valve or check valve to be installed in the suction pipework in suction lift applications as appropriate.

Whenever the installation position of the pump is higher than the lowest water level, a foot valve fitted to the end of the suction pipe as illustrated in (A) below is required. Ensure that the foot valve is at least $^1/_2$ metre below minimum water level.

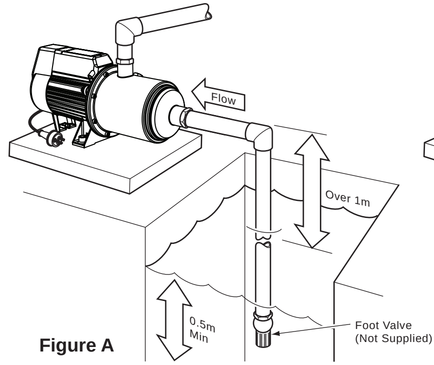


Figure A

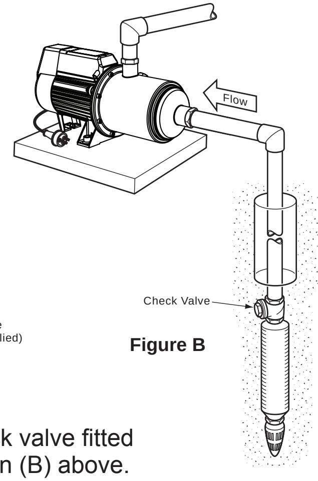


Figure B

SPEAR POINT INSTALLATIONS

When a HM is installed on a spear or well point a check valve fitted immediately on top of the spear point itself, as shown in (B) above.

NOTE: DO NOT install the check valve at the pump or at the top of the well. DO NOT run the pump without water.

NOTE: Be certain to select the spear point to suit the well conditions and regulate the flow rate from the pump accordingly.

Spear Size		Mesh	Approx. Max. Capacity of Spear Point		
$1^1/_4$"	(32mm)	60	15 - 23 l/min	or	200 - 300 gal/hr
$1^1/_2$"	(38mm)	60	23 - 38 l/min	or	300 - 500 gal/hr
2"	(50mm)	60	38 - 75 l/min	or	500 - 1000 gal/hr

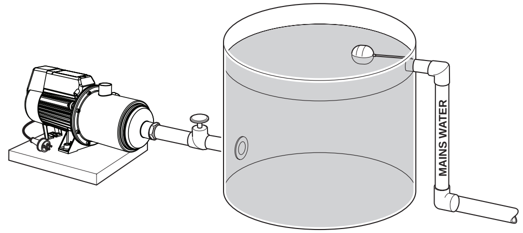
Dry-running protection

To avoid accidental loss of prime of the pump, we recommend protecting it with a suitable device. Note: damage from dry-running is not covered by guarantee.

Connection of Mains Scheme or Town Water Supply to either Suction or Discharge of Pumps

Most Water Supply Authorities have strict regulations regarding direct connection of pumps to mains water supplies. In most cases an isolating tank is required between mains supply and pump. Davey also recommend this method. Directly applied mains pressure can exceed pump operating pressure and damage pump.

Davey Water Products Pty Ltd can not accept responsibility for loss or damage resulting from incorrect or unauthorised installations.



MUKMOVA
MANURE & “TRASH” PUMP
INSTALLATION AND OPERATING INSTRUCTIONS

Please pass these instructions on to the operator of this equipment

WARNING: Failure to follow these instructions and comply with all applicable codes may cause serious bodily injury and/or property damage.

Prior to using this pump you must ensure that:
- The pump is installed in a safe and dry environment
- The pump enclosure has adequate drainage in the event of leakage
- Any transport plugs are removed
- The pipe-work is correctly sealed and supported
- The pump is primed correctly
- The power supply is correctly connected
- All steps have been taken for safe operation

Appropriate details for all of these items are contained in the following Installation and Operating Instructions. Read these in their entirety before switching on this pump. If you are uncertain as to any of these Installation and Operating Instructions please contact your Davey dealer or the appropriate Davey office as listed on the back of this document.

Location

The pump must be protected from the weather. If it is to be located outside, a weatherproof shelter must be put over the pump and motor. This shelter must have ventilation to allow the motor to draw in air for cooling, and adequate space, so as not to restrict the flow of air to the motor. The shelter should be readily removable for access to the pump at a later date. Locate the pump as close as possible to the liquid to be pumped. Provision is made in the base of the pump for bolting down, and it is recommended that the pump be permanently secured, particularly for dairy and piggery use.

Installation

Power

In accordance with AS 3350.2.41 we are obliged to inform you that this pump is not to be used by children or infirm persons and must not be used as a toy by children.

NOMINAL POWER SUPPLY	PHASE	CYCLES	MAXIMUM * RATED CURRENT	LOCKED ROTOR CURRENT
230V $\pm$10%	1	50 Hz	11 Amps	68 Amps
480V $\pm$10%	1	50 Hz	5.5 Amps	38 Amps
415V $\pm$6%	3	50 Hz	5.1 Amps	24 Amps

* Maximum rated current is the maximum for the motor, and is higher than that required when pumping clean water - this is to allow a motor power reserve when pumping effluent.

Single Phase

The single phase 240/480V motor on this pump is fitted with an in-built 240V thermal overload switch located under the terminal cover on the end of the motor. For 480V operation the terminal connections must be changed as per the wiring diagram included in the capacitor housing. A 480V overload and fitment kit is supplied with the pump. This overload is fitted into the endshield just above the terminal block.

Single phase units should be restricted to no more than 20 starts per hour.

Three Phase

The three phase 415V TEFC motor on this pump must have a contactor wired in which has correctly rated quick trip (M10) thermal overloads, otherwise any failure will not be the responsibility of Davey.

Davey recommend the use of overloads which also have the ability to detect “single phasing” or “dropped phase” conditions in the power supply.

Three phase Mukmova models have been designed to allow for connection either side of the Capacitor Cover (marked “A” in figure one) on the motor. (NOTE: Three phase motors do not have capacitors fitted in the Capacitor Cover). This is achieved by way of either of the two 19mm access holes (marked “B” in figure one). The access holes are designed to accept most standard cable grommets. The unused hole can be sealed by inserting the plug enclosed with the pump. To connect a three phase Pressure Pump start by removing the Terminal Cover (“C”).

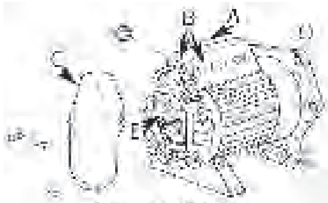


Figure One

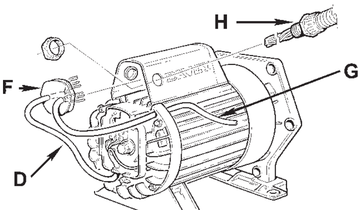


Figure Two

A short four core flex (“D”) is fitted from the motor terminals (“E”). This lead is inserted through the blanking grommet (“F”).
Pressure switch or other control leads (“G”) can be fitted as well. Incoming power (“H”) can be fitted through the preferred access hole, and terminated as shown in Figure Three. A termination kit is available if required.

Insert the blanking grommet (“F”) into the capacitor cover (“A”). Fix the short lead (“D”) into the path provided in the non-drive endshield and replace the terminal cover (“C”).

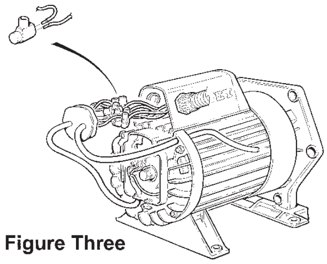


Figure Three

IMPORTANT NOTE: THREE PHASE MODELS ONLY

Before finalising wiring connections, check that motor rotates in direction of arrow (clockwise when shaft is viewed from wiring connection end). To alter rotation, change any two power leads at motor terminals.

When the unit is connected and operating the phase balance should be checked. This should be within 5% variation. “Rolling” the leads may help to improve a small unbalance, but major phase unbalance will usually be attributed to an input power unbalance. This must be addressed before the pump is used.

Power connections and wiring must be carried out by an Authorised Electrician.

Note: Minimum three phase voltage supply at the motor must not fall below 374 volts, otherwise motor damage may result which is not claimable under Guarantee.

A registered electrician is required to directly wire in the pump. EXTENSION LEADS MUST NOT BE USED.

Suction Piping - As this pump does not have a fixed column, it may be used on a wide variety of collection pits without modification. Furthermore, by using flexible suction pipe, the pit may be almost fully emptied.
The suction inlet to the pump is $2\frac{1}{2}$” BSP female and for optimum performance, $2\frac{1}{2}$” or larger smooth bore reinforced suction hose should be used. Maximum suction lift of the pump should be limited to 6 metres (20 ft) and the length of suction pipe should not exceed approximately 8 metres.

NOTE: The use of suction piping smaller than $2^1/_2$" I.D. will result in decreased pump performance. When pumping dairy or piggery slurry, no inlet strainer should be fitted to the end of the suction hose as this may easily be blocked.

Discharge Piping - The pump outlet is 2” BSP female and 2” or larger polythene piping or equivalent should be used, particularly if sprinkler is to be operated.

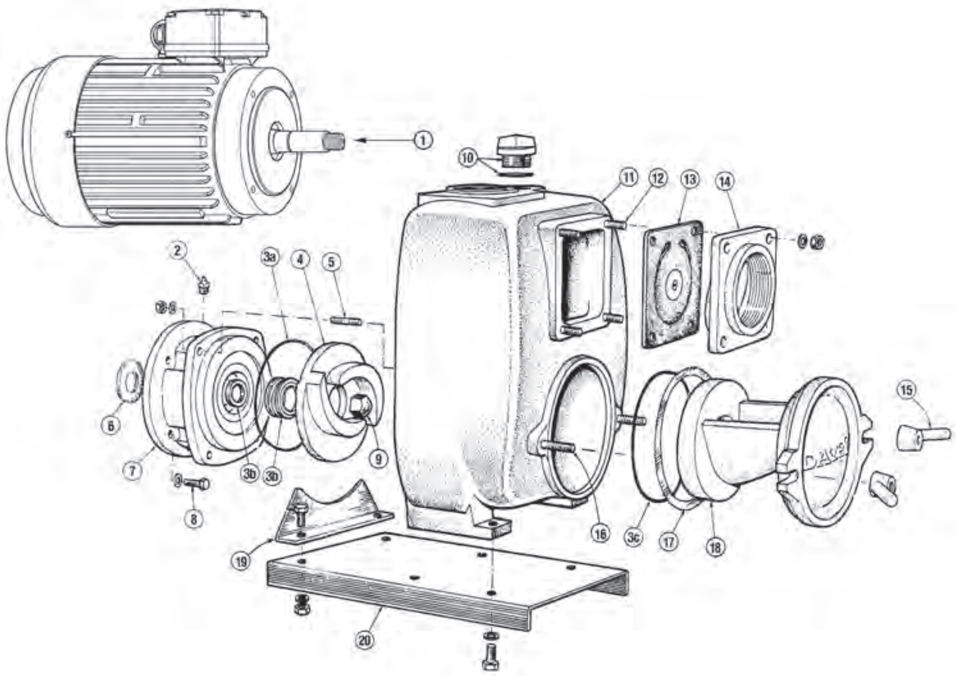
Operation

When first installed the pump must be filled with water at the priming hole adjacent to pump outlet. A weighted flap valve on the suction inlet retains the liquid within the pump for subsequent operation.
As this pump has excellent self priming characteristics, there is no need to fit a foot valve or fill the suction pipe.
An automatic float switch may be wired into the contactor coil to operate the pump.

The pump is capable of pumping up to 3/4” dia. solids in suspension, however pumping stones or hard solids of any size for extended periods will shorten the pump’s life. A coarse screen should be installed at the entrance to the collection pit to prevent large items including rocks, sticks and some straw from entering.

Maintenance

1. **Monthly** grease the seal area at the nipple (see exploded view - Item 2) located in the yoke (Item 7) joining pump and motor. Use **BP “ENERGREASE”** multi purpose LS2 or equivalent.
2. Regular flushing of the pump with clean water is good practice when pumping dairy or piggery manure, and will prevent build up and the need to unclog frequently.
3. If the pump has been idle for a long period, remove the inspection cover. (Item 18 located below the pump inlet), and ensure pump impeller can rotate freely.
4. To clean any blockages, the large inspection hole provides excellent access to pump impeller area for cleaning. Periodic cleaning out of the pump is good practice.



Impeller Clearance Adjustment

The Mukmova pump has an open face impeller (see the exploded view – Item 4). As this pump is used to pump manure and “trash”, the impeller will wear over time.
The optimal performance of the pump is maintained by close fit of the inspection cover (Item 18) to the front of the impeller. This close fit is maintained over the life of the pump by periodic removal of the impeller shims (Item 17). When the pump is manufactured the correct number of shims will be inserted for peak performance. As this performance declines over time, impeller shims will need to be removed to optimise the performance.
If all shims are removed and performance continues to decline, it is time to replace the impeller.

Spare Parts

Should any parts be required, be sure to quote **Model and/or Build** number from the nameplate on the pump.

Davey® Repair or Replacement Guarantee

In the unlikely event in Australia or New Zealand that this Davey product develops any malfunction within one year of the date of original purchase due to faulty materials or manufacture, Davey will at our option repair or replace it for you free of charge, subject to the conditions below.

Should you experience any difficulties with your Davey product, we suggest in the first instance that you contact the Davey Dealer from which you purchased the Davey product. Alternatively you can phone our Customer Service line on 1300 367 866 in Australia, or 0800 654 333 in New Zealand, or send a written letter to Davey at the address listed below. On receipt of your claim, Davey will seek to resolve your difficulties or, if the product is faulty or defective, advise you on how to have your Davey product repaired, obtain a replacement or a refund.

Your Davey One Year Guarantee naturally does not cover normal wear or tear, replacement of product consumables (i.e. mechanical seals, bearings or capacitors), loss or damage resulting from misuse or negligent handling, improper use for which the product was not designed or advertised, failure to properly follow the provided installation and operating instructions, failure to carry out maintenance, corrosive or abrasive water or other liquid, lightning or high voltage spikes, or unauthorized persons attempting repairs. Where applicable, your Davey product must only be connected to the voltage shown on the nameplate.

Your Davey One Year Guarantee does not cover freight or any other costs incurred in making a claim. Please retain your receipt as proof of purchase; you **MUST** provide evidence of the date of original purchase when claiming under the Davey One Year Guarantee.

Davey shall not be liable for any loss of profits or any consequential, indirect or special loss, damage or injury of any kind whatsoever arising directly or indirectly from Davey products. This limitation does not apply to any liability of Davey for failure to comply with a consumer guarantee applicable to your Davey product under the Australian or New Zealand legislation and does not affect any rights or remedies that may be available to you under the Australian or New Zealand Consumer Legislation.

In Australia, you are entitled to a replacement or refund for a major failure and for compensation for any other reasonably foreseeable loss or damage. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

Should your Davey product require repair or service after the guarantee period; contact your nearest Davey Dealer or phone the Davey Customer Service Centre on the number listed below.

For a complete list of Davey Dealers visit our website (davey.com.au) or call:

DEPEND ON DAVEY
WATER PRODUCTS

AUSTRALIA

Customer Service Centre
6 Lakeview Drive,
Scoresby, Australia 3179
Ph: 1300 367 866
Fax: 1300 369 119
Website: davey.com.au

NEW ZEALAND

Customer Service Centre
7 Rockridge Avenue,
Penrose, Auckland 1061
Ph: 0800 654 333
Fax: 09 527 7654
Website: daveynz.co.nz

Davey Water Products Pty Ltd
Member of the GUD Group
ABN 18 066 327 517

P/N 47755-6 supersedes P/N 47755-5

*** Installation and operating instructions are included with the product when purchased new. They may also be found on our website.**

Whakapapa Waste Water Treatment Plant
SAND FILTER PLANT

FUNCTIONAL DESCRIPTION

INDEX

1.0 INTRODUCTION

1.1 PROCESS OVERVIEW

Waste water from settlement tanks flows into wet well chamber, located before sand filter plant. Level transmitter automatically controls submersible pump start/stop sequence – linked to PC programme control unit. Waste water pumped to sand filter plant, where it is filtered through three sand filters each containing single media of sand (1-2 mm size).

Filtered waste water passes through a Trojan UV3000 system that effectively inactivates bacteria and viruses. Treated waste water is further piped to Disposal Valves in nearby National Park, whereby controlled discharge to ground by time clock (via PLC programme) by solenoid valves.

Option of two flow rates through sand filter plant:
a. 30 m^3/hr
b. 10 m^3/hr

Option (1) is high flow setting.
Option (2) is low flow setting bypass OPEN, with a 10 m^3/hr flow restrictor inline after sand filters, before UV system.

Sand filter plant has auto control sequence, controlled by Vision 120 PLC programme. Keystone Valves, controlled by pressurised air line feeds for open/close settings - air supplied via ABAC Air Compressor.

1.2 PROCESS PLANT

The sand filter plant consists of:
a. Three sand filters
b. Keystone air valve auto control sequence
c. Inlet pressure gauge
d. Manual bypass for;
   1. Plant flow rates: Low and high settings
   2. Bypass flow to sand filters, direct to Passveer Ditch
e. Trojan UV3000
f. ABAC Air Compressor
g. Grundfos Submersible Pump

2.0 SYSTEM FUNCTION AND CONTROL

2.1 KEYSTONE VALVE FUNCTION LIST

Filter 1 Inlet	V01	Filter 2 Inlet	V04	Filter 3 Inlet	V07	Filtered Outlet	V10
Filter 1 Backwash Outlet	V02	Filter 2 Backwash Outlet	V05	Filter 3 Backwash Outlet	V08	Air Inlet	V11 V12
Filter 1 Drain	V03	Filter 2 Drain	V06	Filter 3 Drain	V09		

2.2 SAND FILTER PLANT ONLINE – VALVE ARRANGEMENT

Keystone Valve	OPEN
Filter 1 Inlet	V01
Filter 2 Inlet	V04
Filter 3 Inlet	V07
Filtered Water Outlet	V10
Wet Well Pump	ON

ALL OTHER VALVES CLOSED
EXCEPT AIR BLOWER VALVE
V11 OPEN

2.3 BACKWASH SEQUENCE

Backwash initiated either by time clock or differential pressure switch located at main inlet pipe just before sand filters. Manual backwash sequence starts available on control panel. On completion of backwash sequence, sand filter plant reverts to online.

Gems Pressure Sensor measures pressure (bar), before sand filters. Increase of inlet pressure due to solid load build up on sand filters.

2.4 AUTO BACKWASH SEQUENCE

Backwash start up will only be initiated when level of wet well chamber is 1500 mm (indicated on main page of PLC screen). In the event level of wet well chamber has not reached 1500 mm, plant will go offline and wait until level is obtained.

PLC programme controls Keystone air valves in auto and manual backwash start up. Sand filter is drained down, followed by air scouring to effectively loosen up sand media: a settling time to vent residual air, followed by backwash with filtered water from other two filters. Backwash water piped to Passveer Ditch.

2.5 FILTER WASH SEQUENCE OPERATION

In-service	Filtering online
Stop for backwash	Wet well pump stopped
Close inlets	Inlet valves closed/filtered outlet closed
Drain down F1	Open drain and backwash valves

Air scour F1	Drain valve closed. Air blower on: air inlet valve open/air vent valve closed
Air scour complete	Air blower off: air inlet valve closed/air vent open. Settling time
Backwash F1	Wet well pump on. Inlet valves open other two filters
Finish backwash F1	Backwash valve closed, inlet valves open to three filters/filtered outlet open
In-service	Filter online

Sequence repeated for F2 & F3

Filter 1, 2 and 3 are washed in sequence one after another. Completion of filter wash programme on completion of three filters successfully backwashed. Wet well pump start up ONLY at backwash stage within sequence for each filter wash. *Refer to Section 2.0 for Keystone Valve Function.*

2.6 MANUAL BACKWASH

Operator initiated by push button on control panel. Sequence steps same as auto backwash. Refer Section 2.5. On completion of backwash sequence, plant reverts automatically to online.

2.7 CONTROL PANEL OVERVIEW

Control Switch;
LOW POSITION – System run on bypass for 10 m^3/hr.
HIGH POSITION – System run on 30 m^3/hr. Bypass closed.

LOW and HIGH settings relate to inlet pressure values for backwash initiation (Refer to Section 3.2.8).

OFF POSITION – Wet Well Chamber Pump OFF. Sand Filter Plant filtered outlet valve (V10) closed: Inlet valves to filters open.

Emergency Stop; Sand Filter Plant defaults to OFF Position. Wet Well Chamber pump STOPS.

Mains power switch ON/OFF to panel.
Disposal Valves: ON/OFF

2.8 MANUAL BYPASS

In the event of sand filters requiring being shut down for any reason, manual bypass valve allows for continued pumping out of wet well chamber, direct to Passveer Ditch.

To operate;
CLOSE inlet valves to filters.
CLOSE drain and backwash valves.
OPEN interconnecting manual bypass valve.

WARNING; Care must be taken on start up of wet well pump, that flow of waste water does not dead end.

3.0 OPERATOR INTERFACE

3.1 VISION 120 SYSTEM

Allows for operator to view, monitor and adjust select process parameters. A visual screen indicates relevant process information.

3.2 INTERFACE OVERVIEW

Steps 1 to 3 provide process data, steps 4 to 9 allow for operator adjustments.

1. **Main Page**:
   - Wet well chamber level in millimeters
   - Inlet pressure reading in bar

2. **Press REVIEW button**:
   - Pump run time in hours

3. **Press NEXT button**:
   - Time since last back wash in hours/minutes

4. **Press NEXT button**:
   - Filter 1 set up
   - For adjustment to backwash settings press ADJUST button:
     a. Draining – 120 seconds
     b. Air Scour – 180 seconds
     c. Settling – 60 seconds
     d. Backwash – 600 seconds
     e. Above backwash settings at time of commissioning
     In sequence, as listed, each page allows for viewing and adjustment of time settings. For accepting of new value press ↵ button. This is this case for ALL adjustment points. Press ESC to exit viewing page.

5. **Press NEXT button**:
   - Filter 2 set up
   - Follow procedures as detailed in section (4)

6. **Press NEXT button**:
   - Filter 3 set up
   - Follow procedures as detailed in section (4)

7. **Press NEXT button**:
   - Maximum filter run before backwash in hours
   - 12 hours set at commissioning
   - Press ADJUST button to change hour valve

8. **Press NEXT button:**
   - Backwash start pressure
   - High flow 0.8 bar setting at commissioning
   - Low flow 1.2 bar setting at commissioning
   - Press ADJUST button to alter pressure values and ↵ to accept. Note, decimal point has to be entered, e.g. 0.8 in sequence of data input.

9. **Press NEXT button:**
   - This indicates filter run time in hours, since last backwash
   - Press ESC to exit viewing page
   - Press ↵ button to proceed to next page

10. **Press NEXT button:**
    - Disposal Valves;
      a. 25:00 Minutes
      b. 25:00 Minutes
      c. 25:00 Minutes
      d. 25:00 Minutes

    - Press ADJUST button to adjust valve times and press ↵ button to accept new value.

3.3 SAND FILTER PLANT ALARMS

Incorporated within the programme are several key alarm settings. Alarm settings are not part of normal viewing of data on screen (apart from 3.3.5 below). ALL alarms have to be accepted by pressing ↵ button in order for plant to be restarted when appropriate.

3.3.1 Level Transmitter Failed (wet well chamber)
Loss of signal to PLC programme.

3.3.2 Pressure Monitor Failed
Loss of signal from Gems Pressure Sensor

3.3.3 Wet Well Pump Overload Trip
Grundfos pump potentially blocked/jammed.

3.3.4 Air Pressure Failed
Pressure Switch indicates loss of air pressure to Keystone Valves.
Normal setting 60 PSI, alarm setting at 40 PSI.

3.3.5 System Over Pressure Fail
Potential submersible pump blockage/ backwash valve fault sequence.
This alarm is viewed by pressing ◄ on main page.
This is password protected. Current setting is 3 bar for 0.5 seconds; plant shutdown on alarm. Press ↵ button to accept alarm.

4.0 WET WELL CHAMBER

A submersible pump (Grundfos) pumps direct from wet well chamber to inlet to sand filter plant. Current set point levels for operation:

Top Level: 2800 mm
Low Level: 500 mm
Minimum Level for Backwash Sequence:1500 mm

Overflow of wet well chamber direct to oxidation pond.

4.1 MANUAL SUBMERSIBLE PUMP CONTROL

Manual START button located at top of wet well chamber. In the event operator wishes to run submersible pump manually from top of chamber, plant switch at PLC panel has to be turned OFF. Plant automatically defaults to online mode (inlet valves open and main outlet valve open).

Submersible pump will only start on manual press of START button. Releasing START button will stop pump.

Note: For sand filter plant to revert back to PLC control, system has to be switched back to low or high flow setting.

5.0 MANUAL AIR SCOUR/BACKWASH PROCEDURE

In the event of increase solid loading onto the sand filters, it is recommended to initiate a manual air/water scour. Increase inlet pressure and filter backwashing are indicators of increase in solid loading.

Sand Filter Plant is switched off at control panel. All inlet valves to filters are closed.

The following stages are carried out one filter at a time:

5.1 Inlet pipe arm to filter (straight upright line) is disconnected at mac union joint. A flexible hose is connected (22-30 mm) to one end, and fed direct to drain on floor.

5.2 Other two filter air release valves at top of filters are blocked.

5.3 Air blower is manually started to feed air direct to filter via normal route at base off filter. This will loosen up/remove solids on the sand bed.

5.4 Water supply connection, either by garden hose supply or site HP unit, connected to bottom tap connection. Flow of clean feed water to wash off solids to drain outlet.

5.5 Observe outlet pipe at drain for sand loss; regulate air/water if sand loss evident. Run for 10-15 minutes.

5.6 Repeat procedures (1) to (5) for each filter.

6.0 TROJAN UV3000

UV located after sand filters. System is **ON** continually, except for maintenance or service requirements. On wall unit measures UV intensity and elapsed time in hours. UV intensity measured in milliwatts per square centimeter (mW/cm^2), is the UV dose level delivered. The display will flash when the intensity falls below Low UV Intensity Alarm Set Point. Elapsed time measures time lamps have been running. Following 12,000 hours, display will flash (and continue to count) indicating the lamps to be changed in the near future.

Warning: care should always be exercised as direct exposure to UV can result in skin burn and damage to eyes. Transition boxes at inlet and outlet should not be opened to view inside chamber when UV is ON.

Note: Refer to Section 7.4 for complete O/M Manual, which also details cleaning protocol.

7.0 DATA RECORDING

In order to monitor plant performance, several key process points for recording are listed:

1. Date and Time
2. Pump Run Time
3. Time Since Last Backwash and Total
4. Inlet Pressure Reading
5. UV Intensity
6. UV Elapsed Time
7. Log Sheet

WHAKAPAPA WWTP SAND FILTER PLANT: OPERATOR LOG SHEET

DATE/TIME	INLET FLOW TO WET WELL	PUMP RUN TIME	INLET PRESSURE (BAR)	TIME SINCE LAST BACKWASH (TOTAL)	UV INTENSITY (mW / cm^2)	UV ELAPSED TIME (HRS)

COMMENTS/ACTIONS

8.0 MAINTENANCE

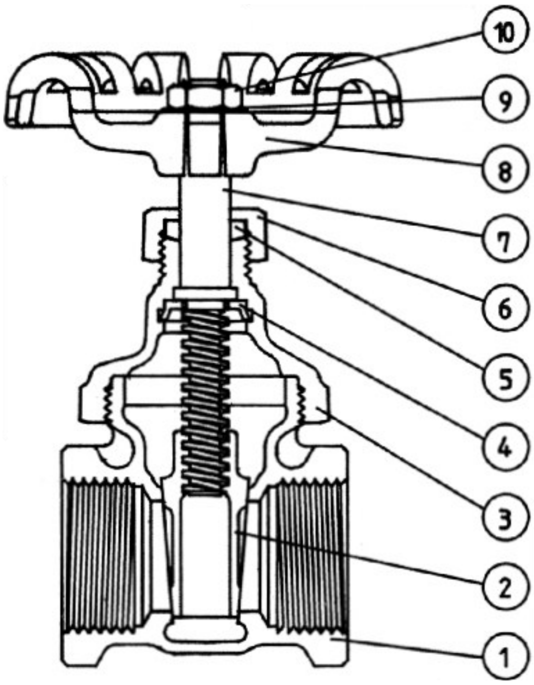
Refer to Equipment Specification information.

9.0 SPECIFICATION SHEETS

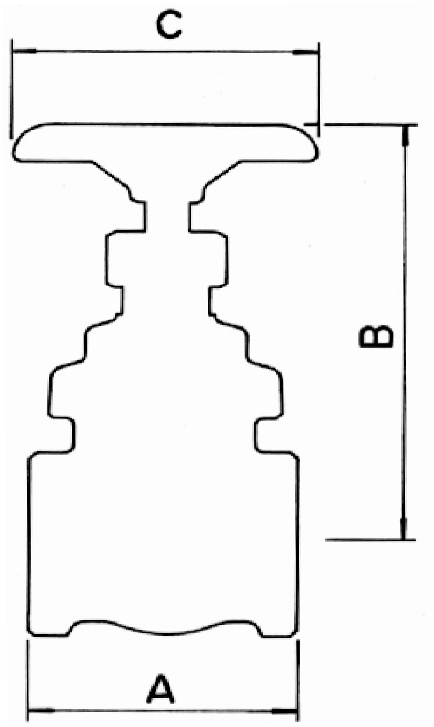
9.1 KEYSTONE VALVE
9.2 AIR BLOWER
9.3 TROJAN UV3000
9.4 ABAC AIR COMPRESSOR
9.5 GRUNDFOS SUBMERSIBLE PUMP
9.6 UNITRONICS PLC

LVG3 BRONZE GATE VALVE

- *Non rising stem.*
- *BSP threaded ends.*
- *All valves pressure tested to BS5154 & BS6755*
- *ANSI Class 125S, 200 CWP*
- *Quality Assurance Standard ISO/NZS 9002/3*



Part Number	Description	Material
1	Body	LG2 Gunmetal Bronze
2	Solid Wedge	LG2 Gunmetal Bronze
3	Bonnet	LG2 Gunmetal Bronze
4	Lock Washer	CZ121 Brass
5	Packing	PTFE
6	Packing Nut	LG2 Gunmetal Bronze
7	Spindle	CZ121 Brass
8	Handwheel	Aluminium or Synthetic
9	Identification Plate	Aluminium
10	Handwheel Nut	ZP Steel



Sizes		Weight	Dimensions (mm)		
NB*	DN**	Kg	A	B	C
1/4	6	0.253	40	66	50
1/2	15	0.248	45.5	69.5	50
3/4	20	0.334	50	82	60
1	25	0.520	58	98	70
1 1/4	32	0.850	65	115.5	80
1 1/2	40	1.110	67	128	80
2	50	1.800	80	156.5	90

*NB: Nominal Bore. **DN: Diameter Nominal

MADE IN ITALY

Ball Valves/ Catalog

CONTI

valve manufacturer since 1919

90°

1919 - 2009

90°
1919 - 2009

1919-2009: a 90-year history of quality and reliability

CONTI RUBINETTERIE, established in 1919 by Giovanni Conti, was the first valve manufacturing company to be erected in Valduggia which is located in northeastern Piedmont. Valduggia became in time one of the most important production areas of valves and fittings in the world. With its more than 90-year experience, today Conti Rubinetterie has become a major leader in the production of bronze and brass valves and its products are sold in more than 50 countries worldwide.

Thanks to its advanced manufacturing techniques and equipment, its continued programme of engineering research, its skilled craftsmen and technical expertise, Conti designs and constructs reliable products for these fields and applications:

- Petrochemical industry
- Irrigation systems
- Mining and infrastructure industries
- Shipyard industry
- Compressed air
- Textile industry
- Mechanical industry
- Steam applications
- Other various industries

In addition to these, Conti Rubinetterie has become highly successful at developing specialized bronze and bronze alloy valves for industries which require the following characteristics:

- Desalination
- Highly corrosive environments

Conti Rubinetterie is the ideal business partner for any industrial sector, thanks to its wide range of products (ball valves, gate valves, globe valves, check valves, etc.) as well as custom-made solutions, making it one of the most complete in Europe. In addition to the European market the valves are successfully sold in South America, North and South Africa, Middle East, Australia and Singapore.

The company is still ran by the Conti family who over time has created a solid organization aimed at building up an innovative environment based on quality, reliability and availability.

Conti Rubinetterie has two manufacturing plants as well as its own bronze foundry (a very rare case in the industry), which allows it to have complete control over every aspect of the production process: purchase of the raw materials, casting of the individual pieces, tooling and machining of all components, assembling and packaging of all items. A final testing is carried out on each valve before it is considered ready to be shipped.

Today, Conti Rubinetterie is a complete premier source for all valve needs and 100% of its production is proudly “Made in Italy”.

CONTI
valve manufacturer since 1919

Directions

Conti manufacturing facilities
and foundry

Certified know-how

Conti holds a leading role in the quest of quality construction and production processes. Our valves completely designed and manufactured in our factories by a skilled team and with the most innovative equipment, are constructed to last over time. They undergo a stringent and rigorous sequence of tests and internal inspections.
Today, just as 90 years ago, product quality continues to be at the heart of every stage of the production cycle.
Qualified certifying laboratories worldwide have certified our valves for their performance, solidity and duration.

CSI CERT

Certificato n° / Certificate n. SQ99300 — Settore EA / EA Sector 18 - 29a

CONTI RUBINETTERIE DI CONTI & C. Sas

Sede legale / Registered office

Via Astabbio, 5 - 13018 VALDUGGIA (VC) - ITALIA

Unità operativa / Place of business

Via Astabbio, 5 - 13018 Valduggia (VC) - Italia

È conforme alla norma / Is compliance with the standard UNI EN ISO 9001:2008

Per i seguenti servizi / processi / prodotti - Concerning the following services / processes / products

Progettazione, produzione e commercializzazione di rubinetterie e valvole industriali.

Design, production and marketing of industrial taps and valves

→ Conti Rubinetterie has a quality system certificate in compliance with **UNI EN ISO 9001:2008** standards

→ Our valves are manufactured according to the European **PED 97/23/CE** standards

100% Production Control

→ Raw materials are purchased directly from certified suppliers

→ Internal foundry guarantees quality from the earliest stages of production

→ Bodies and components are entirely machined on-site

→ Tooling, assembly and testing machineries have been developed according to our specific needs

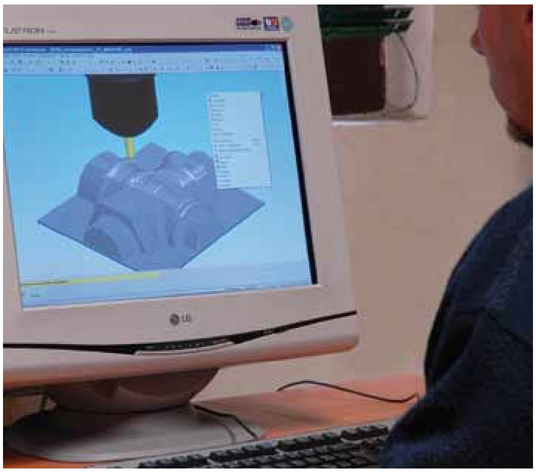
Technology

→ All production processes use the most technologically advanced equipment

Reliability

→ Each and every valve is tested before being sent out

Solutions



→ Special requirements and custom needs are taken care of quickly and with expertise

Respecting the Environment

The SUN provides 40% of the energy our production process requires

The WATER used during the production processes is purified with a filtration system and recycled

The AIR from the foundry vapors is gathered, purified by a certified filtration system and released clean into the environment

INDEX

PAGE

CUSTOM OPTIONS AVAILABLE

Upon customer requests the following alloys and/or materials may be chosen. Please note that each color corresponds to a specific option shown in the catalog.

STAINLESS STEEL AISI 316

ALUMINIUM/BRONZE ALLOY

MONEL 400 ALLOY

CAST IRON GS 400

- THREADED VALVES can be manufactured according to the following standards:

ANSI - ASME B1.20.1 - NPT
GAS UNI - ISO228
ISO7/1 RC - RP THREADS

- FLANGED VALVES can be manufactured according to the following standards:

PN16
PN20
B16.24 ASA 150

04352

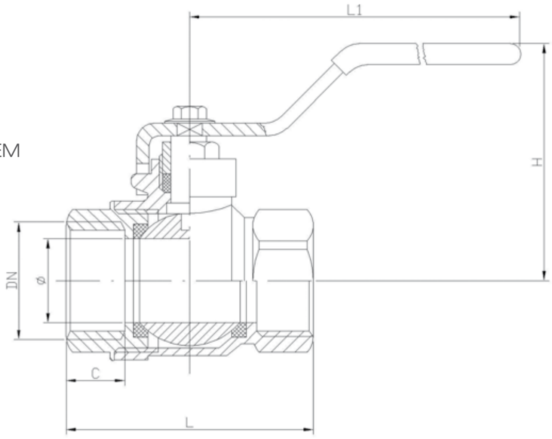
BRASS BALL VALVE PN25 FULL WAY FXF BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN25 600WOG

04355

PN25 600WOG

AISI 316 BALL AND STEM



	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-4"	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"	2"1-2	3"	4"
Ø (mm)	10	10	15	20	25	32	40	50	65	80	100
L (mm)	39	39	55	62	71	83	95	114	147	169	191
L1 (mm)	80	80	93	91	128	128	140	140	286	286	286
H (mm)	39	39	53	58	65	70	82	92	120	130	145
C (mm)	9	9	13	14	16	17	18	21	28	28	32
WEIGHT (Kg)	0,100	0,110	0,220	0,325	0,515	0,710	1,170	1,800	3,810	5,570	8,900

04354

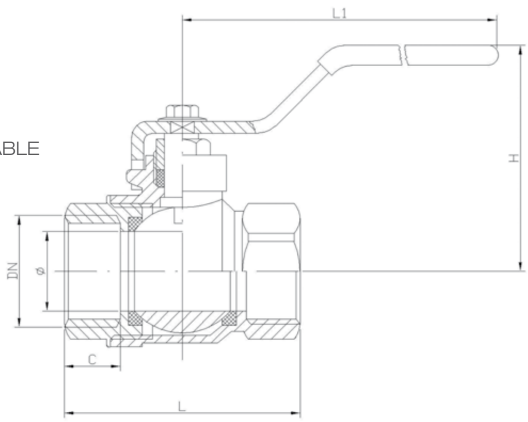
DZR BRASS BALL VALVE PN25 FULL WAY FXF BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN25 600WOG

04357

PN25 600WOG

BALL AISI 316 BALL SUITABLE FOR DRINKING WATER



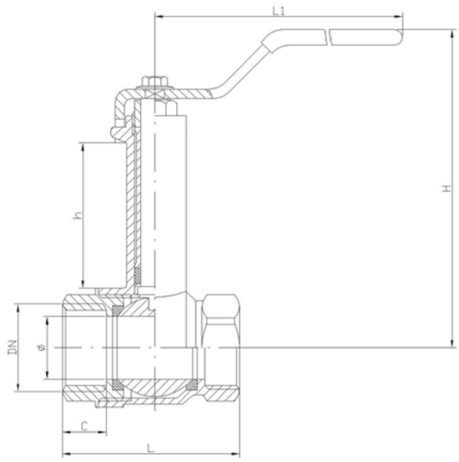
	STANDARD MATERIALS
Body	Dzr Brass-CW602N UNI EN12165
Body End	Dzr Brass-CW602N UNI EN12165
Ball	Dzr Brass-CW602N UNI EN12164
Stem	Dzr Brass-CW602N UNI EN12164
Seat	PTFE

	1-4"	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	10	10	15	20	25	32	40	50
L (mm)	39	39	55	62	71	83	95	114
L1 (mm)	80	80	93	91	128	128	140	140
H (mm)	39	39	53	58	65	70	82	92
C (mm)	9	9	13	14	16	17	18	21
WEIGHT (Kg)	0,100	0,110	0,220	0,325	0,515	0,710	1,170	1,800

04363

BRASS BALL VALVE PN25 FULL WAY FXF LONG NECK, ADJUSTABLE PACKING

PN25 600WOG



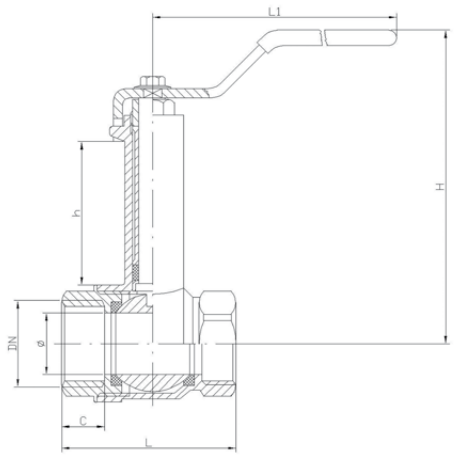
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body end	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	10	15	20	25	32	40	50
h (mm)	14	46,5	46,5	50,2	50,2	57,5	57,5
H (mm)	50	94	98	106	111	130	138
L (mm)	39	54,5	61,5	70	84	95,5	114
C (mm)	9	13	14	16	17	18	21
L1 (mm)	80	92	92	129	129	140	140
WEIGHT (Kg)	0,280	0,330	0,400	0,600	0,800	1,350	2,000

04364

DZR BRASS BALL VALVE PN25 FULL WAY FXF LONG NECK, ADJUSTABLE PACKING

PN25 600WOG



	STANDARD MATERIALS
Body	Dzr Brass-CW602N UNI EN12165
Body End	Dzr Brass-CW602N UNI EN12165
Ball	Dzr Brass-CW602N UNI EN12164
Stem	Dzr Brass-CW602N UNI EN12164
Seat	PTFE

	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	10	15	20	25	32	40	50
h (mm)	14	46,5	46,5	50,2	50,2	57,5	57,5
H (mm)	50	94	98	106	111	130	138
L (mm)	39	54,5	61,5	70	84	95,5	114
C (mm)	9	13	14	16	17	18	21
L1 (mm)	80	92	92	129	129	140	140
WEIGHT (Kg)	0,280	0,330	0,400	0,600	0,800	1,350	2,000

04456

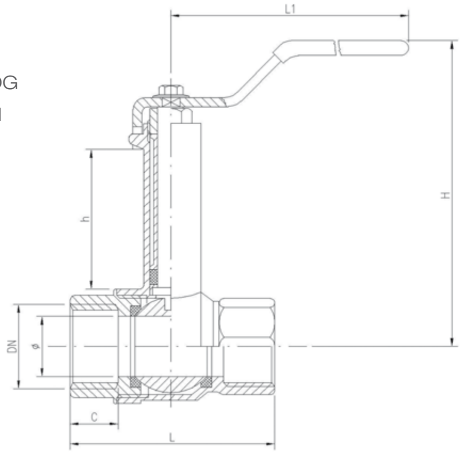
BRONZE BALL VALVE PN25 FULL WAY FXF LONG NECK, ADJUSTABLE PACKING

PN25 600WOG

04458

PN25/B 150WSP 300WOG

AISI 316 BALL AND STEM



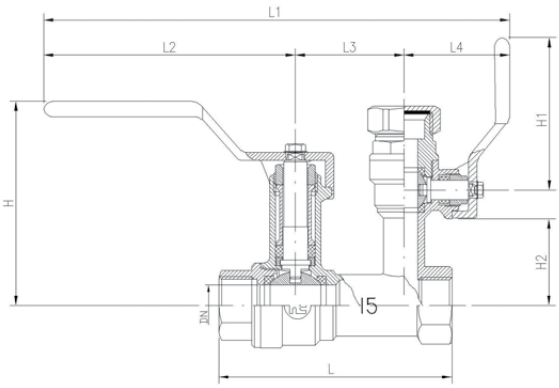
	STANDARD MATERIALS
Body	Bronze-CC491K UNI EN1982
Body end	Bronze-CC491K UNI EN1982
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	15	20	25	32	40	46
h (mm)	46,5	46,5	50,2	50,2	57,5	55
H (mm)	94	98	106	111	130	138
L (mm)	57	68	79	93	101	121
C (mm)	14	16	19	21	22	26
L1 (mm)	92	92	129	129	140	140
WEIGHT (Kg)	0,300	0,440	0,660	0,890	1,500	2,780

04366

BRASS BALL VALVE PN16 FULL WAY FXF DOUBLE NECK, ADJUSTABLE PACKING

PN16 600WOG



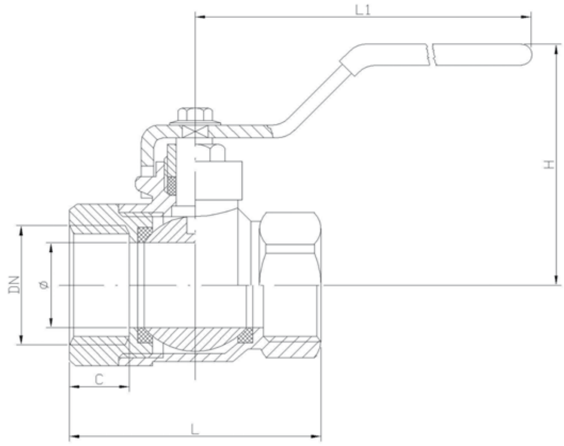
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body end	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	15	20	25	32	40	46
L (mm)	85,4	91	98,8	106,8	117	119
L1 (mm)	169,7	169	202,5	202,5	220	225,5
L2 (mm)	93	93	125,5	125,5	140	144,5
L3 (mm)	39,7	39	40	40	43	44
L4 (mm)	37	37	37	37	37	37
H (mm)	75	80	85	90	100	138
H1 (mm)	80	80	80	80	80	80
H2 (mm)	31,65	45,2	48,6	53	66	84
WEIGHT (Kg)	0,408	0,550	0,800	1,200	1,800	2,570

04001

BRASS BALL VALVE PN16 REDUCE WAY FXF BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN16



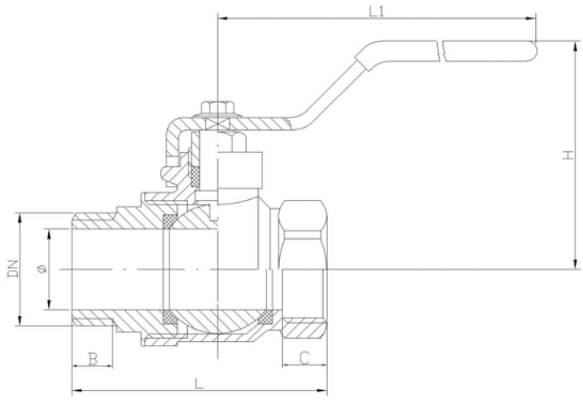
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body end	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-2"	3-4"	1"	1"1-4	1"1-2	2"	2"1-2	3"
Ø (mm)	12	15	20	25	32	40	50	65
L (mm)	53	65	71	83	95	117	148	169
L1 (mm)	91	91	128	128	140	140	240	286
H (mm)	52	56	64	69	80	95	125	130
C (mm)	13	13	16	17	18	19	28	28
WEIGHT (Kg)	0,216	0,345	0,522	0,835	1,180	1,880	3,460	5,570

04452

BRASS BALL VALVE PN25 FULL WAY MXF, BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN25 600WOG



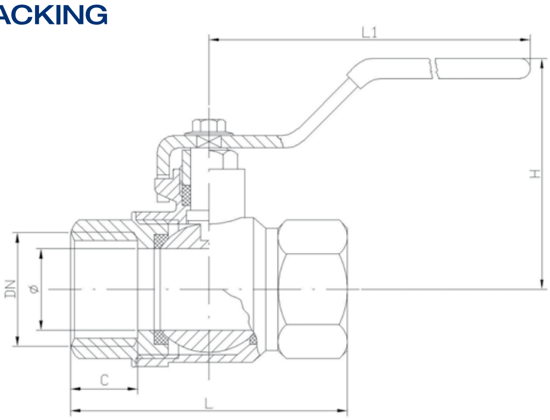
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-4"	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	10	10	15	20	25	32	40	50
L (mm)	47	47	64	71	82	96	108	127
L1 (mm)	80	80	93	93	126	126	145	145
H (mm)	39	39	53	56	65	70	80	88
C (mm)	9	9	12	13	15	15	16	18
B (mm)	10	10	12	12	16	18	19	21
WEIGHT (Kg)	0,130	0,127	0,340	0,530	0,530	0,840	1,260	1,890

04442

BRONZE BALL VALVE PN40 FULL WAY FXF, BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN40 600WOG



04443

PN40 600WOG

ALL IN Bz/Al

04445

PN40 600WOG

Bz/Al BALL AND STEM

04446

PN40 600WOG

AISI 316 BALL AND STEM

04448

PN40 600WOG

Bz/Al BODY, AISI 316 BALL AND STEM

04449

PN40 600WOG

MONEL 400 BALL AND STEM

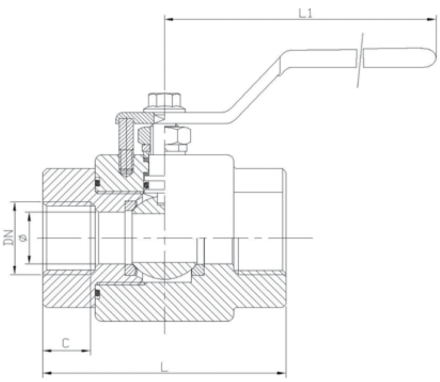
	STANDARD MATERIALS
Body	Bronze-CC491K UNI EN1982
Body End	Bronze-CC491K UNI EN1982
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-4"	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"	2"1/2	3"	4"
Ø (mm)	10	10	15	20	25	32	40	50	65	80	100
L (mm)	39	39	57	68	79	93	107	130	152	175	200
L1 (mm)	80	80	92	92	126	126	142	142	286	286	286
H (mm)	38	38	55	56	68	72	82	91	125	135	165
C (mm)	9	9	14	17	19	21	22	26	30	30	30
WEIGHT (Kg)	0,110	0,120	0,255	0,380	0,580	0,920	1,650	2,300	4,150	5,800	9,100

04480

BRONZE BALL VALVE PN64 FULL WAY FXF, BLOW-OUT PROOF STEM

PN64 800WOG



04481

PN64 800WOG

Bz/Al BALL

04482

PN64 800WOG

ALL IN Bz/Al

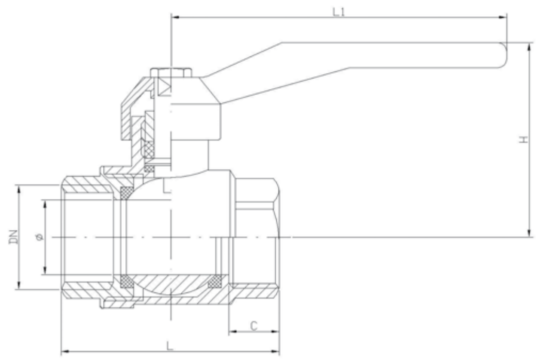
	STANDARD MATERIALS
Body	Bronze CC491K UNI EN1982
Body End	Bronze CC491K UNI EN1982
Ball	Bronze CC491K UNI EN1982
Stem	AISI 316
Seat	PTFE

	1-2"	3-4''	1''	1''1-4	1''1-2	2''
Ø (mm)	15	20	25	32	40	50
L (mm)	70	80	95	115	120	140
L1 (mm)	90	90	125	125	142	142
C (mm)	15	16	18	19	19	19

VSF04302

BRASS BALL VALVE PN20 FULL WAY FXF, BLOW-OUT PROOF STEM

PN20



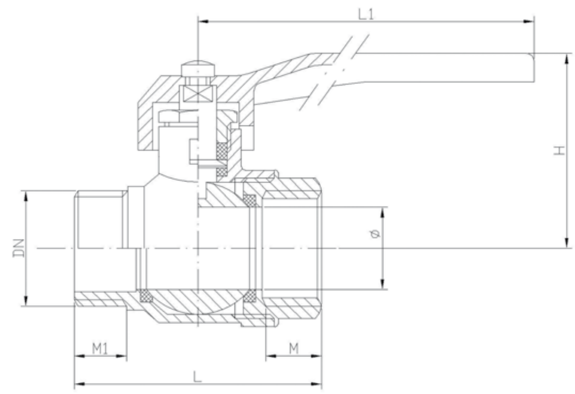
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-4"	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"	2"1-2	3"	4"
Ø (mm)	10	10	14	19	25	31	39	49	63	75	100
L (mm)	42	42	49	58	68	82	89	105	131	150	190
L1 (mm)	90	90	90	90	115	115	150	150	270	270	320
H (mm)	40	40	45	50	58	65	80	87	110	120	155
C (mm)	10	10	12	13	14	16	16	17	23	25	26
PN	20	20	20	20	20	16	16	16	10	10	10
WEIGHT (Kg)	0,148	0,148	0,148	0,200	0,342	0,542	0,810	1,280	2,675	4,424	7,000

VSF04342

BRASS BALL VALVE PN20 FULL WAY MXF, BLOW-OUT PROOF STEM

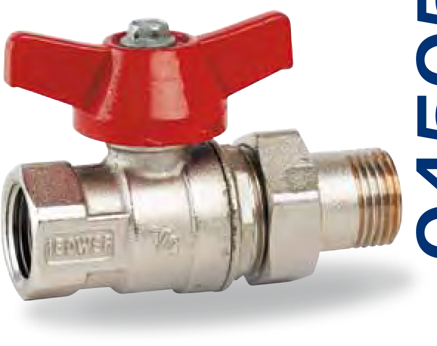
PN20



	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

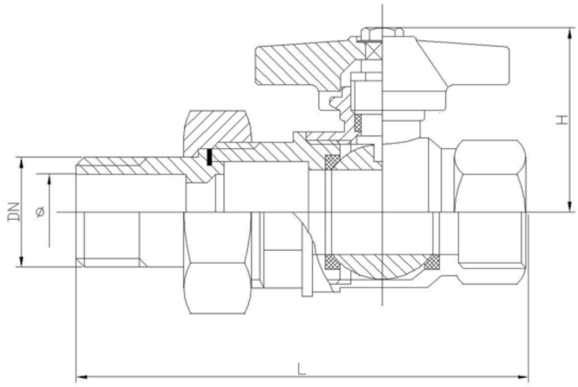
	1-4"	3-8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	10	10	14	19	25	31	39	49
L (mm)	42	42	54	59	68	82	89	105
L1 (mm)	90	90	90	90	115	115	150	150
H (mm)	40	40	45	50	58	68	80	87
M (mm)	10	10	12	13	14	17	17	19
M1 (mm)	9	10	13	14	16	18	18	20
PN	20	20	20	20	20	16	16	16

04505



BRASS BALL VALVE PN25 FULL WAY MXF, BLOW-OUT PROOF STEM WITH PIPE UNION

PN25 600WOG



	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-2"	3-4"	1"
Ø (mm)	15	20	25
L (mm)	84	97	112
H (mm)	55	56	78

VSF04900

BRASS BALL VALVE PN25 THREE WAY SCREWED ENDS, BLOW-OUT PROOF STEM

PN25 600WOG

L

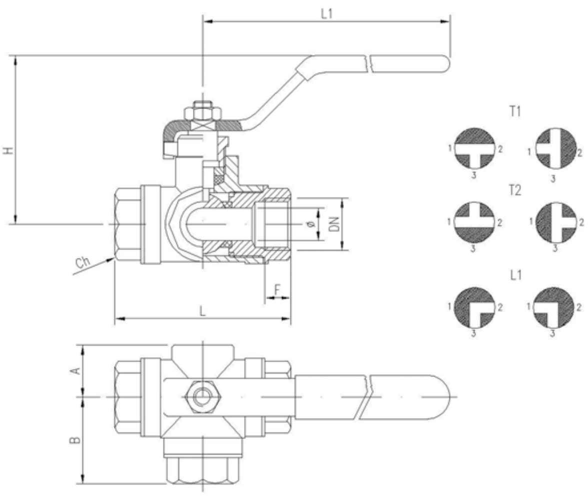
BALL TYPE “L”

T1

BALL TYPE “T1”

T2

BALL TYPE “T2”



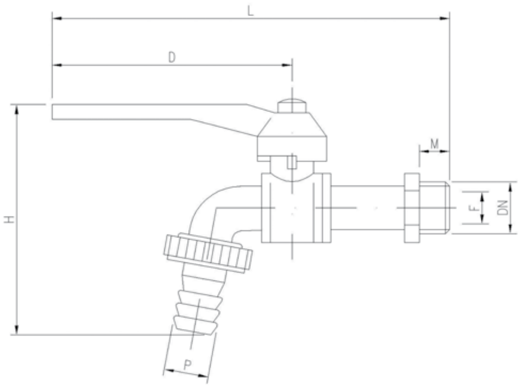
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1/4"	3/8"	1-2"	3-4"	1"	1"1-4	1"1-2	2"
Ø (mm)	10	10	12	15	20	25	32	40
F (mm)	12	12	14	16	19	21	23	26
L (mm)	74	74	80	90	105	115	138	161
H (mm)	58	58	60	64	73	79	100	105
L1 (mm)	90	90	125	125	140	140	220	220
A (mm)	22	22	24	28	31	35	42	48
B (mm)	37	37	39	46	52	58	69	80
Ch (mm)	22	22	29	34	42	50	57	68
PN (mm)	32	32	32	32	32	25	25	25

VSF04708

BRASS BALL BIBCOCK PN10 M WITH HOSE JOINTS

PN10



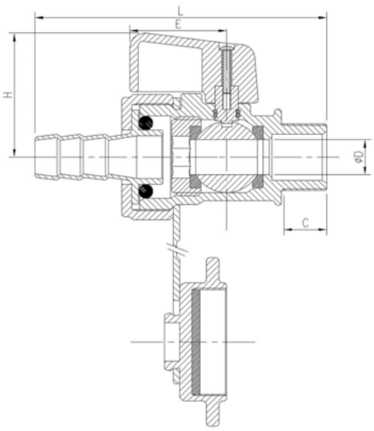
	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-2"	3-4"	1"
D (mm)	90	90	90
H (mm)	92	103	118
L (mm)	136	155	170
M (mm)	10	14	15
P (mm)	14	20	25
F (mm)	10	12	14
WEIGHT (Kg)	0,190	0,320	0,435

VSF05700

BRASS BALL VALVE PN16 FOR DRAINING BOILER

PN16

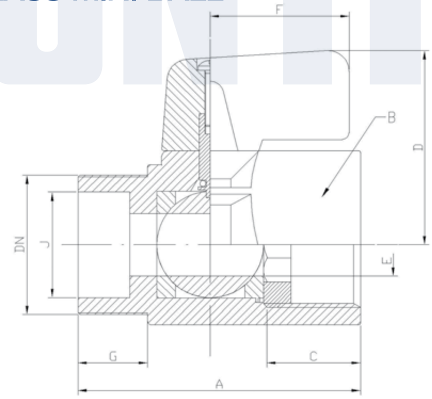


	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Body End	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	3-8"	1-2"
Ø (mm)	10	11
L (mm)	69	69
H (mm)	31	31
E (mm)	22	22
C (mm)	9	10

VSF05650

HOT PRESSED BRASS MINI BALL VALVE PN16 FXM
PN16

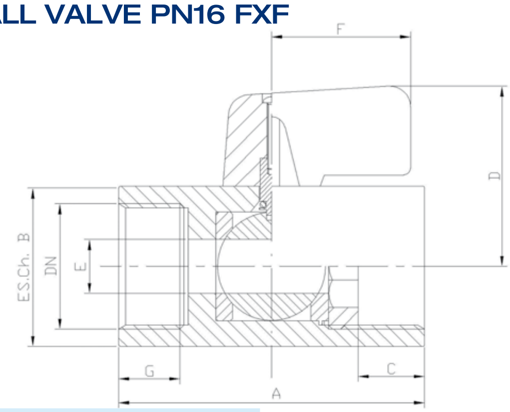


	STANDARD MATERIALS
Body	Brass-CW617N UNI EN12165
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-4"	3-8"	1-2"	1-2"	1-2"	1-2"	3-4"	1"
J (mm)	8	12	12	14	15	16	18	25
G (mm)	9	10	10,5	10,5	10,5	10,5	13,5	15
C (mm)	10	10	10,5	10,5	10,5	10,5	13,5	15
A (mm)	39	40	45	45	45	45	51	62,5
E (mm)	8	8	10	10	10	10	12	17,5
B (mm)	21	21	25	25	25	25	30	37
D (mm)	27	27	29	29	29	29	31,5	35
F (mm)	22	22	22	22	22	22	22	22

VSF05500

BRASS MINI BALL VALVE PN16 FXF
PN16

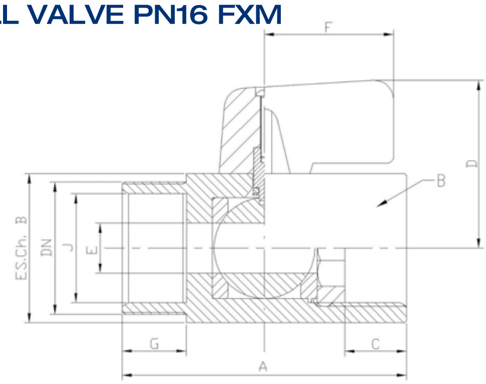


	STANDARD MATERIALS
Body	Brass-CW614N UNI EN12164
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-8"	1-4"	3-8"	1-2"	3-4"
G (mm)	9	9	10	10,5	13,5
C (mm)	9	9	9	10,5	13,5
A (mm)	39	39	42	47	54
E (mm)	6	8	8	10	12
B (mm)	21	21	21	25	30
D (mm)	27	27	27	29	31,5
F (mm)	22	22	22	22	22

VSF05550

BRASS MINI BALL VALVE PN16 FXM
PN16



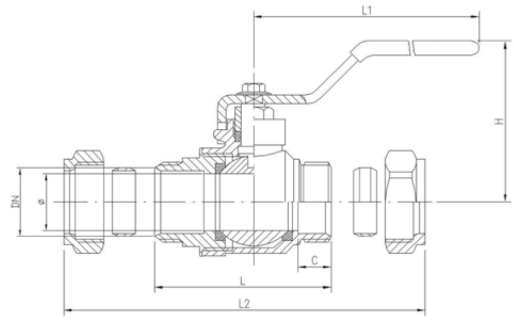
	STANDARD MATERIALS
Body	Brass-CW614N UNI EN12164
Ball	Brass-CW614N UNI EN12164
Stem	Brass-CW614N UNI EN12164
Seat	PTFE

	1-8"	1-4"	3-8"	3-8"	1-2"	1-2"	1-2"	1-2"	3-4"
J (mm)	6	8	10	12	12	14	15	16	18
G (mm)	9	9	10	10	10,5	10,5	10,5	10,5	13,5
C (mm)	10	10	10	10	10,5	10,5	10,5	10,5	13,5
A (mm)	39	39	40	40	45	45	45	45	51
E (mm)	6	8	8	8	10	10	10	10	12
B (mm)	21	21	21	21	25	25	25	25	30
D (mm)	27	27	27	27	29	29	29	29	31,5
F (mm)	22	22	22	22	22	22	22	22	22

04372

COPPER COMPRESSION DZR BRASS BALL VALVE PN25 FULL WAY, BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN25 600WOG



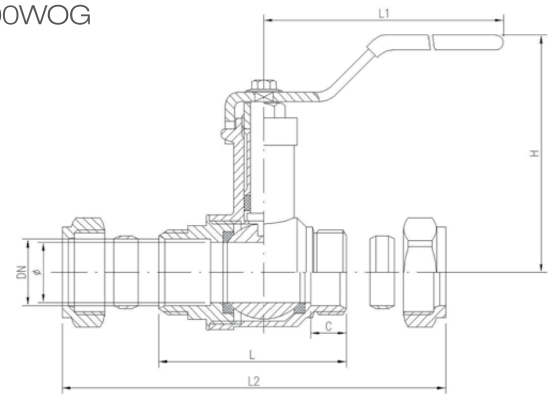
	STANDARD MATERIALS
Body	DZR Brass-CW602N UNI EN12165
Body End	DZR Brass-CW602N UNI EN12165
Ball	DZR Brass-CW602N UNI EN12164
Stem	DZR Brass-CW602N UNI EN12164
Seat	PTFE

	10	12	15	18	22	28	35	42	54
Ø (mm)	10	10	14	16	20	25	32	40	50
L (mm)	46	46	57	63	67	77	93	104	113
L1 (mm)	80	80	95	95	95	127	128	140	140
L2 (mm)	60	60	74	80	85	97	112	128	140
H (mm)	38	38	52	56	56	64	69	80	88
C (mm)	9	9	13	15	13	16	17	20	20
WEIGHT (Kg)	0,165	0,165	0,250	0,290	0,390	0,600	1,000	1,600	2,430

04383

COPPER COMPRESSION DZR BRASS BALL VALVE PN25 FULL WAY MEDIUM NECK, BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN25 600WOG



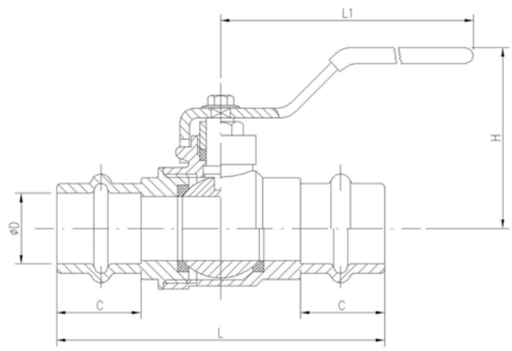
	STANDARD MATERIALS
Body	DZR Brass-CW602N UNI EN12165
Body End	DZR Brass-CW602N UNI EN12165
Ball	DZR Brass-CW602N UNI EN12164
Stem	DZR Brass-CW602N UNI EN12164
Seat	PTFE

	10	12	15	18	22	28	35	42	54
Ø (mm)	10	10	14	20	20	25	32	40	50
L (mm)	46	46	57	67	67	77	93	104	113
L1 (mm)	80	80	95	95	95	127	128	140	140
L2 (mm)	60	60	74	85	85	97	112	128	142
H (mm)	50	50	78	81	81	84	90	96	105
C (mm)	9	9	13	13	13	16	17	20	20
WEIGHT (Kg)	0,170	0,170	0,290	0,420	0,420	0,650	1,100	1,443	2,110

04470

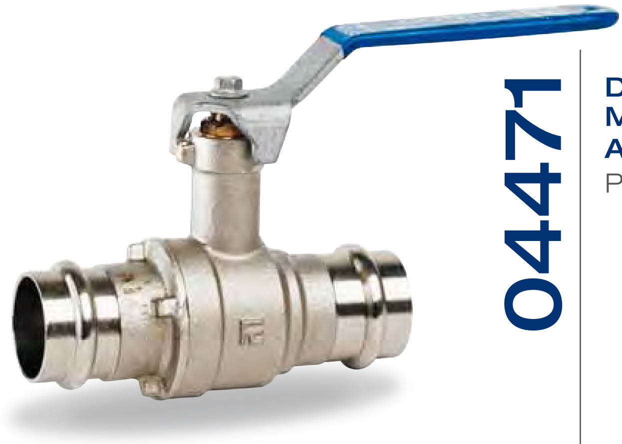
DZR BRASS BALL VALVE PN16 FULL WAY SHORT NECK PRESS FITTING ENDS, BLOW-OUT PROOF STEM, ADJUSTABLE PACKING

PN16



	STANDARD MATERIALS
Body	DZR Brass-CW602N UNI EN12165
Body End	DZR Brass-CW602N UNI EN12165
Ball	DZR Brass-CW602N UNI EN12164
Stem	DZR Brass-CW602N UNI EN12164
Seat	PTFE

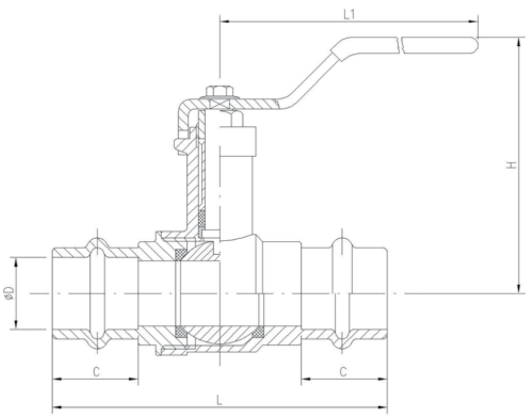
	15	22	28
Ø (mm)	15,2	22,3	28,3
L (mm)	86	105	122
L1 (mm)	95	95	127
H (mm)	52	56	64
C (mm)	20	24	24



04471

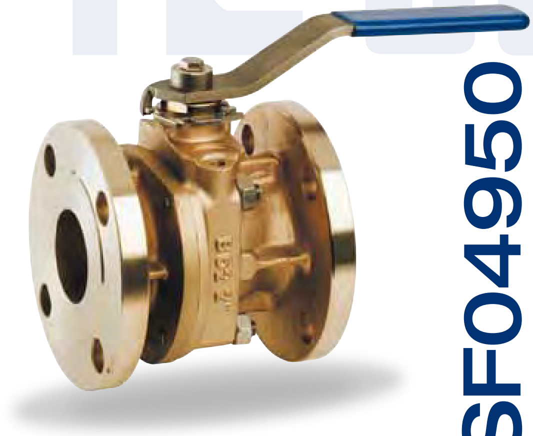
DZR BRASS BALL VALVE PN16 FULL WAY MEDIUM NECK PRESS FITTING ENDS, ADJUSTABLE PACKING

PN16



	STANDARD MATERIALS
Body	DZR Brass-CW602N UNI EN12165
Body End	DZR Brass-CW602N UNI EN12165
Ball	DZR Brass-CW602N UNI EN12164
Stem	DZR Brass-CW602N UNI EN12164
Seat	PTFE

	15	22	28
Ø (mm)	15,2	22,3	28,3
L (mm)	86	105	122
L1 (mm)	95	95	127
H (mm)	78	81	84
C (mm)	20	24	24



VSF04950

BRONZE BALL VALVE PN16 FULL WAY FLANGED ENDS

PN16

VSF04951

PN16

ALL Bz/Al

VSF04953

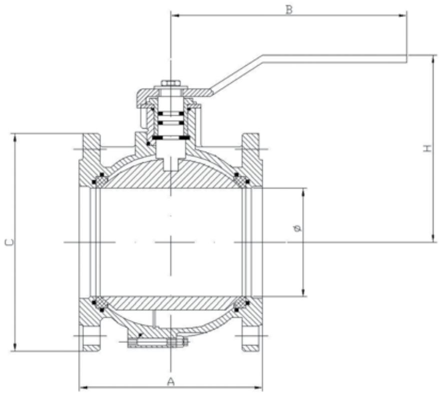
PN16

BALL AND STEM Bz/Al

VSF04954

PN16

BALL AND STEM AISI 316



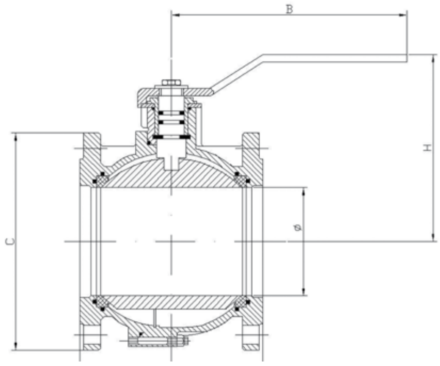
	STANDARD MATERIALS
Body	Bronze-CC491K UNI EN1982
Body End	Bronze-CC491K UNI EN1982
Ball	Brass-CW617N UNI EN12165
Stem	Brass-CW614N UNI EN12164
Seat	PTFE+GRAPHITE

	1/2"	3/4"	1"	1"1/4	1"1/2	2"	2"1/2	3"	4"	5"	6"	8"
Ø (mm)	15	20	25	32	40	50	63	76	95	120	145	190
A (mm)	115	120	125	130	140	150	170	180	190	200	210	400
B (mm)	160	160	170	170	220	220	284	284	360	447	560	1000
C (mm) (PN16)	95	105	115	140	150	165	185	200	220	250	285	340
H (mm)	84	84	95	100	118	125	152	166	180	225	242	320
OP.TORQUE (Nm)	15	15	18	18	18	20	40	70	100	180	250	600
WEIGHT (Kg)	2,800	3,400	4,800	5,600	7,900	10,500	15,100	19,100	24,000	36,700	44,600	93,000

VSF04956

CAST IRON BALL VALVE PN16 FULL WAY FLANGED ENDS

PN16



	STANDARD MATERIALS
Body	CAST IRON G25
Body End	CAST IRON G25
Ball	CAST IRON G25
Stem	BRASS-CW614N UNI EN12164
Seat	PTFE+GRAPHITE

	1/2"	3/4"	1"	1"1/4	1"1/2	2"	2"1/2	3"	4"	5"	6"
Ø (mm)	15	20	25	32	40	50	63	76	95	120	145
A (mm)	115	120	125	130	140	150	170	180	190	200	210
B (mm)	160	130	170	170	220	220	284	284	360	447	560
C (mm) (PN16)	95	105	115	140	150	165	185	200	220	250	285
H (mm)	84	85	95	100	118	125	152	166	180	225	242
OP.TORQUE (Nm)	15	15	18	18	18	20	40	70	100	180	250
WEIGHT (Kg)	2,800	3,400	4,800	5,600	7,900	10,500	19,100	24,000	36,700	44,600	93,000

LIQUID	Series 400	AISI304	AISI316	MONEL	CAST IRON	BRONZE	COPPER	NBR	EPDM	NICKEL	VITON
Butile acetate		1	1			1					
Amyl acetate			1	1		2					
Ethly acetate		2	1		3		2		2		
Acetylene		1	1	1							
Vinegar	1	1	1			2		2	1		1
Acetone		1	1	1	1	1				1	
Acetic acid	1	1	1		4	1			1		
Glacial acetic acid	2	3	1			4					
Boric acid		1	1	1	4	2				1	
Bromidic acid		4	4	3	4	3				3	
Hydrocyanic acid		1	1	1	3						
Citric acid		2	1		3	3		1	1		1
Hydrochloric acid (HCl + H_2O)		1	1		2						1
Hydrochloric acid (HCl)		4	4								1
Chloroacetic acid		4	4		4	4				2	
Chlorosulphonic acid		2		2							
Chromic acid			1	2		4					
Fluoridic acid		4	4		4	2					1
Fluosilicic acid		4	4	3	4						
Formic acid		4	3		4	3			1		
Phosphoric acid (85% 80°C)		2	3			2			1		1
Phosphoric acid (25% < 80°C)	2	1	1			3			1		1
Phosphoric acid (60% < 20°C)	1	1	1		4	2			1		1
Hydrofluoric acid											
Lactic acid cold		3	2	1	4	3				1	
Nitric acid		1	1		4	4			2		1
Oleic acid		1	1	1	4	4				1	
Oxalic acid		2	2		4	2		3	1		1
Palmitic acid		1	1	1	1	1					
Sulfamic acid											
Sulfonic acid											
Sulfuric acid		4	2		4	2					
Sulfurous acid											
Stearic acid		1	1	1	3	3				1	
Tannic acid		2	2	1		1				1	
Tartaric acid		2	1					1	2		1
Acid mineral water with oxydising salts		1	1	4	4	3				4	
Deionised water									1		
Demineralised water		2	1		3	4	4		1		1
Desalinated water		1	1		3			1	1		1
Distilled water											
Ionised water		1	1		3	3	3	1	1		
Oxygenated water		1	1					3	3		1
Salinated turpentine		2	2		3			1	1		1
Saline water		2	2		4						1
Water + abrasives		1	1		2	2		1	1		1
Ethyl alcohol		1	1					2	1		3
Isopropyl alcohol		1	1		1	1		2	1		1
Amide									1		
Ammoniac (NH_4OH)		2	2		2			1	1		1
Ammoniac (NH_3)		2	2		2				1		
Carbonic anhydride liq.		1	1		3			1	2		2
Carbonic anhydride +H2O		1	1		3			2	1		1
Maleic anhydride		2	1		3						1
Aniline, aniline oil		1	1	1	1	4					
Asphalts		1	1	1	1	1					
Photo developing baths		2	1						1		
Photo fixing baths		2	1						2		
Nickeling bath		2	1						1		2
Gasoline and water	1	1	1			1		1			1
Ammonium bicarbonate									1		
Sodium bicarbonate		3	3	1	4	2				1	
Calcium bisulfite			1	4	4	4					
Carbon bisulfite		1	1	1	1	4					
Chlorine dioxide		4	4		4	4					1
Beer								1	1		1
Wine lees fertiliser								2	1		3
Potassium bromide											
Butane			1	1	1						
Butanol, buticil alcohol				1	1	1					
Butyrolactone		1	1		2			3	3		3
Sodium carbonate								1	1		
Tar		1			1						
Kerosene		1	1	1	1	1					
Potassium cyanide								1	1		1
Pure actice chlorine (8ATE)		2	2		2	2					1
Calcium chloride		2	3		2		2	1	1		1
Magnesium chloride	2	2	2					1	1		1
Potassium chloride								1	1		1
Sodium chloride		2	2		4	3		1	1		1
Hydrogen chloride											1
Ethyl chloride											2
Ammonium chloride		2	2	2	3	4				2	
Aluminium chloride		4	4	1	2	2					
Calcium chloride		3	3	2	1	1					
Nickel chloride		2	2	3		4					
Copper chloride		4	4	2	2	3					
Methyl chloride				1	1	1					
Zinc chloride		4	4	1	3	4					
Sulfur chloride			3	3	3	4					
Ferric chloride		4	4	4	4	4				4	
Stannous chloride		3	3	4		4				4	
Mercuric chloride		4	4	4	3	4				4	
Barium chloride		2	1							1	
Creosote, timber		1	1	1	1	1					
Liquid detergent									1		2
Dowtherm					1	4					
Hexane		1	1		1	1		1	4		1
Ethers				1	1	1					
Ethyl benzene		1	1		1	1					1
Ethyl cellulose				1						1	
Phenol											1
Phenol pentachloride		1	1		1	1					
Aluminium fluoride		3	3								
Formaldehyde		1	2		4		2		2		
Ferrious phosphates		1	1		2						1
Calcium phosphate		2	2					1	1		1
Trisodium phosphate			1	1	1	3				1	
Tribasic ammonium phosphate		1	1	1	1	2				1	
Furaldehyde		1	1	1	1	1					
Freon 111		1	1								2
Freon 113 (R113)	1	1	1		1	1		1			2
Freon 12		2	1		1			1	2		1
Blast furnace gas		3		3	1	4					
Carbon furnace gas			1	1	1	1					

LIQUID	Series 400	AISI304	AISI316	MONEL	CAST IRON	BRONZE	COPPER	NBR	EPDM	NICKEL	VITON
Natural gas		1	1	1	1	3					
Gasogene				1	1	3					
Diesel											1
White diesel	1	1	1		2			3	3		1
Glycerine								1	1		1
Diethylene glycol		1	1					1	1		1
Propylene glycol	1	1	1						1		
Triethylene glycol (Radiator fluid)	1	1	1						1		2
Glucose		1	1	1	1	1					
Calcium hydrate/hydroxide		1	1			1		1	1		1
Sodium hydroxide											
Potassium hydroxide		2	2	1	3	4				1	
Calcium hypochlorite		3	3	3	3	3					
Sodium hypochlorite		4	4	3	4	3				3	
Isocyanate											2
Kerosene		1	1		1	1		3	2		1
Aviation kerosene		1	1		1	1		3	2		1
Kerosene + foaming agents +H_2O		1	1		1						1
Varnishes		1	1	1	3	3					
Varnish solutions		1	1	1	3	3					
Lactate		1	2		3	3		1	1		1
Calcium lactate		2	1		2				1		
Methylene chloride		2	1								2
Mercury		1	1	1	1	4					
Sodium metaphosphate		1		1		3				1	
1-methyl-2-pyrrolidone	1	2	1		-	3	-	4	4		4
Ammonium nitrate		1	1	3	1	4					
Sodium nitrate		2	1	1	1	2				1	
Nitrobenzene			1		1	2					
Cutting oil + H2O	1	1	1		1			3	3		1
Combustible oil		1		1	1	3					
Linseed oil		1	1		1			1	4		1
Castor oil		1		1	1						
Diathermic oil	1	1	1		1	4					1
Mineral oil	1	1	1		1						1
Oil SEA 10W30	1	1	1								1
Oil SEA 20W 50HD	1	1	1								1
Cerium oxide + water											
Carbon oxide warm		1	1		1	4					
Magnesium oxide		1	1	1	1	4				1	
Frozen oxygen		1	1	1	1	1					
Ozone + water											
P3 ferrofos 8579 (Henkel)	1	1	1		1						1
Sodium perborate		1	1	1	3					1	
Perchloroethylene /ethyl		2	2			3					1
Percolate											
Hydrogen peroxide											1
Sodium peroxide		1	1	1	3					1	
Crude oil		1	1	3	1	3				3	
Polyol		1	1						1		2
Potassium nitrate											
Perfume		1	1						1		
Propane		1	1	1	1						
R ethanol (ethane)		1	1		1			2	1		2
Blood + water		1	1		1	1	1	1	1		1
Brine		1	1		3	1	1				
Pure liquid soap		1	1		4	4		2	1		2
Sodium silicate		1	1		1	1		1	1		1
Whey		1	1		4	-	-	4	4		1
Caustic soda + H2O		2	1		2			1	1		2
Soda (5%) + nitric acid (5%)											
Sodium hypochlorite		3	2		4			2	2		1
Sodium sulfite		1	1					1	1		1
Ammonium sulfate		1	1	1	1	2					
Aluminium sulfate	2	1	1		4	2		1	1		1
Magnesium sulfate		1	1	1	1	1					
Calcium sulfate		1	1						1		
Ferrous sulfate		2	2		4				1		
Copper sulfate		2	2		4	3		1	1		1
Sodium sulfate		1	1	1	1	1				1	
Zinc sulfate		1	1	1	3	4					
Potassium sulfate		2	2	1	1	1				1	
Bicarbonate sulfate		1	1	2	1	4				2	
Barium sulfate		1	1	1		4					
Soap solutions		1		1	1	3					
Solvents with nitrus (explos.)		1	1		1			3	3		3
Concentrated orange juice								1	1		1
Tropical orange juice								1	1		1
Lemon juice											
Concentrated apple juice											
Concentrated cranberry juice											
Tomato juice											
Grapefruit juice								1	1		1
Concentrated grape juice											
Tensides + water		1	1								1
Tetrachlorethylene											
Carbon tetrachloride		3	3	1	3	3					
Aniline tincture		1		1							
Toluene				1	1						
Turpentine		1	1	1		3					
Triacetin + veg. Carbon		2	1			4			2		
Trichloroethylene		3	3	1	3	3					
Tricloroethane (solution)		1	1								1
Trieline/acetone/toluene		2	1		2			4	3		3
Trieline/ethylene trichloride		1	2		2			4	4		1
Triethyle amina		1	1					1	4		4
Urea									2		
Steam below 260 °C		1	1	1	1	1				1	
Steam from 260°C to 530°C		1	1	3	1	3				3	
Vaseline								1			1
White vaseline 206903											
Vaseline F3 Codex											
Wine	1	1	1		1	1		1	1		1
Vodka		1	1					2	1		3
Whiskey		1	1					1	1		1
Yoghurt								1			
Sulphur		2	2	4	1	4				4	
Sugar + Water 65° Brix		1	1					1	1		1

LEGEND

INDEX OF METAL RESISTANCE TO CORROSION

Class Resistence

Corrosion

Class	Resistence
1	optimum
2	sufficient
3	insufficient
4	poor

CONTI

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BALL VALVE DIVISION
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RUS **Руководство по эксплуатации**

GB **Instructions for use manual**

ВОЗДУШНЫЙ КОМПРЕССОР - AIR COMPRESSOR

RUS СИСТЕМА СИМВОЛОВ

GB SYMBOLS

RUS Перед тем, как приступить к работе, внимательно прочитайте инструкцию по эксплуатации
GB Before use, read the handbook carefully

RUS Вместительность резервуара
GB Tank capacity

RUS Опасность ожога
GB Warning, hot surfaces

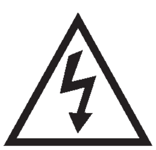
RUS Всасываемый воздух
GB Air intake

RUS Обязательная защита зрения
GB Obligatory eye protection

RUS Максимальное давление
GB Max. pressure

RUS Опасность автоматического включения
GB Danger - automatic control (closed loop)

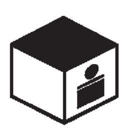
RUS Обороты/мин.
GB Revolutions / min. (rpm)



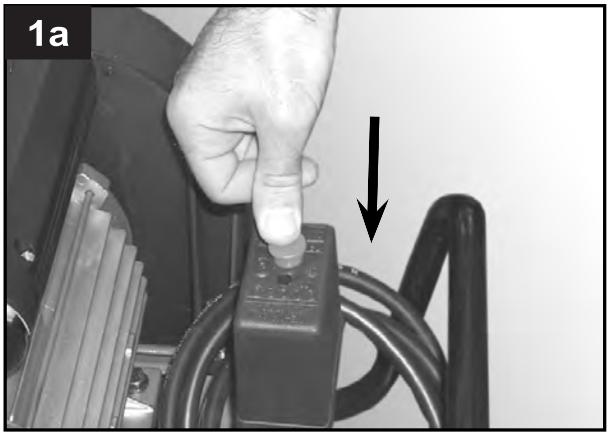
RUS Риск электрического напряжения
GB Dangerous voltage

RUS Напряжение и частота
GB Voltage and frequency

RUS Мощность мотора
GB Power



RUS Масса
GB Weight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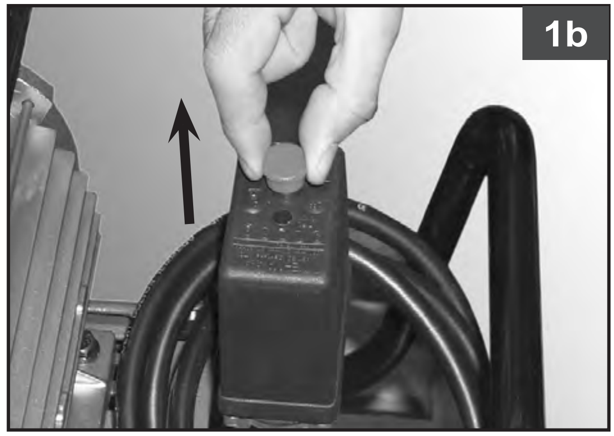
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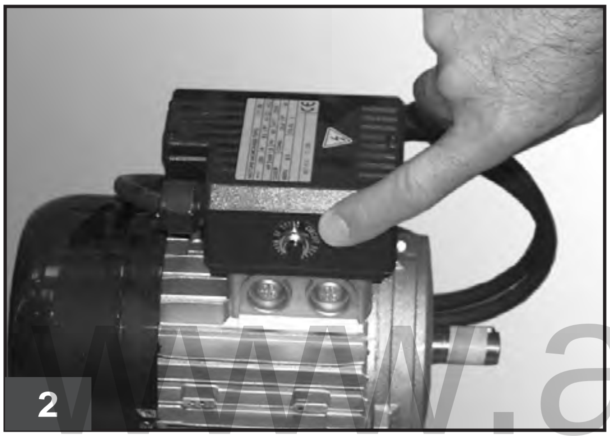
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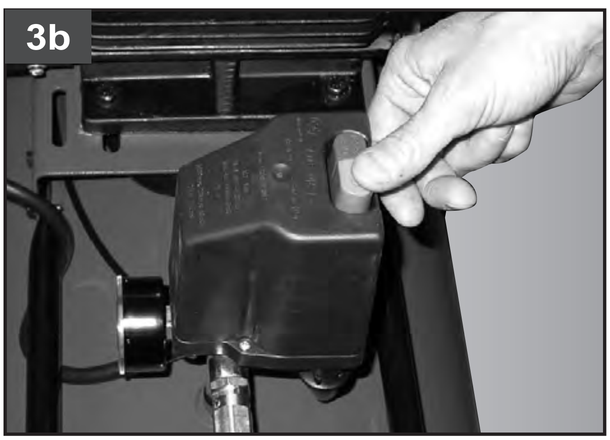
3a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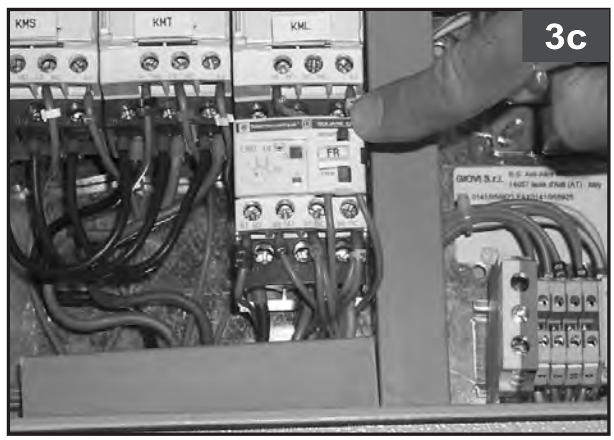
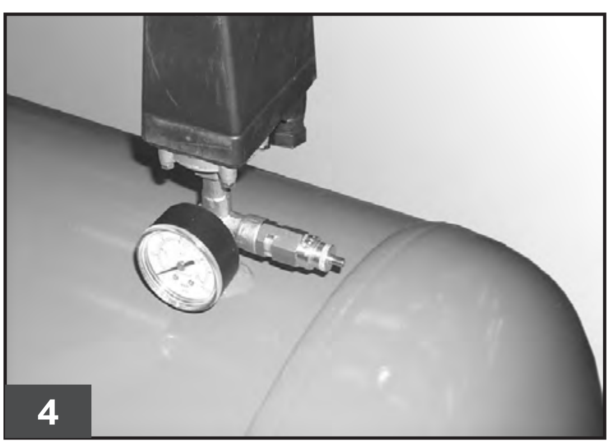

3c
KMS
KMT
KML
FR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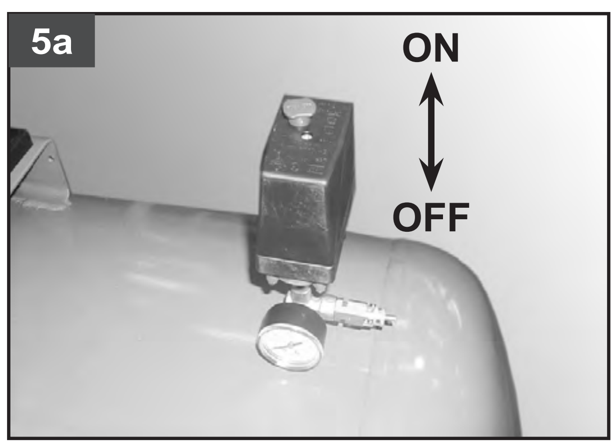
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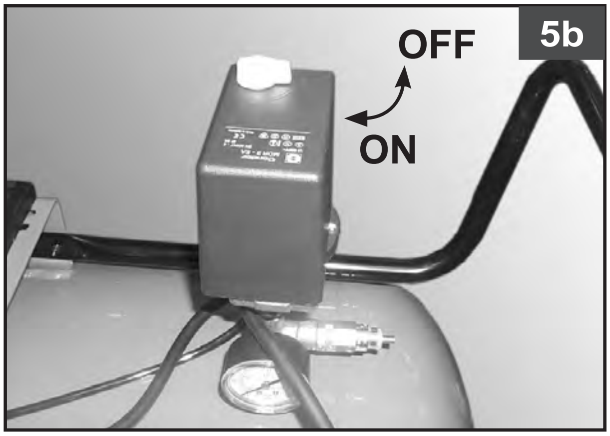
ON
OFF



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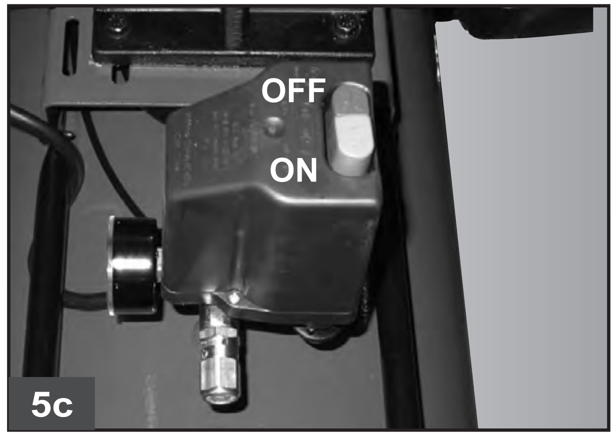

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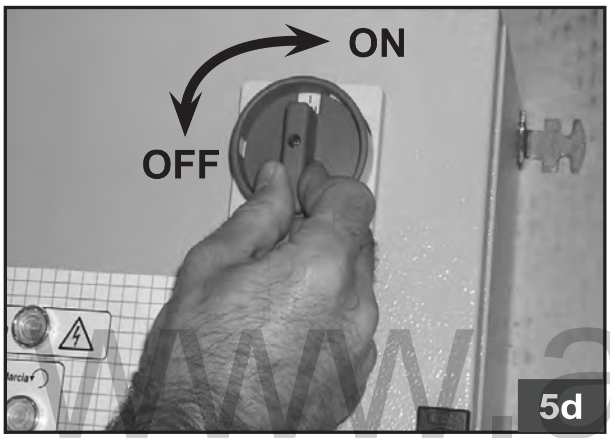
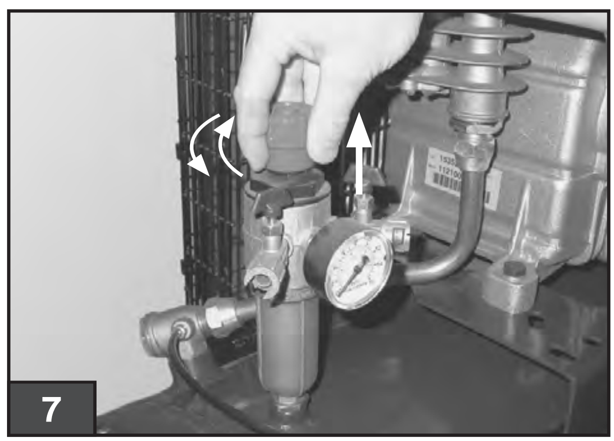


5d


6a


6b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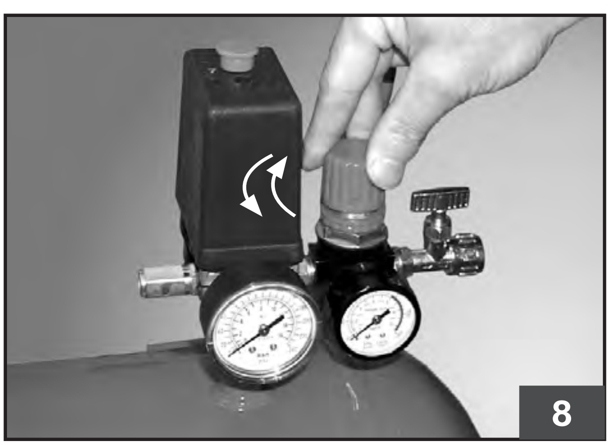
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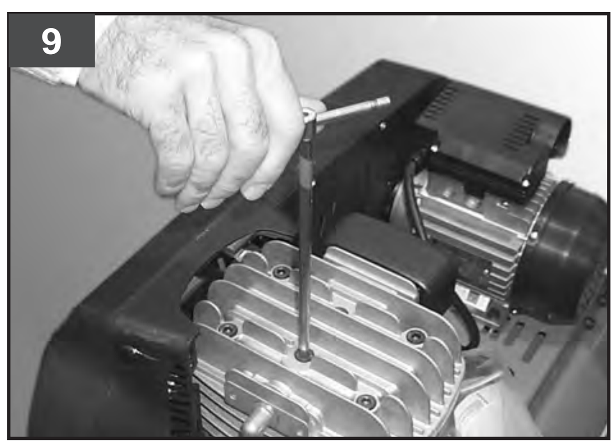
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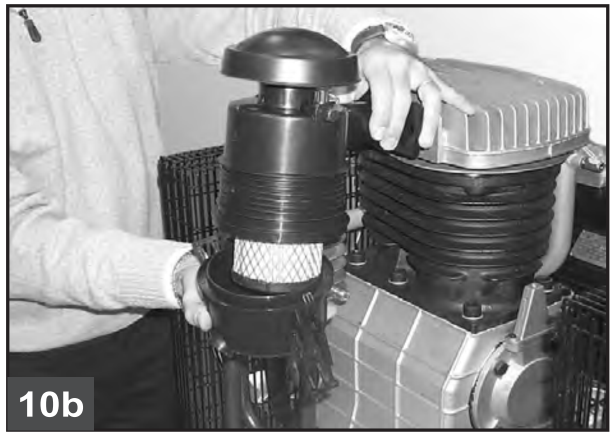
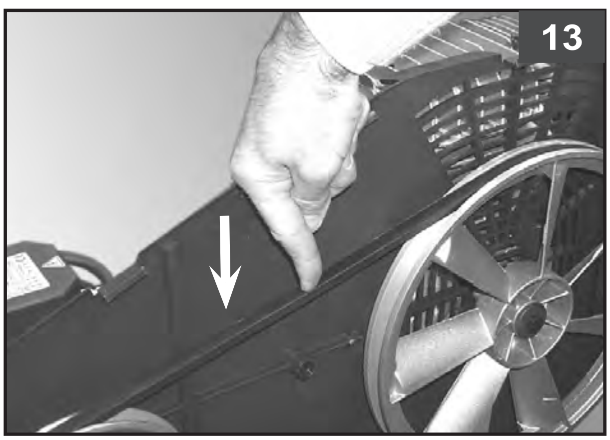
10a


10b


11


12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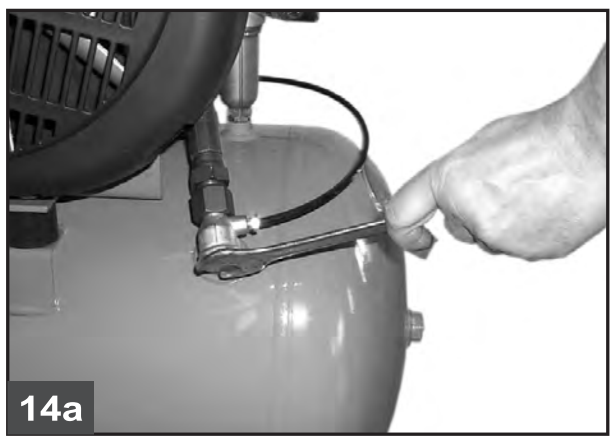
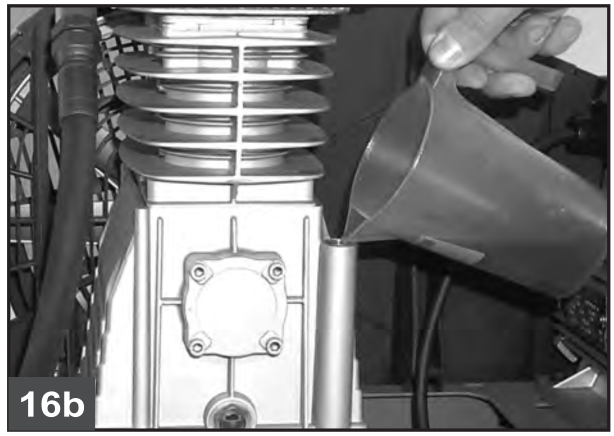

14a


14b


15


16a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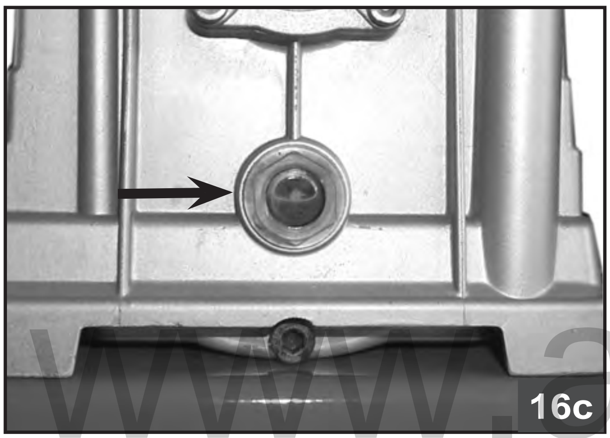
16c


17

Сохраняйте данное руководство в течение всего периода эксплуатации компрессора

1 МЕРЫ ПРЕДОСТОРОЖНОСТИ

Значение АКУСТИЧЕСКОГО ДАВЛЕНИЯ, измеренного на 4 m в свободном поле, эквивалентно значению АКУСТИЧЕСКОЙ МОЩНОСТИ, обозначенной на жёлтой этикетке, расположенной на компрессоре, минус 20 dB.

⚠ ПРАВИЛА РАБОТЫ

- **Компрессор должен работать в хорошо вентилируемых помещениях, при температуре от +5°C до +40°C. В воздухе помещения не должно содержаться пыли, паров кислот, взрывоопасных или легко воспламеняющихся жидкостей или газов.**
- Безопасное расстояние от работающего компрессора – не менее 4 м до места основной работы.
- Если брызги распыляемой при помощи компрессора краски попадают на защитный кожух ременного привода, значит компрессор стоит слишком близко к месту работы.
- Сетевой разъем для вилки электропровода должен соответствовать ей по форме, напряжению, частоте и соответствовать действующим нормами ТБ.
- Для трехфазных электродвигателей вилку электропровода должнен устанавливать только квалифицированный электрик, соблюдая действующие нормативы. При первом включении проверьте направление вращения ротора, которое должно совпадать со стрелкой на защитном кожухе привода (в моделях с пластмассовым кожухом) или на двигателе (в моделях с металлическим кожухом).
- При использовании удлинителя длина его кабеля не должна превышать 5 м, а его сечение должно соответствовать сечению кабеля компрессора.
- Не рекомендуется использовать удлинители большей длины, многоконтактные штепсели или переходные устройства.
- Выключайте компрессор всегда и только при помощи выключателя, расположенного на реле давления, либо при помощи выключателя электрощита, если он имеется в используемой вами модели. Чтобы после остановки компрессор не запускался с высоким давлением в головной части, не никогда не выключайте его, просто вынимая вилку из сети.
- Перемещая компрессор, тяните его только за предназначенную для этого скобу.
- Устанавливайте работающий компрессор на устойчивой горизонтальной поверхности: это гарантирует правильную смазку всех его узлов.
- Чтобы обеспечить нормальный приток охлаждающего воздуха к работающему компрессору, не устанавливайте его у стены ближе чем на 50 см.

⚠ НЕ ДЕЛАЙТЕ ЭТОГО

- Направлять струю сжатого воздуха на людей, животных или на собственное тело. (Чтобы со струей сжатого воздуха в глаза не попали мелкие частицы пыли, надевайте защитные очки).
- Направлять струю сжатого воздуха в сторону самого компрессора.
- Работать без защитной обуви, касаться работающего компрессора мокрыми руками и/или ногами.
- Резко дергать электропровод питания, выключая компрессор из сети, или тянуть за него, пытаясь сдвинуть компрессор с места.
- Оставлять компрессор под воздействием неблагоприятных атмосферных явлений (дождь, прямые солнечные лучи, туман, снег).
- Перевозить компрессор с места на место, не сбросив предварительно давление из ресивера.
- Производить механический ремонт или сварку ресивера. При обнаружении дефектов или признаков коррозии металла необходимо его полностью заменить.
- Допускать к работе с компрессором неквалифицированный или неопытный персонал. Не разрешайте приближаться к компрессору детям и животным. Размещать рядом с компрессором легко воспламеняющиеся предметы или класть на корпус компрессора изделия из нейлона и других легко воспламеняющихся тканей.
- Протирать корпус компрессора легко воспламеняющимися жидкостями. Пользуйтесь исключительно смоченной в воде ветошью. Не забудьте предварительно отключить компрессор от электросети.
- Использовать компрессор для сжатия иного газа, кроме воздуха.
- Данный компрессор разработан только для технических нужд. В больницах, в фармацевтике и для приготовления пищи к компрессору необходимо подсоединять устройство предварительной подготовки воздуха. Нельзя применять компрессор для наполнения аквалангов.
- Включать компрессор в работу без защитного кожуха ременного привода и касаться его движущихся частей.

⚠ ЧТО НАДО ЗНАТЬ

- **Во избежание чрезмерного перегрева электродвигателя компрессор работает в двухстадийном режиме периодического включения, соотношение между продолжительностью работы и выключением указано на табличке с техническими данными** (например, S3-50 означает 5 минут работы и 5 минут остановки). В случае перегрева срабатывает защитная термопара, установленная на электродвигателе.
- Для плавности пуска двигателя, кроме указанного выше, переключатель реле давления необходимо перевести сначала в положение «выкл.», а затем снова в положение «вкл.» (**рис. 1a-1b**).
- У однофазных электродвигателей, когда они отключаются вследствие перегрева, снова включить двигатель в работу можно только выключателем на клеммной коробке самого двигателя (**рис. 2**).
- У **трехфазных** двигателей достаточно вручную перевести переключатель реле давление в положение «включено» или нажать переключатель термопары, расположенный на электрощите (**рис 3a-3b-3c**).
- Для обеспечения плавного пуска в однофазных двигателях предусмотрено реле давления с выпускным воздушным клапаном замедленного действия (или с дополнительным на стопорном клапане). Поэтому при порожнем ресивере выход из воздушного клапана небольшой струи воздуха в течение нескольких секунд является нормальным.
- Для повышения безопасности работы все компрессоры оборудованы предохранительным клапаном, срабатывающим при отказе реле давления (**рис. 4**).
- Подсоединяя к шлангу компрессора пневмоинструмент, не забывайте перекрывать воздушный кран.
- При использовании сжатого воздуха (надувание, распыление через пневмоинструмент, окраска, мойка растворами на водной основе и т.п.) соблюдайте все правила ТБ для каждого конкретного случая.

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2 ПУСК И ЭКСПЛУАТАЦИЯ

- Установите колеса и ножку (в некоторых моделях шарнирно закрепленные) следуя инструкции. Если компресор снабжен неподвижными или вибрационно устойчивыми ножками, установите переднюю скобу или иной предусмотренный комплект деталей.
- Проверьте, чтобы параметры, указанные на заводской табличке, соответствовали фактическим параметрам электрической проводки; допустимое колебание напряжения составляет ± 10% от номинального значения.
- Вставить вилку питающего кабеля в розетку; переключатель реле давления при этом должен находиться в положении «O» (ВЫКЛ) (**рис. 5a-5b-5c-5d**).
- Для трехфазных электродвигателей вилка должна подсоединяться к электрощиту, оборудованному соответствующими плавкими предохранителями.
- Для моделей компрессоров с электрощитом (блок управления "Tandem" или пускатель с соединением «звезда-треугольник») установка электрощита и подсоединения всех необходимых контактов (на электродвигателе, реле давления, электроклапане) должна выполняться только квалифицированным персоналом.
- По контрольному глазку проверьте уровень масла, при необходимости отвинтите крышку маслоналивного отверстия и долейте масла (**рис. 6a-6b**).
- Теперь компрессор готов к работе.
- При переводе выключателя реле давления (или переключателя на электрощите) в положение «пуск» (**рис. 5a-5b-5c-5d**) компрессор начинает работать, подавая воздух через нагнетательный патрубок в ресивер.
- После того, как достигнуто максимальное рабочее давление (задается производителем в ходе испытаний), компрессор останавливается, излишек воздуха в головке и в напорном патрубке спускается

через клапан сброса под реле давления (при соединениях «звезда-треугольник» – через электроклапан, срабатывающий при остановке двигателя).

- Этим снимается избыточное давление в головной части компрессора, и нагрузка на двигатель при последующем пуске снижается. По мере расходования воздуха давление в ресивере падает и как только достигнет нижнего предела (разница между верхним и нижним уровнем составляет 2 бара), электродвигатель автоматически вновь включается в работу.
  Фактическое давление в ресивере показывается на манометре, входящем в комплект поставки. (**рис. 4**).
- В автоматическом режиме попеременного пуска и остановки компрессор работает до тех пор, пока выключатель реле давления (или на электрощите, см. **рис. 5a-5b-5c-5d**) не будет выключен.
- В моделях с электрощитом выключатель реле давления должен всегда находиться в положении ВКЛ. I (ON).
- Блок управления «Tandem», предусмотренный в некоторых моделях, позволяет использовать два компрессора – попеременно или, при необходимости, одновременно. В последнем случае, чтобы избежать пикового потребления электроэнергии, пуск второго относительно первого будет всегда немного сдвинут по времени.
- Редукционным клапаном давления оборудуются только компрессоры на тележке (в случае моделей на ножках такие клапаны обычно устанавливаются на линии подачи воздуха). При работе с пневмоинструментом давление можно регулировать поворачивая ручку клапана при открытом кране: поднять вверх и повернуть по часовой стрелке для повышения давления и против – для его уменьшения (**рис. 7**). Получив оптимальное для работы давление, заблокируйте клапан в нужном, снова опустив его ручку вниз.
- Давление можно проверить по манометру (в моделях, где он входит в комплект поставки, **рис. 8**).
- **Проверить, чтобы расход воздуха и максимльное эксплуатационное давление пневмтического инструмента были совместимы с давлением, установленным на регуляторе давления, и с количеством воздуха, подаваемого компрессором**
- По окончании работы остановите компрессор, отключите его от сети питания и сбросьте давление из ресивера.

3 ТЕХНИЧЕСКОЕ ОБСЛУЖИВАНИЕ

- Срок службы компрессора во многом зависит от правильного технического обслуживания.
- **ДО НАЧАЛА ЛЮБЫХ РАБОТ ПО ТЕХОБСЛУЖИВАНИЮ ПЕРЕВЕДИТЕ ПЕРЕКЛЮЧАТЕЛЬ РЕЛЕ ДАВЛЕНИЯ В ПОЛОЖЕНИЕ «ВЫКЛ.», ОТКЛЮЧИТЕ КАБЕЛЬ ОТ СЕТИ ЭЛЕКТРОПИТАНИЯ И СТРАВИТЕ ВОЗДУХ ИЗ РЕСИВЕРА.**
- Проверьте затяжку всех винтов, в особенности, в головной части узла (**рис. 10**). Контроль необходимо провести перед первым запуском компрессора.

ТАБЛИЦА 1 – ЗАТЯГИВАНИЕ БОЛТОВ КРЫШКИ ЦИЛИНДРА

	Мин. момент затяжки, Нм	Макс. момент затяжки, Нм
Болт M6	9	11
Болт M8	22	27
Болт M10	45	55
Болт M12	76	93
Болт M14	121	148

- Проверяйте чистоту воздушного фильтра на всасе каждые 100 часов, при загрязненном воздухе помещения – чаще. Своевременно заменяйте его (загрязненный фильтр приводит к снижению КПД компрессора и преждевременному износу его частей, **рис. 10a-10b**.
- После первых 100 часов работы смените масло; в дальнейшем заменяйте его через каждые 300 часов. Периодический проверяйте уровень масла.
- Используйте минеральное масло марки **API CC/SC SAE 40** (для холодного климатова рекомендуется **API CC/SC SAE 20**). Никогда не смешивайте разные марки масла. Если масло меняет свой нормальный цвет (светлее обычного = попала вода; темнее обычного = перегрелось), немедленно замените.
- После смены масла тщательно заверните крышку наливного отверстия (**рис. 11**), проверьте на утечку во время работы компрессора. Чтобы все работающие части компрессора достаточно смазывались, еженедельно проверяйте уровень масла (**рис. 6a**).
- Периодически (или по окончании работы, если она длилась более одного часа) слейте накопившийся в ресивере конденсат (**рис. 12**). Это помогает не только предотвращать коррозию металла, из которого изготовлен ресивер, но и не уменьшать его полезный объем.
- Периодически проверяйте натяжение ремней привода: прогиб (f) должен составлять около 1 см (**рис. 13**).

ТАБЛИЦА 2 – ВРЕМЕННЫЕ ПРОМЕЖУТКИ МЕЖДУ ТЕХНИЧЕСКИМ ОБСЛУЖИВАНИЕМ

РАБОТА	СПУСТЯ ПЕРВЫЕ 100 ЧАСОВ	КАЖДЫЕ 100 ЧАСОВ	КАЖДЫЕ 300 ЧАСОВ
Чистка фильтра всасывания и/или замена фильтрующего элемента		●	
Замена масла*	●		●
Затягивание болтов крышки цилиндра	Контроль необходимо провести перед первым запуском компрессора		
Избавление от конденсата в резервуаре	Переодически в конце работы		
Проверка напряжённости ремней	Переодически		

* Отработанное масло и конденсат должны сливаться в соответствии с действующими нормами ОХРАНЫ ОКРУЖАЮЩЕЙ СРЕДЫ.

Компрессор должен быть переработан следуя соответствующим каналам, предусмотренными местными нормативами

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4 ВОЗМОЖНЫЕ НЕПОЛАДКИ И СПОСОБЫ ИХ УСТРАНЕНИЯ

Неполадки в электрической части (кабели, электродвигатель, реле давления, электрощит и т.п.) должны устраняться квалифицированным электриком.

НЕПОЛАДКИ	ПРИЧИНЫ	СПОСОБЫ УСТРАНЕНИЯ
Воздушный клапан реле давления пропускает воздух.	Стопорный клапан износился или загрязнен.	Отвинтить шестигранную головку стопорного клапана, очистить седловину и резиновую прокладку (заменить, если изношена). Привинтить головку и аккуратно затянуть (**рис. 14a-14b**).
	Не закрыт кран спуска конденсата.	Закрыть кран.
	Рильсановая трубка, соединенная с реле давления, неправильно установлена.	Поставить правильно трубку **(рис. 15)**.

НЕПОЛАДКИ	ПРИЧИНЫ	СПОСОБЫ УСТРАНЕНИЯ
Снижение КПД. Частые пуски. Недостаточное давление сжатого воздуха.	Чрезмерное потребление сжатого воздуха.	Уменьшить запрос сжатого воздуха.
	Утечки в уплотнительных прокладках или шлангах.	Заменить прокладки.
	Фильтр на всасе засорен.	Очистить/заменить фильтр на всасе (**рис. 10a-10b**).
	Ослаблено натяжение ремня.	Проверить натяжение ремня **(рис. 13).**
Электродвигатель и/или сам компрессор нагреваются неравномерно.	Недостаточное воздушное охлаждение.	Проверить помещение, в котором находится компрессор.
	Каналы системы воздушного охлаждения засорены.	Проверить, при необходимости сменить воздушный фильтр.
	Недостаточная смазка.	Долить или заменить масло (**рис. 16a-16b-16c**).
Компрессор после попытки пуска тут же останавливается, потому что срабатывает термозащита по причине повышенной нагрузки на двигатель.	При пуске головная часть компрессора остается под давлением.	Разрядить головку компрессора, воздействуя на кнопку маностата.
	Низкая температура в помещении.	Проверить температуру помещения.
	Недостаточное напряжение в сети.	Проверить сетевое напряжение. При необходимости исключите работу с удлинителями кабеля.
	Недостаточная смазка или неправильно выбранная марка масла.	Проверить урвоень масла, долить или сменить марку при необходимости.
	Неисправности в электроклапане.	Обратиться в СТО.
Во время работы компрессор останавливаетс без видимых причин.	Срабатывает термозащита двигателя.	Проверить уровень масла
		Однофазный одноступенчатый: Перевести переключатель термозащиты в положение «выкл.» (**рис. 1a**). Сменить термопару (**рис. 2**) и повторить пуск (**рис. 1b**). Если остановки повторяются, обратитесь СТО.
		Пусковой блок «звезда-треугольник»: Переключить кнопку термозащиты на электрощите (**рис. 3c**) и повторить пуск (**рис. 5b**). Если остановки повторяются, обратитесь СТО.
		Другие модели: Перевести переключатель термозащиты в положение «выкл.» и затем снова в «вкл.» (**рис. 1a-1b**). Если остановки повторяются, обратитесь СТО.
	Неполадка в электрической части.	Обратитесь в СТО.
Во время работы компрессора наблюдатеся сильная вибрация, двигатель нерегулярно гудит. После остановки компрессор не перезапускается, хотя гул работающего двигателя слышен.	**Однофазный двигатель:** дефектный конденсатор.	Заменить конденсатор.
	Трехфазный двигатель: Одна фаза отключена, вероятно после срабатывания плавкого предохранителя.	Проверить состояние предохранителей на электрощите или в клеммной коробке, при необходимости заменить вышедшие из строя (**рис. 17**).
Наличие следов масла в воздушных каналах.	Чрезмерное количество масла в системе.	Проверить уровень масла.
	Изношены компоненты маслосистемы.	Обратитесь в СТО.
Спускной кран пропускает конденсат.	Кран загрязнен изнутри.	Прочистить кран.

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Во всех остальных случаях ремонт компрессора должен производиться на Станции Технического Обслуживания с использованием оригинальных запасных частей. Посторонние вмешательства приведут к отмене гарантийных обязательств производителя.

Preserve this handbook for future reference

1 PRECAUTIONS

The ACOUSTIC PRESSURE's value measured at 4 m in free field corresponds to the ACOUSTIC POWER's value stated on the yellow label located on the compressor, minus 20 dB.

⚠ THINGS TO DO

- **The compressor must be used in a suitable environment (well ventilated with an ambient temperature of between +5°C and +40°C) and never in places affected by dust, acids, vapors, explosive or flammable gases**.
- Always maintain a safety distance of at least 4 meters between the compressor and the work area.
- Any coloring of the belt guards of the compressor during painting operations indicates that the distance is too short.
- Insert the plug of the electric cable in a socket of suitable shape, voltage and frequency complying with current regulations.
- For 3-phase versions, have the plug fitted by a qualified electrician according to local regulations. When starting the compressor for the first time, check the correct direction of rotation and that this matches the direction indicated by the arrow on the belt guard (versions with plastic protection) or on the motor (versions with metal protection).
- Use extension cables with a maximum length of 5 meters and of suitable cross-section.
- The use of extension cables of different length and also of adapters and multiple sockets should be avoided.
- Always use the switch of the pressure switch to switch off the compressor or use the switch of the electric panel for models equipped with this. Never switch off the compressor by pulling out the plug in order to avoid restart with pressure in the head.
- Always use the handle to move the compressor.
- When operating, the compressor must be placed on a stable, horizontal surface to guarantee correct lubrication.
- Position the compressor at least 50 cm from the wall to permit optimal circulation of fresh air and to guarantee correct cooling.

⚠ THINGS NOT TO DO

- Never direct the jet of air towards persons, animals or your body. (Always wear safety goggles to protect your eyes from flying objects that may be lifted by the jet).
- Never direct the jet of liquids sprayed by tools connected to the compressor towards the compressor.
- Never use the appliance in your bare feet or with wet hands or feet.
- Never pull the power cable to pull the plug out of the socket or to move the compressor.
- Never leave the appliance exposed to adverse weather conditions (rain, sun, fog, snow).
- Never transport the compressor with the reservoir pressurized
- Never weld or machine the reservoir. In the case of faults or corrosion, replace it completely.
- Never allow inexpert persons to use the compressor. Keep children and animals away from the work area.
- Never position flammable or nylon or fabric articles close to and/or on the compressor.
- Never clean the compressor with flammable liquids or solvents. Clean with a damp cloth only, after making sure that you have unplugged the compressor.
- The compressor is designed only to compress air and must not be used for any other type of gas.
- The compressed air produced by the compressor cannot not be used for pharmaceutical, food or hospital purposes except after particular treatments. It is not suitable for filling the air bottles of scuba divers.
- Never use the compressor without guards (belt guard) and never touch moving parts.

⚠ THINGS YOU SHOULD KNOW

- **To avoid overheating of the electric motor, this compressor is designed for intermittent operation as indicated on the dataplate** (for example, S3-50 means 5 minutes ON and 5 minutes OFF). In the case of overheating, the thermal cutout of the motor trips, automatically cutting off the power when the temperature is too high due to excess current take-off.
- **To facilitate machine restart, it is important not only to carry out the operations indicated but also to set the button of the pressure switch, returning this to the OFF position and then ON again (figures 1a-1b).**
- On single-phase versions, press the reset button on the terminal box of the motor (**fig. 2**).
- On 3-phase versions, operate manually on the button of the pressure switch, returning this to the ON position, or press the button of the thermal cutout inside the box of the electric panel (**figures 3a-3b-3c**).
- The single-phase versions are fitted with a pressure switch equipped with a delayed closing air vent valve (or with a valve located on the check valve) that facilitates motor start-up; therefore a few-second jet of air from this, with the reservoir empty, is to be considered normal.
- To guarantee machine safety, all the compressors are fitted with a safety valve that is activated in the case of failure of the pressure switch (**fig. 4**).
- When connecting an air-powered tool to a hose of compressed air supplied by the compressor, interruption of the flow of air from the hose is compulsory.
- Use of the compressed air for the various purposes envisaged (inflation, air-powered tools, painting, washing with water-based detergents only, etc.) requires knowledge of and compliance with the rules established for each individual use.

2 START-UP AND USE

- Fit the wheels and foot (or the caster wheel for models that are fitted with this) according to the instructions provided in the packaging. For versions with fixed feet, assemble the front bracket kit or the vibration-dampers if furnished. Check that the rating data match the effective characteristics of the system (voltage and power).
- Check for correspondence between the compressor plate data with the actual specifications of the electrical system. A variation of ± 10% with respect of the rated value is allowed.
- Insert the power plug in a suitable socket checking that the button of the pressure switch located on the compressor is in the "O" (OFF) position (**figures 5a-5b-5c-5d**).
- For the 3-phase versions, connect the plug to a panel protected by suitable fuses.
- For the versions fitted with electric panel ("Tandem" control units or delta/star starters) have installation and connections (to the motor, to the pressure switch and to the electrovalve if any) carried out by qualified personnel.
- Check the oil level using the sight glass and if necessary unscrew the vent plug and top up. (**figures 6a-6b**).
- At this point, the compressor is ready for use.
- Operating on the switch of the pressure switch (or the selector for versions with electric panel, (**figures 5a-5b-5c-5d**), the compressor starts, pumping air in the reservoir through the delivery hose.
- On reaching maximum operating pressure (factory-set during testing), the compressor stops, venting the excess air present in the head and in the delivery hose through a valve located under the pressure switch (in delta/star versions, through an electrovalve that is activated when the motor stops).
- The absence of pressure in the head facilitates subsequent restart. When air is used, the compressor restarts automatically when the lower calibration value is reached (approx. 2 bar between upper and lower). The pressure inside the reservoir can be checked on the gauge provided (**fig. 4**).
- The compressor continues to operate automatically with this work cycle until the position of the switch of the pressure switch (or of the selector of the electric panel) figures **5a-5b-5c-5d**) is modified. To use the compressor again, wait at least 10 seconds after this has been switched off before restarting.
- In the versions with electric panel, the pressure switch must always be aligned with the **I** (**ON**) position.
- In tandem versions, the control unit provided permits use of only one of the two compressor groups (if necessary alternatively) or of both at the same time according to requirements. In this second case, start-up will be differentiated slightly to avoid excessively high current take-off at start-up (timed starting).
- Only the wheel-mounted compressors are fitted with a pressure reducer (in the versions with fixed feet, it is usually installed on the use line). Air pressure can be regulated in order to optimize use of air-powered tools

operating on the knob with the valve open (pulling it up and turning it in a clockwise direction to increase pressure and counterclockwise to reduce this) (**fig. 7**). Once you have set the value required, push the knob down to lock it.

- The value set can be checked on the gauge (for versions equipped with this, **fig. 8**).
- **Please check that the air consumption and the maximum working pressure of the pneumatic tool to be used are compatible with the pressure set on the pressure regulator and with the amount of air supplied by the compressor**.
- When you have finished working, stop the machine, pull out the plug and empty the reservoir.

3 MAINTENANCE

- The service life of the machine depends on maintenance quality.
- **PRIOR TO ANY OPERATION SET THE PRESSURE SWITCH TO THE OFF POSITION, PULL OUT THE PLUG AND COMPLETELY DRAIN THE RESERVOIR.**
- Check that all screws (in particular those of the head of the unit) are tightly drawn up (**fig. 9**). The check must be carried out prior to the first compressor starting.

TABLE 1 – TIGHTENING OF HEAD TENSION RODS

	Nm Min. torque	Nm Max. torque
Screw M6	9	11
Screw M8	22	27
Screw M10	45	55
Screw M12	76	93
Screw M14	121	148

- Clean the suction filter according to the type of environment and in any case at least every 100 hours. If necessary, replace the filter (a clogged filter impairs efficiency while an inefficient filter causes harsher wear on the compressor **(figures 10a - 10b)**.
- Change the oil after the first 100 hours of operation and subsequently every 300 hours. Check the oil level periodically.
- Use **API CC/SC SAE 40**. (For cold climates, **API CC/SC SAE 20** is recommended). Never mix different grade oils. If the oil changes color (whitish = presence of water; dark = overheated), it is good practice to replace the oil immediately.
- After topping up, tighten the plug (**fig. 11**) making sure that there are no leaks during use. Once a week, check the oil level to assure lubrication in time (**fig. 6a**).
- Periodically (or after completing work if for more than an hour), drain the condensate that forms inside the reservoir due to the humidity in the air (**fig. 12**) in order to protect the reservoir from rust and so as not to restrict its capacity.
- Periodically, check the tension of the belts which must have a flexion (f) of around 1 cm (**fig. 13**).

TABLE 2 – MAINTENANCE

FUNCTION	AFTER THE FIRST 100 HOURS	EVERY 100 HOURS	EVERY 300 HOURS
Cleaning of intake filter and/or substitution of filtering element		•	
Change of oil*	•		•
Tightening of head tension rods	The check must be carried out prior to the first compressor starting.		
Draining tank condensate	Periodically and at the end of work		
Checking the tension of the belts	Periodically		

* Spent oil and condensate **MUST BE DISPOSED OF** in compliance with protection of the environment and current legislation.

The compressor must be disposed in conformity with the methods provided for by local regulations

4 POSSIBLE FAULTS AND RELATED PERMITTED REMEDIES

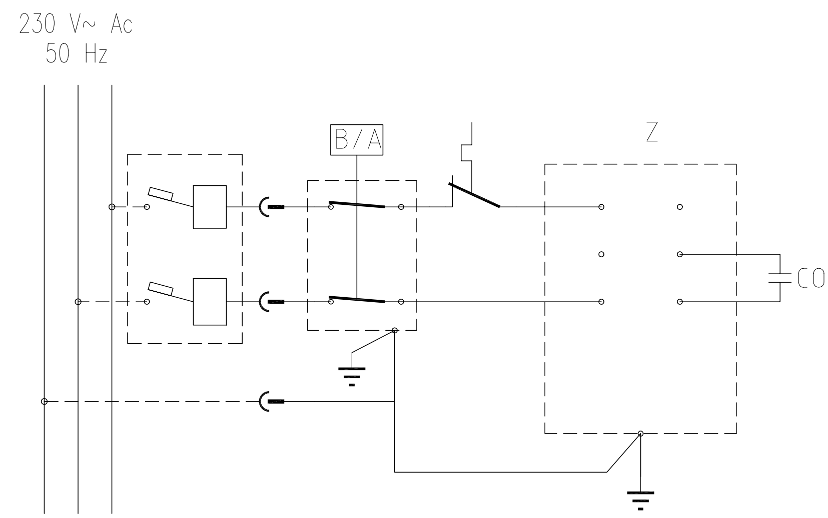
Request the assistance of a qualified electrician for operations on electric components (cables, motor, pressure switch, electric panel, etc).

FAULT	CAUSE	REMEDY
Air leak from the valve of the pressure switch.	Check valve does not perform its function correctly due to wear or dirt on the seal.	Unscrew the hex-shaped head of the check valve, clean the housing and the special rubber disk (replace if worn). Re-assembler and tighten carefully (**figures 14a-14b**).
	Condensate drainage cock open.	Close the Condensate drainage cock.
	Rilsan hose not inserted correctly in pressure switch.	Insert the Rilsan hose correctly inside the pressure switch **(fig. 15)**.
Reduction of efficiency, frequent start-up. Low pressure values.	Excessively high consumption.	Decrease the demand of compressed air.
	Leaks from joints and/or pipes.	Change gaskets.
	Clogging of the suction filter.	Clean/replace the suction filter (**figures 10a-10b**).
	Slipping of the belt.	Check belt tension **(fig. 13).**
The motor and/or the compressor overheat irregularly.	Insufficient ventilation.	Improve ambient conditions.
	Closing of air ducts.	Check and if necessary clean the air filter.
	Insufficient lubrication.	Top up or change oil (**figures 16a-16b-16c**).
After an attempt to start the compressor, it stops due to tripping of the thermal cutout caused by forcing of the motor.	Start-up with head of the compressor charged.	Release the compressor head by using the pressure switch push button.
	Low temperature.	Improve ambient conditions.
	Voltage too low.	Check that the mains voltage matches that of the dataplate. Eliminate any extensions.

GB

FAULT	CAUSE	REMEDY
After an attempt to start the compressor, it stops due to tripping of the thermal cutout caused by forcing of the motor.	Incorrect or insufficient lubrication.	Check level, top up and if necessary change the oil.
	Inefficient electrovalve.	Call the Service Center.
During operation, the compressor stops for no apparent reason.	Tripping of the thermal cutout of the motor.	Check level oil.
		Single-stage, mono-phase versions: operate on the button of the pressure switch returning this to the OFF position (**fig. 1a**). Reset the thermal cutout (**fig. 2**) and restart (**figures 1b**). If the fault persists, call the Service Center.
		Versions with delta-star starter: operate on the button of the thermal cutout located inside the box of the electric panel (**fig. 3c**) and restart (**fig. 5d**). If the fault persists, call the Service Center.
		Other versions: Operate on the button of the pressure switch returning this to the OFF position and then to ON again (**fig. 1a-1b**). If the fault persists, call the Service Center.
	Electric fault.	Call the Service Center.
When operating, the compressor vibrates and the motor emits an irregular buzzing sound. If it stops, it does not restart although the sound of the motor is present.	**Single-phase motors:** faulty capacitor.	Have the capacitor replaced.
	3-phase motors: One of the phases of the 3-phase power supply is missing due probably to blowing of a fuse.	Check the fuses inside the electric panel or the electric box and if necessary replace those that have been damaged (**fig. 17**).
Irregular presence of oil in the network.	Too much oil inside the unit.	Check oil level.
	Wear on segments.	Call the Service Center.
Leaking of condensate from the vent cock.	Presence of dirt/grit inside the cock.	Clean the cock.

Any other type of operation must be carried out by authorized Service Centers, requesting original parts. Tampering with the machine may impair its safety and in any case make the warranty null and void.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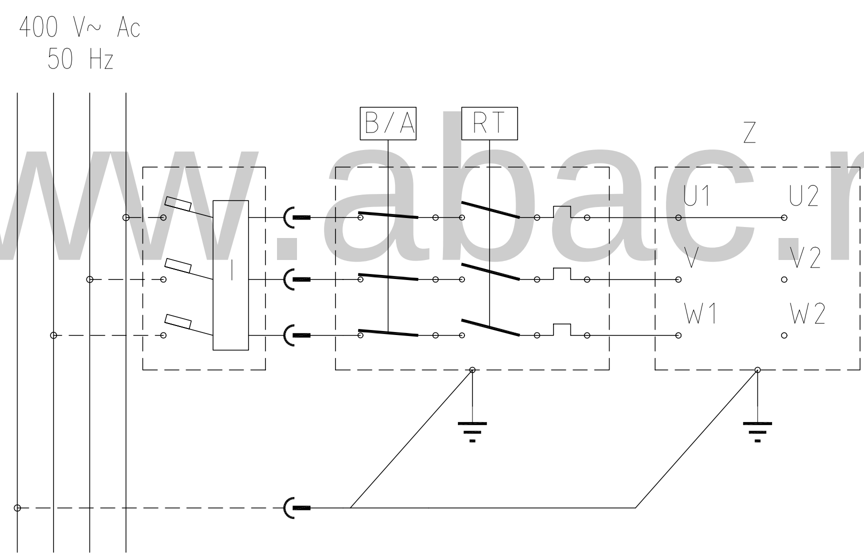
400 V~ Ac
50 Hz
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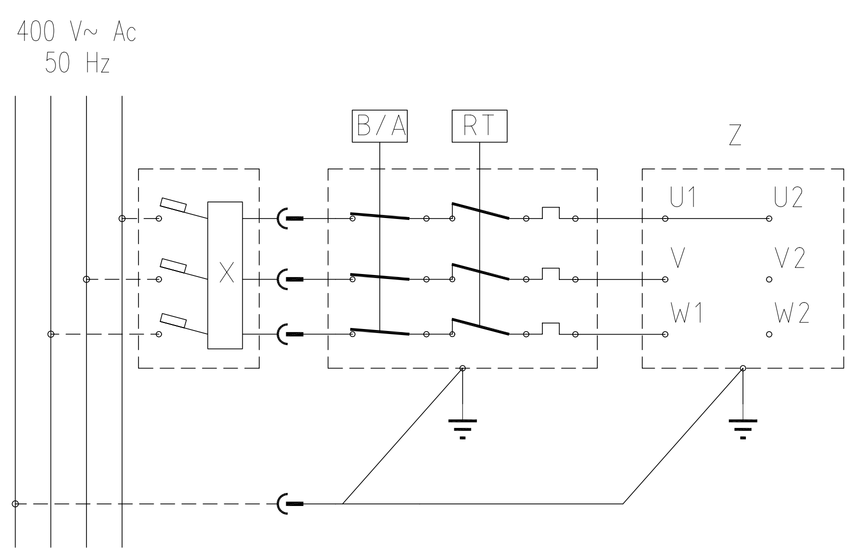
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ITT

Water & Wastewater

Installation, Operation, and Maintenance Manual

Flygt 8050

FLYGT

Engineered for life

Table of Contents

Introduction and Safety

Introduction

Purpose of this manual

The purpose of this manual is to provide necessary information for:

- Installation
- Operation
- Maintenance

CAUTION:

Read this manual carefully before installing and using the product. Improper use of the product can cause personal injury and damage to property, and may void the warranty.

NOTICE:

Save this manual for future reference, and keep it readily available at the location of the unit.

Inspect the delivery

Inspect the package

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.

   If the product has been picked up at a distributor, make a claim directly to the distributor.

Inspect the unit

1. Remove packing materials from the product.

   Dispose of all packing materials in accordance with local regulations.
2. Inspect the product to determine if any parts have been damaged or are missing.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.

   For your personal safety, be careful when you handle nails and straps.
4. Contact your sales representative if anything is out of order.

Product warranty

Coverage

ITT undertakes to remedy faults in products from ITT under these conditions:

- The faults are due to defects in design, materials, or workmanship.
- The faults are reported to an ITT representative within the warranty period.
- The product is used only under the conditions described in this manual.
- The monitoring equipment incorporated in the product is correctly connected and in use.
- All service and repair work is done by ITT-authorized personnel.
- Genuine ITT parts are used.
- Only Ex-approved spare parts and accessories authorized by ITT are used in Ex-approved products.

Limitations

The warranty does not cover faults caused by these situations:

- Deficient maintenance
- Improper installation
- Modifications or changes to the product and installation made without consulting ITT

- Incorrectly executed repair work
- Normal wear and tear

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

ITT products are high-quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, then contact your ITT representative.

Spare parts

ITT guarantees that spare parts will be available for 15 years after the manufacture of this product has been discontinued.

Safety

WARNING:

- The operator must be aware of safety precautions to prevent physical injury.
- Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
- Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT. If there is a question regarding the intended use of the equipment, please contact an ITT representative before proceeding.
- This manual clearly identify accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal.
- Do not change the service application without the approval of an authorized ITT representative.

CAUTION:

You must observe the instructions contained in this manual. Failure to do so could result in physical injury, damage, or delays.

Safety message levels

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product
- Product malfunction

Definitions

Safety message level	Indication
DANGER:	A hazardous situation which, if not avoided, will result in death or serious injury

Safety message level	Indication
WARNING:	A hazardous situation which, if not avoided, could result in death or serious injury
CAUTION:	A hazardous situation which, if not avoided, could result in minor or moderate injury
Electrical Hazard:	The possibility of electrical risks if instructions are not followed in a proper manner
NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

User safety

General safety rules

These safety rules apply:

- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.

Safety equipment

Use safety equipment according to the company regulations. Use this safety equipment within the work area:

- Helmet
- Safety goggles, preferably with side shields
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection
- First-aid kit
- Safety devices

NOTICE:

Never operate a unit unless safety devices are installed. Also see specific information about safety devices in other chapters of this manual.

Electrical connections

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations. For more information about requirements, see sections dealing specifically with electrical connections.

Hazardous liquids

The product is designed for use in liquids that can be hazardous to your health. Observe these rules when you work with the product:

- Make sure that all personnel who work with biologically hazardous liquids are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.

Wash the skin and eyes

Do the following if chemicals or hazardous fluids have come into contact with your eyes or your skin:

If you need to wash your...	Then...
Eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least one minute. 3. Seek medical attention, if required.

Monitoring equipment

For additional safety, use condition-monitoring devices. Condition-monitoring devices include but are not limited to the following:

- Level indicators
- Temperature detectors

Environmental safety

The work area

Always keep the station clean to avoid and/or discover emissions.

Recycling guidelines

Always recycle according to these guidelines:

1. Follow local laws and regulations regarding recycling if the unit or parts are accepted by an authorized recycling company.
2. If the first guideline is not applicable, then return the unit or parts to your ITT representative.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Appropriately dispose of all waste.
- Handle and dispose of the processed liquid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.

Electrical installation

For electrical installation recycling requirements, consult your local electric utility.

Transportation and Storage

Transportation guidelines

Precautions

WARNING:

- Stay clear of suspended loads.
- Observe accident prevention regulations in force.

Position and fastening

The pump can be transported either horizontally or vertically. Make sure that the product is securely fastened during transportation, and cannot roll or fall over.

Lifting

WARNING:

- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- Lift and handle the product carefully, using suitable lifting equipment.
- The product must be securely harnessed for lifting and handling. Use eyebolts or lifting lugs if available.
- Always lift the unit by its lifting handle. Never lift the unit by the motor cable or by the hose.
- Do not attach sling ropes to shaft ends.

Lifting equipment

Lifting equipment is always required when handling the pump. It must fulfill the following requirements:

- The minimum height (contact ITT for information) between the lifting hook and the floor must be sufficient to lift the pump.
- The lifting equipment must be able to hoist the pump straight up and down, preferably without the need for resetting the lifting hook.
- The lifting equipment must be securely anchored and in good condition.
- The lifting equipment must support weight of the entire assembly and must only be used by authorized personnel.
- Two sets of lifting equipment must be used to lift the pump for repair work.
- The lifting equipment must be dimensioned to lift the pump with any remaining pumped media in it.
- The lifting equipment must not be oversized.

NOTICE:

Oversized lifting equipment could cause damage if the unit should stick when being lifted.

Storage guidelines

Storage location

The product must be stored in a covered and dry location free from heat, dirt, and vibrations.

NOTICE:

- Protect the product against humidity, heat sources, and mechanical damage.
- Do not place heavy weights on the packed product.

Freezing precautions

The pump is frost-proof while operating or immersed in liquid, but the impeller/propeller and the shaft seal may freeze if the pump is lifted out of the liquid into a surrounding temperature below freezing.

Follow these guidelines to avoid freezing damage:

When	Guideline
Before storage	• The pump must be allowed to run for a short time after raising it to discharge remaining pumped liquid. This does not apply to propeller pumps. • The discharge opening must be covered in a suitable way, or placed facing down so that any still remaining pumped liquid runs out. • If present, the cooling jacket must be drained manually by opening the air vent screws at the top of the cooling jacket.
After storage	If the impeller/propeller is frozen, it must be thawed by immersing the pump in liquid before operating the pump. **NOTICE:** Never use a naked flame to thaw the unit.

Long-term storage

If the pump is stored more than 6 months, the following apply:

- Before operating the pump after storage, it must be inspected with special attention to the seals and the cable entry.
- The impeller/propeller must be rotated every other month to prevent the seals from sticking together.

Product Description

Pump design

The pump is submersible, and driven by an electric motor.

Intended use

The product is intended for moving waste water, sludge, raw and clean water. Always follow the limits given in *Application limits*. If there is a question regarding the intended use of the equipment, please contact an ITT representative before proceeding.

WARNING:
In explosive or flammable environments, only use Ex- or MSHA-approved pumps.

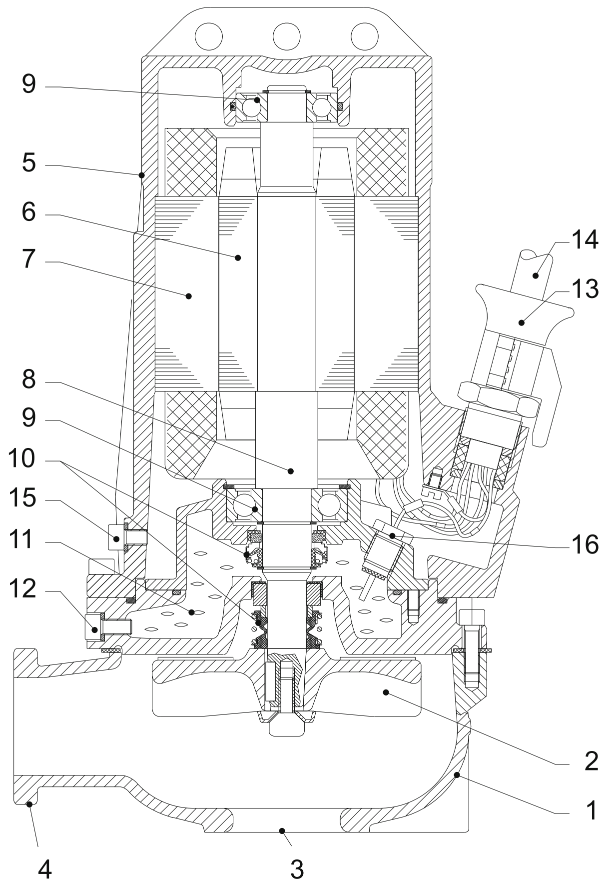
Spare parts

- Modifications to the unit or installation should only be carried out after consulting with ITT.
- Original spare parts and accessories authorized by ITT are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation. For more information contact your ITT representative.

Pressure class

LT	Low head
MT	Medium head
HT	High head

Parts



Position	Part	Description
1	Pump housing	–
2	Impeller	D-impeller
3	Inlet	–
4	Outlet	–
5	Stator housing	For information about the motor, see *Motor data*.
6	Rotor	–
7	Stator	–
8	Shaft	The shaft is made of stainless steel, with an integrated rotor.
9	Bearings	Single-row ball bearings
10	Mechanical seals	One inner and one outer seal: • Aluminium oxide Al_2O_3 • Silicon carbide RSiC For information about the pumps mechanical seals, see Parts List.
11	Oil housing	The oil housing includes a coolant that lubricates and cools the seals; the housing acts as a buffer between the pumped liquid and the drive unit.
12	Oil plug	–
13	Cable entry	–
14	Cable	–
15	Inspection plug	–
16	Sensor	–

Monitoring equipment

The following applies to the monitoring equipment of the pump:

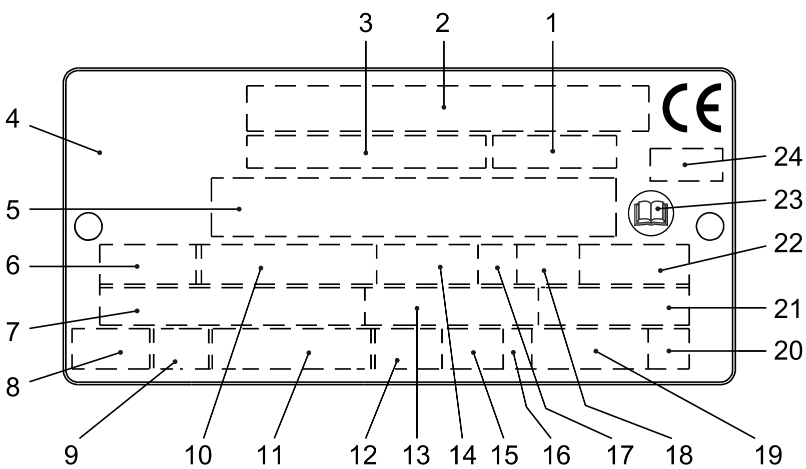
- The stator contains three thermal contacts connected in series which activate the alarm and stop the pump at overtemperature.
- The thermal contacts open at 125°C (257°F).
- Ex-approved pumps must have thermal contacts connected to the control panel.
- Water Detector sensors must be connected to either the OMRON relay 61 F-GP monitoring equipment or an equivalent equipment.
- The monitoring equipment must be of a design that makes automatic restart impossible.
- Information in the junction box shows if the pump is equipped with optional sensors.

Optional sensors

Water Detector The Water Detector detects water which have entered the oil housing or the stator housing due to seal failure or cable damage. The Water Detector probe is a non-active electrode, placed in the oil- and stator housing. It is used in conjunction with a relay in the control circuit that measures the resistance between probe and frame. If only air or oil is present, the resistance is over 5000 Ohm. If water enters, the resistance decreases to as low as 300 to 500 Ohm.

The data plate

The data plate is a metal label located on the main body of the pump. The data plate lists key product specifications.



1. Curve code/Propeller code
2. Serial number, see *Product denomination* (page 12)
3. Product number
4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection
9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter

21. Power factor
22. Maximum ambient temperature
23. Read installation manual
24. Notified body/only for EN-approved Ex-products

Figure 1: The data plate

Product denomination

Sales denomination

The sales denomination consists of the four-digit sales code and two letters that indicate the hydraulic end and type of installation.

This is an example of a sales denomination, and an explanation of its parts.

NP 3085

1 2 3

1. Hydraulic part
2. Installation type
3. Sales code

Product code

The product code consists of nine characters divided into two parts.

This is an example of a product code, and an explanation of its parts.

NP 3085.183

1 2

1. Sales denomination
2. Version

Serial number

The serial number is used for identification of an individual product, and is divided into four parts.

This is an example of a serial number, and an explanation of its parts.

NP 3085.183 - 951 0163

1 2 3 4

1. Product code
2. Production year
3. Production cycle
4. Running number

Installation

Install the pump

WARNING:

- Before installing the pump, check that the cable and cable entry have not been damaged during transportation.
- Note that special rules apply to installation in explosive atmospheres.
- Make sure that the pump cannot roll or fall over and injure people or damage property.
- Do not install CSA-approved products in locations that are classified as hazardous in the national electric code, ANSI/NFPA 70-2005.

NOTICE:

- Do not run the pump dry.
- Never force piping to make a connection with a pump.

These requirements apply:

- Use the pump dimensional drawing in order to ensure proper installation.
- Provide a suitable barrier around the work area, for example, a guard rail.
- Check the explosion risk before you weld or use electric hand tools.
- Remove all debris from the inlet piping system before you install the pump.

Authority regulation

Vent the tank of a sewage machine station in accordance with local plumbing codes.

Fasteners

WARNING:

- Only use fasteners of the proper size and material.
- Replace all corroded fasteners.
- Make sure that all fasteners are properly tightened and that there are no missing fasteners.

Install with P-installation

In the P-installation, the pump is installed on a stationary discharge connection, and operates either completely or partially submerged in the pumped liquid. These requirements and instructions only apply when the installation is made according to the dimensional drawing.

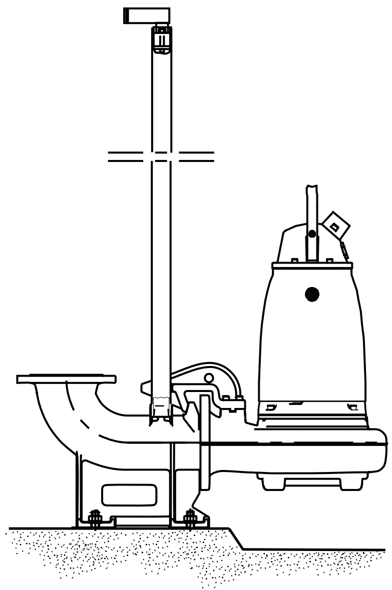


Figure 2: P-installation

These items are required:

- Guide bars
- Guide bar bracket for attaching the guide equipment to the access frame or to the upper part of the sump
- Cable holder for holding the cable
- Access frame (with covers) to which the upper guide bar bracket and cable holder can be attached
- Discharge connection for connecting the pump to the discharge line

  The discharge connection has a flange which fits the pump casing flange and a bracket for attaching the guide equipment.
- Fasteners for the discharge connection
- Anchor bolts

1. Install the access frame:
   a) Place the access frame in position and align it horizontally.
   b) Grout the frame in place.
2. Grout the anchor bolts in place.

   Be careful when you align and position the discharge connection in relation to the access frame.
3. Place the discharge connection in position, and tighten the nuts.
4. Install the guide bars:
   a) Secure the guide bars in the bracket.
   b) Check that the guide bars are placed vertically. Use a level or a plumb line.
5. Connect the discharge pipe to the discharge connection.
6. Lower the pump along the guide bars.

   When it reaches the bottom position, the pump automatically connects to the discharge connection.
7. Secure the motor cable:
   a) Fasten the permanent lifting device to the pump and to the access frame. For example, you can use a stainless-steel lifting chain with shackles.
   b) Fasten the cable to the cable holder.

Make sure that the cable cannot be sucked into the pump inlet or that it is neither sharply bent, or pinched. Support straps are required for deep installations.

c) Connect the motor cable and the starter and monitoring equipment according to the separate instructions.

Make sure that the impeller rotation is correct. For more information, see *Check the impeller rotation* (page 22).

Clean all debris from the sump before starting the pump.

Install with S-installation

In the S-installation, the pump is transportable and intended to operate either completely or partially submerged in the pumped liquid. The pump is equipped with a connection for hose or pipe and stands on a base stand.

These requirements and instructions only apply when the installation is made according to the dimensional drawing. For information about the different installation types, see Parts List.

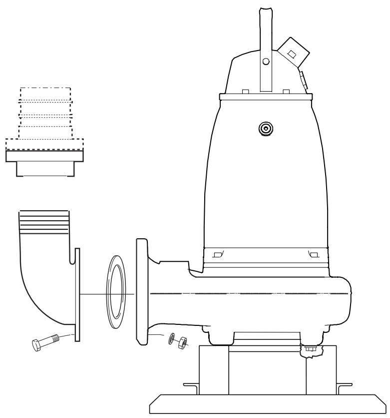


Figure 3: S-installation

1. Run the cable so that it has no sharp bends, is not pinched, and cannot be sucked into the pump inlet.
2. Connect the discharge line.
3. Lower the pump into the sump.
4. Place the pump on the base and make sure it cannot fall over or sink.

   Alternatively, the pump can be suspended with a lifting chain just above the sump bottom. Make sure that the pump cannot rotate at startup or during operation.
5. Connect the motor cable and the starter and monitoring equipment according to the separate instructions.

   Make sure that the impeller rotation is correct. For more information, see *Check the impeller rotation* (page 22).

Make the electrical connections

General precautions

Electrical Hazard:
- A certified electrician must supervise all electrical work. Comply with all local codes and regulations.
- Before starting work on the pump, make sure that the pump and the control panel are isolated from the power supply and cannot be energized. This applies to the control circuit as well.
- Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the end of the motor cable above the liquid level.
- Make sure that all unused conductors are insulated.
- There is a risk of electrical shock or explosion if the electrical connections are not correctly carried out or if there is fault or damage on the product.

CAUTION:
If the pump is equipped with automatic level control and/or internal contactor, there is a risk of sudden restart.

Requirements

These general requirements apply for electrical installation:
- The supply authority must be notified before installing the pump if it will be connected to the public mains. When the pump is connected to the public power supply, it may cause flickering of incandescent lamps when started.
- The mains voltage and frequency must agree with the specifications on the data plate. If the pump can be connected to different voltages, the connected voltage is specified by a yellow sticker close to the cable entry.
- The fuses and circuit breakers must have the proper rating, and the pump overload protection (motor protection breaker) must be connected and set to the rated current according to the data plate and if applicable the cable chart. The starting current in direct-on-line starting can be up to six times higher than the rated current.
- The fuse rating and the cables must be in accordance with the local rules and regulations.
- If intermittent operation is prescribed, the pump must be provided with monitoring equipment supporting such operation.
- The motor is convertible between different voltages, if stated on the data plate.
- The thermal contacts/thermistors must be in use.

Cables

These are the requirements to follow when you install cables:
- The cables must be in good condition, not have any sharp bends, and not be pinched.
- The sheathing must not be damaged and must not have indentations or be embossed (with markings, etc.) at the cable entry.
- The cable entry seal sleeve and washers must conform to the outside diameter of the cable.
- The minimum bending radius must not be below the accepted value.
- If using a cable which has been used before, a short piece must be peeled off when refitting it so that the cable entry seal sleeve does not close around the cable at the same point again. If the outer sheath of the cable is damaged, then replace the cable. Contact an ITT service shop.
- The voltage drop in long cables must be taken into account. The drive unit's rated voltage is the voltage measured at the cable connection point in the pump.

NOTICE:
Do not use Variable Frequency Drive (VFD) with this pump.

Earthing (Grounding)

Electrical Hazard:

- You must earth (ground) all electrical equipment. This applies to the pump equipment, the driver, and any monitoring equipment. Test the earth (ground) lead to verify that it is connected correctly.
- If the motor cable is jerked loose by mistake, the earth (ground) conductor should be the last conductor to come loose from its terminal. Make sure that the earth (ground) conductor is longer than the phase conductors. This applies to both ends of the motor cable.
- Risk of electrical shock or burn. You must connect an additional earth- (ground-) fault protection device to the earthed (grounded) connectors if persons are likely to come into physical contact with the pump or pumped liquids.

Connect the motor cable to the pump

CAUTION:

Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the end of the motor cable above the liquid level.

For more information about the cable entry, see the Parts list.

1. Remove the cable clamp (optional), by unscrewing the hexagon socket screws.
2. Remove the cable entry from the stator housing.
3. Remove the stator housing.

   This provides access to the terminal board/closed end splices.
4. Check the data plate to see which connections are required for the power supply:
   - Y
   - D
   - Y serial
   - Y parallel
   - Y/D
5. Arrange the connections on the terminal board/closed end splices in accordance with the required power supply.
6. Connect the mains leads (L1, L2, L3, and earth (ground)) according to applicable cable chart.

   The earth (ground) lead must be 50 mm (2.0 in.) longer than the phase leads in the junction box of the unit.
7. Make sure that the pump is correctly connected to earth (ground).
8. Install the stator housing.
9. Install the cable entry and the cable clamp (optional) and tighten.

Connect the motor cable to the starter and monitoring equipment

WARNING:

Do not install the starter equipment in an explosive zone or in the sump.

NOTICE:

- Thermal contacts are incorporated in the pump.
- Thermal contacts must never be exposed to voltages higher than 250 V, breaking current maximum 4 A. It is recommended that they are connected to 24 V over separate fuses to protect other automatic equipment.

The single phase pumps must be equipped with a starter which has start and run capacitors.

A specially Flygt designed starter is required for the operation of single phase pumps. The connection of the motor cable to the starter is shown in the wiring diagram.

1. If thermal contacts are included in the pump installation, connect the T1 and T2 control conductors to the monitoring equipment.

   Do not connect the T1 and T2 leads to thermal contacts if the temperature of the pumped liquid is above 40°C (104°F).

   NOTICE:

   Ex-approved products must always have the thermal contacts connected irrespective of the ambient temperature.

2. Connect the mains leads (L1, L2, L3, and earth [ground]) to the starter equipment.

   For information about the phase sequence and the color codes of the leads, see *Cable charts* (page 18).

3. Check the functionality of the monitoring equipment:

   a) Check that the signals and the tripping function work properly.

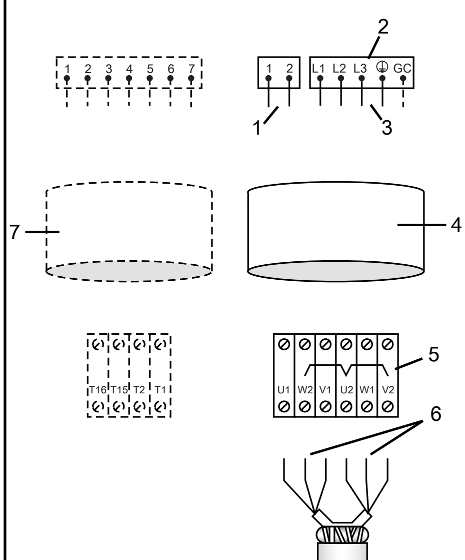
   b) Check that the relays, lamps, fuses, and connections are intact.

   Replace any defective equipment.

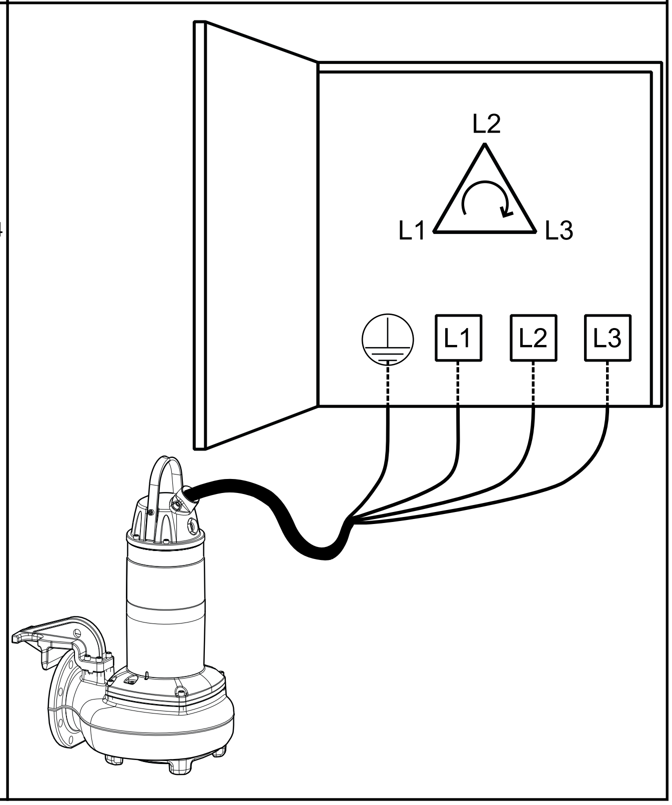
Cable charts

If a longer pump cable is used with an extra 10 mm² earth cable fitted to the motor housing to fulfill the demands of the Low Voltage Directive, then this cable must also be connected to the earth connection.

Connection locations	Phase sequence



1. Control leads
2. Starter equipment
3. Mains leads
4. Motor cable
5. Terminal blocks on pump
6. Stator leads
7. Control cable



Colors and marking of the mains leads

Mains: Three phase motor	Mains: Single phase motor	SUBCAB 7GX / HCR (SO7E6E5-F)	SUBCAB 4GX	SUBCAB AWG	H07RN-F 10GX
L1	P	Black 1	Brown	Red	Black 1
L2	C	Black 2	Black	Black	Black 2
L3	N	Black 3	Grey	White	Black 3

Mains: Three phase motor	**Mains: Single phase motor**	**SUBCAB 7GX / HCR (SO7E6E5-F)**	**SUBCAB 4GX**	**SUBCAB AWG**	**H07RN-F 10GX**
L1		Black 4			Black 4
L2		Black 5			Black 5
L3		Black 6			Black 6
⏚	⏚	Yellow/Green	Yellow/Green	Yellow/Green	Yellow/Green
Groundcheck (GC)	–	–	–	Yellow	–

Colors and marking of the control leads

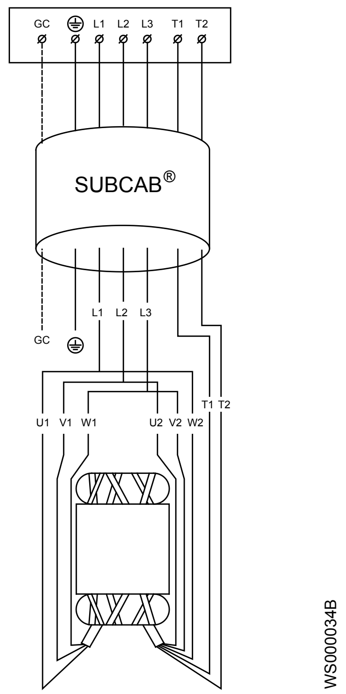
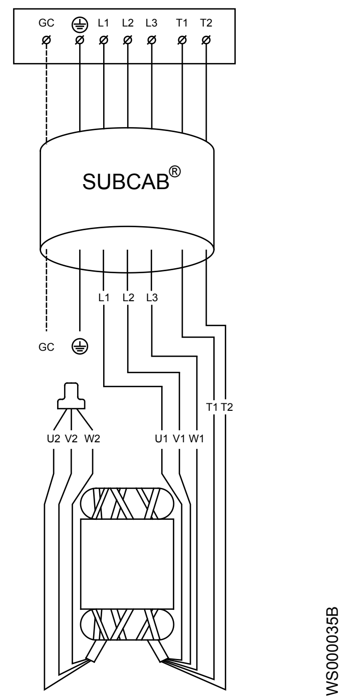
Control	**SUBCAB 7 GX / HCR (SO7E6E5-F) and SUBCAB 4 GX**	**SUBCAB AWG**	**H07RN-F 10GX**
T1	White T1 / Black 4	Orange	Black 7
T2	White T2 / Black 5	Blue	Black 8
Water Detector (Wa)	– / Black 6		Black 9

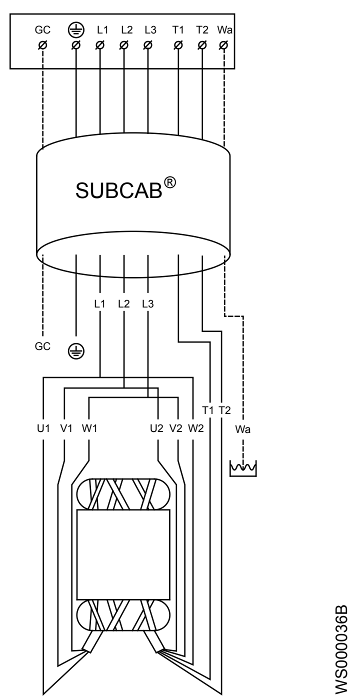
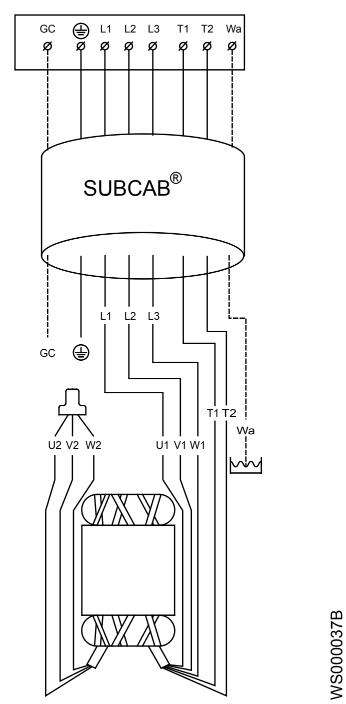
Colors and marking of the stator leads

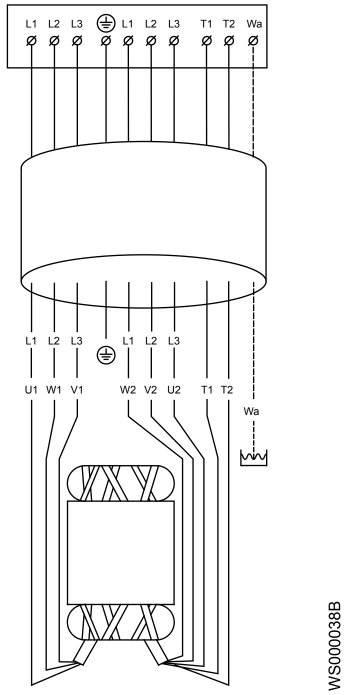
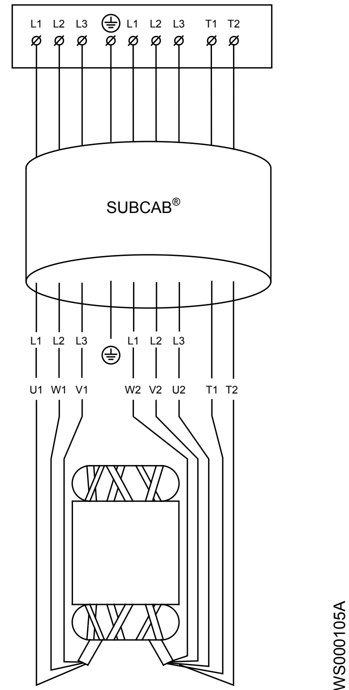
Stator connection	**Lead color**	**Lead color, single phase**
U1	Red	White (main)
U2	Green	Red (main)
U5	Red+U5	
V1	Brown	
V2	Blue	
V5	Brown+V5	
W1	Yellow	
W2	Black	
W5	Yellow+W5	
Z1	–	Black (auxiliary)
Z2	–	Blue (auxiliary)

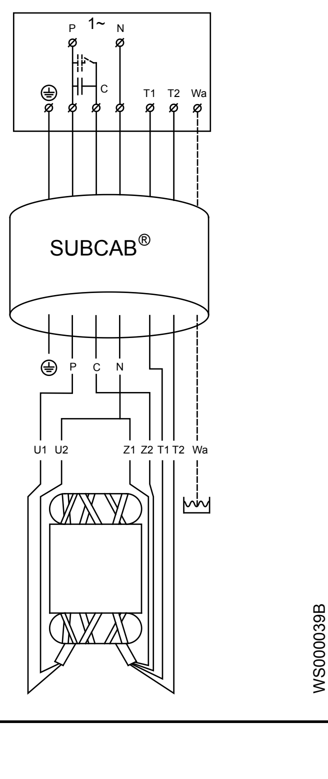
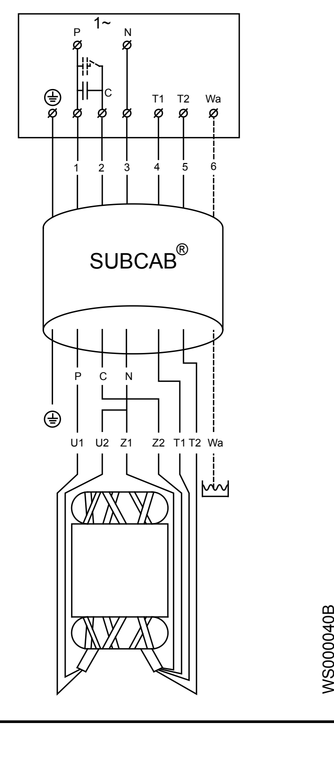
Cable charts

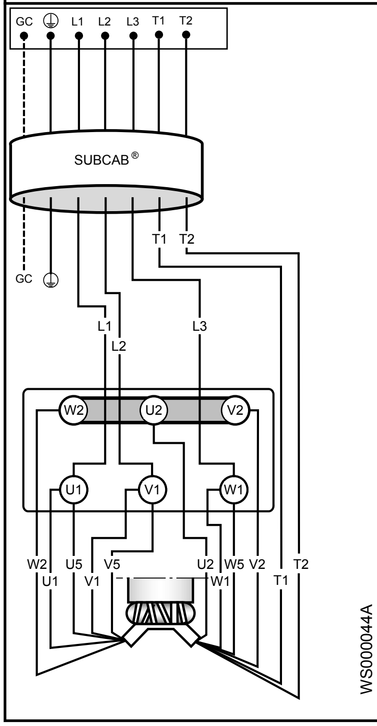
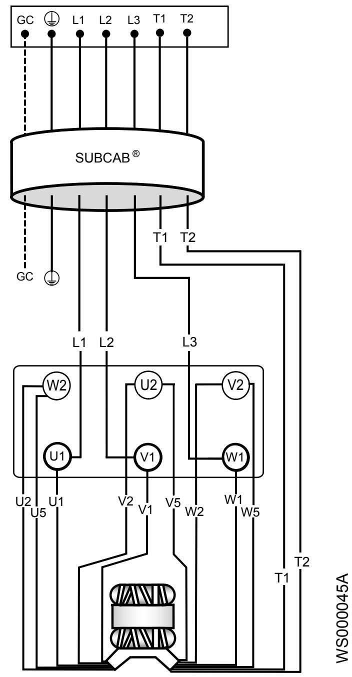
The figures in this section show all applicable cable charts.

SUBCAB 4GX / SUBCAB AWG, 6 stator leads, D connection	SUBCAB 4GX / SUBCAB AWG, 6 stator leads, Y connection
	

SUBCAB 7GX / HCR (SO7E6E5-F) / SUBCAB AWG, 6 stator leads, D connection	SUBCAB 7GX / HCR (SO7E6E5-F) / SUBCAB AWG, 6 stator leads, Y connection
	

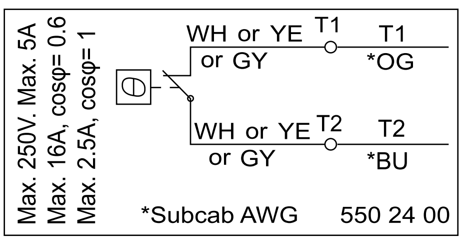
H07RN-F 10GX, 6 stator leads, Y/D connection with Water Detector	SUBCAB 7GX + 2x1.5, 6 stator leads, Y/D connection without Water Detector
	

SUBCAB 7GX / SUBCAB AWG, single phase, 6 stator leads, D connection	SUBCAB 7GX / SUBCAB AWG, single phase, 6 stator leads, D connection
	

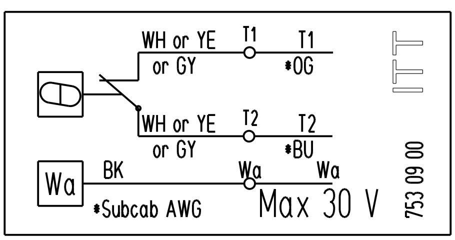
SUBCAB 4GX / SUBCAB AWG, 9 stator leads, 230V, 60 Hz, Y parallel connection	SUBCAB 4GX / SUBCAB AWG, 9 stator leads, 460V, 60 Hz, Y serial connection
	

Sensor-connection

Thermal contact



Water Detector



Alarm

- < 500 Ω
- Output terminal 3 – 4 closed

No alarm

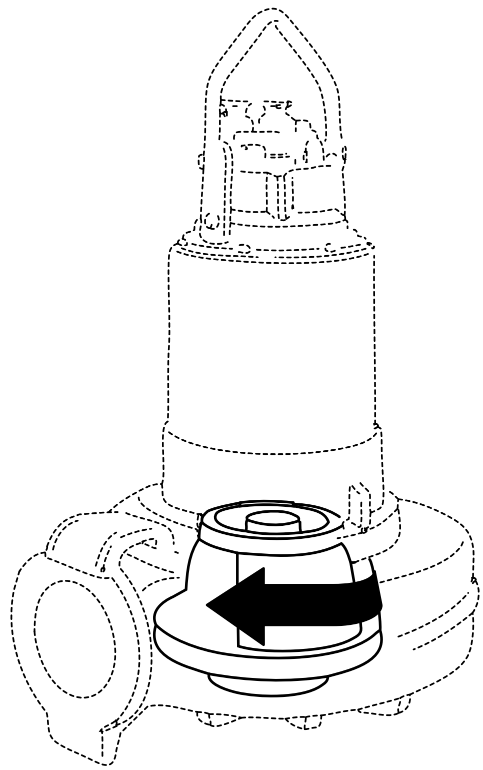
- > 500 Ω
- Output terminal 2 – 4 closed

Check the impeller rotation

WARNING:

The starting jerk can be powerful.

1. Start the motor.
2. Stop the motor after a few seconds.
3. Check that the impeller rotates according to this illustration.



The correct direction of impeller rotation is clockwise when you look at the pump from above.

4. If the impeller rotates in the wrong direction, do one of these steps:
   - If the motor has a 1-phase connection, contact the local ITT shop.
   - If the motor has a 3-phase connection, transpose two phase leads and do this procedure again.

Operation

Precautions

- Never operate the pump without safety devices installed.
- Never operate the pump with the discharge valve closed.
- Make sure that all safety guards are in place and secure.
- Make sure you have a clear path of retreat.
- Never work alone.
- Beware of the risk of a sudden start if the product is used with an automatic level control and/or internal contactor.

Distance to wet areas

Electrical Hazard:

Risk of electrical shock when pumping or mixing near a lake, jetties, beaches, ponds, fountains, or similar. There must be a safety distance of at least 20 m (65 ft.) between the person and the product if the person is in contact with the pumped or mixed liquid.

Noise level

NOTICE:

The noise level of the product is lower than 70 dB. However, the noise level of 70 dB may be exceeded in some installations and at certain operating points on the performance curve. Make sure that you understand the noise level requirements in the environment where the pump is installed. Failure to do so may result in hearing loss or violation of local laws.

Start the pump

WARNING:

- If you need to work on the pump, make sure that it is isolated from the power supply and cannot be energized.
- Make sure that the pump cannot roll or fall over and injure people or damage property.
- In some installations, the pump and the surrounding liquid may be hot. Bear in mind the risk of burn injuries.
- Make sure nobody is close to the pump when it is started. The pump will jerk in the opposite direction of the impeller rotation.

NOTICE:

Make sure that the rotation of the impeller is correct. For more information, see Check the impeller rotation.

1. Check the oil level in the oil housing.
2. Remove the fuses or open the circuit breaker, and check that the impeller can be rotated freely.
3. Conduct insulation test phase to ground. To pass, the value must exceed 5 megohms.
4. Check that the monitoring equipment works.
5. Start the pump.

Maintenance

Precautions

WARNING:

- Always follow safety guidelines when working on the pump. See *Introduction and Safety* (page 3).
- Disconnect and lock out electrical power before installing or servicing the pump.
- Make sure that the pump cannot roll or fall over and injure people or damage property.
- Rinse the pump thoroughly with clean water before working on the pump.
- Rinse the components in water after dismantling.

Make sure that you follow these requirements:

- Check the explosion risk before you weld or use electrical hand tools.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product and its components have been thoroughly cleaned.
- Do not open any vent or drain valves or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.

Maintenance guidelines

During maintenance and before reassembly, always remember to perform these tasks:

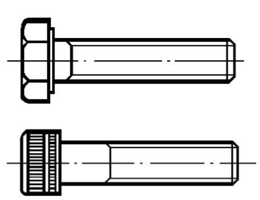
- Clean all parts thoroughly, particularly O-ring grooves.
- Change all O-rings, gaskets, and seal washers.
- Lubricate all springs, screws, and O-rings with grease.

During reassembly, always make sure that existing index markings are in line.

The reassembled drive unit must always be insulation-tested and the reassembled pump must always be test-run before normal operation.

Torque values

Screws and nuts

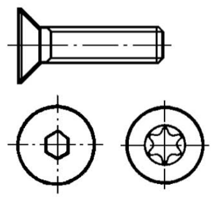


	Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
Stainless steel, A2 and A4, torque Nm (ft-lbs)	70 +80[1]	2.7 (2)	5.4 (4)	9.3 (6.9)	22 (16)	44 (32)	76 (56)	187 (138)	364 (268)	629 (464)	1240 (915)

1 Property class 70 is torque tightened as class 80.

	Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
Carbon steel and alloyed steel, torque Nm (ft-lbs)	8.8	2.9 (2.1)	5.7 (4.2)	9.8 (7.2)	24 (18)	47 (35)	81(60)	194 (143)	385 (285)	665 (490)	1310 (966)
	10.9	4.0 (2.9)	8.1 (6)	14 (10.3)	33 (24.3)	65 (48)	114 (84)	277 (204)	541 (399)	935 (689)	1840 (1357)
	12.9	4.9 (3.6)	9.7 (7.2)	17 (12.5)	40 (30)	79 (58)	136 (100)	333 (245)	649 (480)	1120 (825)	2210 (1630)

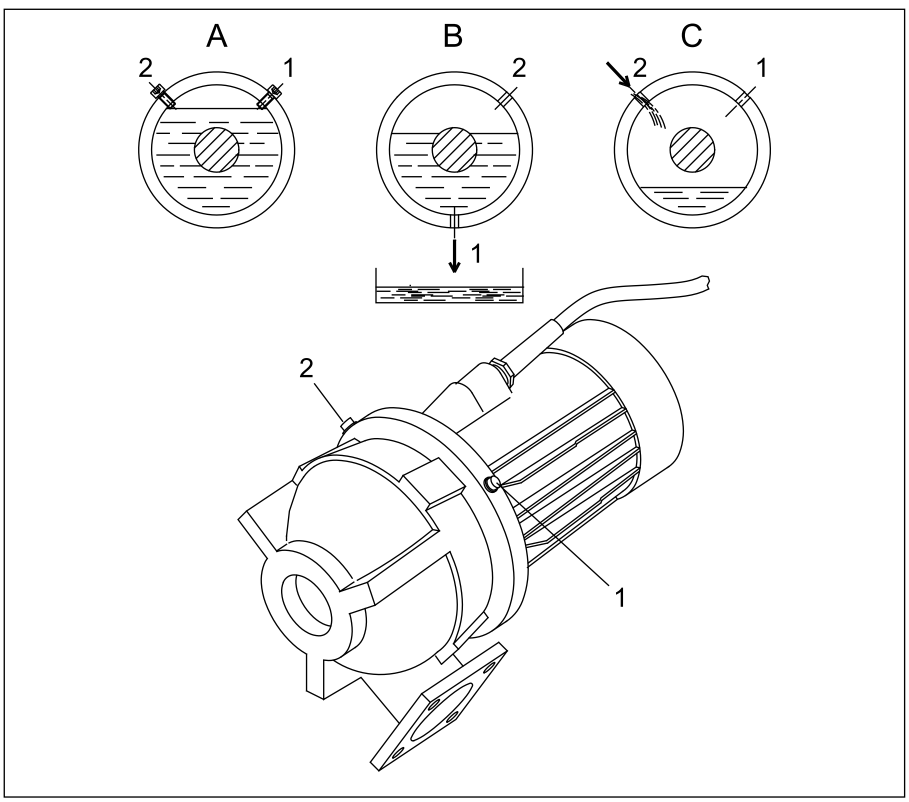
Screws with countersunk heads



	Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24
Stainless steel, A2 and A4, torque Nm (ft-lbs)	70 +80[1]	1.2 (0.9)	2.7 (2)	5.4 (4)	9.3 (6.9)	22 (16)	44 (32)	76 (56)	120 (88)	187 (138)
Carbon steel and alloyed steel, torque Nm (ft-lbs)	8.8	2.3 (1.7)	4.6 (3.4)	7.8 (5.8)	19 (14)	38 (28)	65 (48)	158 (116)	308 (228)	532 (392)
	10.9	3.2 (2.4)	6.5 (4.8)	11(8)	26 (19)	52 (38)	91 (67)	222 (164)	433 (320)	748 (552)
	12.9	3.9 (2.9)	7.8 (5.8)	14 (10.3)	32 (23.6)	63 (46)	109 (80)	266 (196)	519 (383)	896 (661)

Change the oil

This image shows the plugs that are used to change the oil.



Empty the oil

WARNING:
The oil housing may be pressurized. Hold a rag over the oil plug to prevent oil from spraying out.

1. Place the pump in a horizontal position so that the oil plug is at the bottom (number 1 in the figure).
2. Place a container under the pump.
3. Remove the vent plug (number 2 in the figure).
4. Remove the plug and drain the oil.

Fill with oil

The oil should be a medical white oil of paraffin type that fulfills FDA 172.878 (a) and viscosity close to VG32.

1. Replace the O-rings of the oil plugs.
2. Refit the oil plug in the hole that faces downwards, and tighten.
   Tightening torque: 10-40 Nm (7.5-29.5 ft-lbs)
3. Fill with oil.
   The oil level should be at the lower side of the openings (position A in the figure).
   Quantity: approximately 0.4 liters (0.42 quarts).
4. Refit the plugs and tighten.
   Tightening torque: 10-40 Nm (7.5-29.5 ft-lbs)

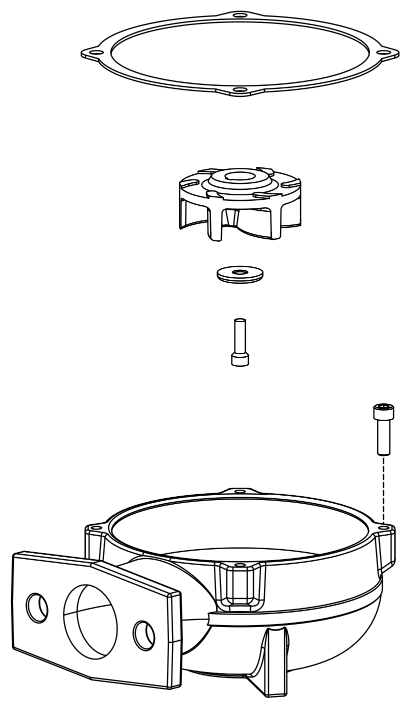
Replace the impeller

Required tools:

- 8 mm hexagon bit adapter.
- Impeller puller
  If applicable, contact your local ITT representative for correct type and size.
- Rod (wooden or copper) for locking the impeller in place, if applicable.
- Two crowbars, if applicable

WARNING:

- If you fail with the impeller installation, you must redo the installation procedure from the beginning.
- A worn impeller and/or pump housing can have very sharp edges. Wear protective gloves.
- When laying the pump on its side, do not allow the weight of the pump to rest on any portion of the impeller. The impeller must not be allowed to make contact with the concrete floor or other hard and rough surfaces.



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Remove the impeller

CAUTION:
A worn impeller and/or pump housing can have very sharp edges. Wear protective gloves.

1. Remove the pump housing.
2. Remove the impeller screw.
   If applicable, use the rod.

3. Remove the washer.
4. Remove the impeller.
   Use the impeller puller or the crowbars.

Install the impeller

1. Prepare the shaft:
   a) Make sure that the end of the shaft is clean and free from burrs.
   Polish off any flaws with a fine emery cloth.
   b) Replace the parallel pin.

   c) Lubricate the shaft.
2. Mount the impeller:
   a) Fit the washer on the lubricated impeller screw.
3. Tighten the impeller screw.
   If applicable, use the rod.
   Tightening torque: 22Nm (16 ft-lbs)

Check that the impeller can rotate freely.

4. Mount the pump housing:
   a) Fit the pump housing.
   b) Fit and tighten the lubricated screws.
      Tightening torque: 57 Nm (42 ft-lbs).

Service the pump

Type of service	Purpose	Inspection interval
Initial inspection	To make a check up of the pump condition by an authorized ITT service representative and, based on the result and findings from these measures, to determine the intervals for periodical inspection and major overhaul for the specific installation.	Within the first year of operation.
Periodical inspection	To prevent operational interruptions and machine breakdown. Measures to secure performance and pump efficiency are defined and decided for each individual application. It can include such things as impeller trimming, wear part control and replacement, control of zinc-anodes and control of the stator.	Up to every year Applies to normal applications and operating conditions at media (liquid) temperatures <40°C.
Major overhaul	To secure a long operating lifetime for the product. It includes replacement of key components and the measures taken during an inspection.	Up to every 3 year These intervals apply to normal applications and operating conditions at media (liquid) temperatures <40°C.

NOTICE:

Shorter intervals may be required when the operating conditions are extreme, for example with very abrasive or corrosive applications or when the liquid temperatures exceed 40°C (104°F).

Inspection

Service item	Action
Cable	1. If the outer jacket is damaged, replace the cable. 2. Check that the cables do not have any sharp bends and are not pinched.
Connection to power	Check that the connections are properly tightened.
Electrical cabinets	Check that they are clean and dry.

Service item	Action
Impeller	1. Check the impeller clearance. 2. Adjust the impeller, if necessary.
Stator housing[2]	1. Drain all liquid, if any. 2. Check the resistance of the leakage sensor. A small amount of water due to condensation is acceptable. More water is an indication of leakage. Oil is an indication of seal failure between the stator housing and the oil housing. Contact your ITT representative.
Insulation	Use a megger maximum 1000 V. 1. Check that the resistance between the earth (ground) and phase lead is more than 5 megohms. 2. Conduct a phase-to-phase resistance check.
Junction box	Check that it is clean and dry.
Lifting device	Check that local safety regulations are followed.
Lifting handle	1. Check the screws. 2. Check the condition of the lifting handle. 3. Replace if necessary.
O-rings	1. Replace the oil plug O-rings. 2. Replace the O-rings at the entrance or junction cover. 3. Grease the new O-rings.
Overload protection and other protections	Check the correct settings.
Personnel safety devices	Check the guard rails, covers, and other protections.
Rotation direction	Check the impeller rotation.
Oil housing[2]	Fill with new oil, if necessary.
Terminal block/closed end splice	Check that the connections are properly tightened.
Thermal contacts	Normally closed circuit; interval 0–1 ohm.
Voltage and amperage	Check the running values.

Major overhaul

For a major overhaul, take this action in addition to the tasks listed under Inspection.

Service item	Action
Support and main bearing	Replace the bearings with new bearings.
Mechanical seal	Replace with new seal units.

Service in case of alarm

For information about indication values for sensors, see *Sensor connection*.

Alarm source	Action
Water Detector	Check for water in the oil in the oil housing, or water in the stator housing. If the oil contains too much water: 1. Drain the oil and water. 2. Replace with new oil.

[2] Regardless of individual applications, the stator housing and the oil housing should not be inspected less frequently than the intervals for normal applications and operating conditions at media (liquid) temperatures <40°C.

Alarm source	Action
	If the stator housing contains water: 1. Drain all liquid, if any. 2. Check the mechanical seal unit, the O-rings, and the cable entry, if liquid was found.
Thermal contact	Check the start and stop levels.
The overload protection	Check that the impeller can rotate freely.

Troubleshooting

Introduction

Follow these guidelines when troubleshooting the pump:

- Disconnect and lock out the power supply except when conducting checks that require voltage.
- Make sure that no one is near the pump when the power supply is reconnected.
- When troubleshooting electrical equipment, use the following:
  - Universal instrument multimeter
  - Test lamp (continuity tester)
  - Wiring diagram

The pump does not start

WARNING:

Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	**Remedy**
An alarm signal has been triggered on the control panel.	Check that: • The impeller rotates freely. • The sensor indicators do not indicate an alarm. • The overload protection is not tripped. If the problem still persists: Contact the local ITT service shop.
The pump does not start automatically, but can be started manually.	Check that: • The start level regulator is functioning. Clean or replace if necessary. • All connections are intact. • The relay and contactor coils are intact. • The control switch (Man/Auto) makes contact in both positions. Check the control circuit and functions.
The installation is not receiving voltage.	Check that: • The main power switch is on. • There is control voltage to the start equipment. • The fuses are intact. • There is voltage in all phases of the supply line. • All fuses have power and that they are securely fastened to the fuse holders. • The overload protection is not tripped. • The motor cable is not damaged.
The impeller is stuck.	Clean: • The impeller • The sump in order to prevent the impeller from clogging again.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local ITT service shop. Always state the serial number of your pump when you contact ITT, see *Product Description* (page 9).

The pump does not stop when a level sensor is used

WARNING:

Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

Cause	Remedy
The pump is unable to empty the sump to the stop level.	Check that: • There are no leaks from the piping and/or discharge connection. • The impeller is not clogged. • The non-return valve(s) are functioning properly. • The pump has adequate capacity. For information:
There is a malfunction in the level-sensing equipment.	• Clean the level regulators. • Check the functioning of the level regulators. • Check the contactor and the control circuit. • Replace all defective items.
The stop level is set too low.	Raise the stop level.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local ITT service shop. Always state the serial number of your pump when you contact ITT, see *Product Description* (page 9).

The pump starts-stops-starts in rapid sequence

Cause	Remedy
The pump starts due to back-flow which fills the sump to the start level again.	Check that: • The distance between the start and stop levels is sufficient. • The non-return valve(s) work(s) properly. • The length of the discharge pipe between the pump and the first non-return valve is sufficiently short.
The self-holding function of the contactor malfunctions.	Check: • The contactor connections. • The voltage in the control circuit in relation to the rated voltages on the coil. • The functioning of the stop-level regulator. • Whether the voltage drop in the line at the starting surge causes the contactor's self-holding malfunction.
The start relay is not correctly set (only for 1-phase motor)	Adjust the start relay.
The run capacitor is defective (only for 1-phase motor)	Replace the run capacitor.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local ITT service shop. Always state the serial number of your pump when you contact ITT, see *Product Description* (page 9).

The pump runs but the motor protection trips

WARNING:

Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
The motor protection is set too low.	Set the motor protection according to the data plate and if applicable the cable chart.
The impeller is difficult to rotate by hand.	• Clean the impeller. • Clean out the sump. • Check that the impeller is properly trimmed.
The drive unit is not receiving full voltage on all three phases.	• Check the fuses. Replace fuses that have tripped. • If the fuses are intact, notify a certified electrician.
The phase currents vary, or they are too high.	Contact the local ITT service shop.
The insulation between the phases and ground in the stator is defective.	1. Use an insulation tester. With a 1000 V DC megger, check that the insulation between the phases and between any phase and ground is > 5 megohms. 2. If the insulation is less: Contact the local ITT service shop.
The density of the pumped fluid is too high.	Make sure that the maximum density is 1100 kg/m^3 (9.2 lb/US gal) • Change to a more suitable pump. • Contact the local ITT service shop.
There is a malfunction in the overload protection.	Replace the overload protection.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local ITT service shop. Always state the serial number of your pump when you contact ITT, see *Product Description* (page 9).

The pump delivers too little or no water

WARNING:

Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
The impeller rotates in the wrong direction.	• If it is a 3-phase pump, transpose two phase leads. • If it is a 1-phase pump: Contact the local ITT service shop.
One or more of the valves are set in the wrong positions.	• Reset the valves that are set in the wrong position. • Replace the valves, if necessary. • Check that all valves are correctly installed according to media flow. • Check that all valves open correctly.
The impeller is difficult to rotate by hand.	• Clean the impeller. • Clean out the sump. • Check that the impeller is properly trimmed.
The pipes are obstructed.	Clean out the pipes to ensure a free flow.

Cause	Remedy
The pipes and joints leak.	Find the leaks and seal them.
There are signs of wear on the impeller, pump, and casing.	Replace the worn parts.
The liquid level is too low.	• Check that the level sensor is set correctly. • Depending on the installation type, add a means for priming the pump, such as a foot valve.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local ITT service shop. Always state the serial number of your pump when you contact ITT, see *Product Description* (page 9).

Technical Reference

Motor data

Feature	Description
Motor type	Squirrel-cage induction motor
Frequency	50 or 60 Hz
Supply	1-phase or 3-phase
Starting method	• Direct on-line • Star-delta
Maximum starts per hour	20 evenly spaced starts per hour
Code compliance	IEC 60034-1
Rated output variation	±5%
Voltage variation without overheating	±10%, provided that it does not run continuously at full load
Voltage imbalance tolerance	2%
Stator insulation class	F (155°C [310°F])

Application limits

Data	Description
Liquid temperature	40°C (104°F) maximum The pump can be operated at continuous duty and full load only if at least 2/3 of the stator housing is submerged. For intermittent duty the recommended liquid level must never sink beneath the top of the volute.
Liquid density	1100 kg/m³ (9.2 lb per US gal) maximum
pH of the pumped media (liquid)	1–13 for stainless steel pumps
Depth of immersion	20 m (65 ft) maximum
Other	For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

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SL1 and SLV pumps

1.1 - 11 kW, 50 Hz

Installation and operating instructions

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innovate

GRUNDFOS

Original installation and operating instructions

CONTENTS

Warning

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

Warning

The use of this product requires experience with and knowledge of the product.
Persons with reduced physical, sensory or mental capabilities must not use this product, unless they are under supervision or have been instructed in the use of the product by a person responsible for their safety.
Children must not use or play with this product.

1. Symbols used in this document

Warning

If these safety instructions are not observed, it may result in personal injury.

Warning

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.

Warning

These instructions must be observed for explosion-proof pumps. We recommend that you also follow these instructions for standard pumps.

Caution — If these safety instructions are not observed, it may result in malfunction or damage to the equipment.

Note — Notes or instructions that make the job easier and ensure safe operation.

2. General description

This booklet includes instructions for installation, operation and maintenance of Grundfos SL1 and SLV submersible sewage and wastewater pumps with motors of 1.1 to 11 kW. Grundfos SL1 and SLV sewage and wastewater pumps are designed for pumping domestic, municipal and industrial sewage and wastewater.

Two types of pumps are available:

- SL1 sewage pumps with S-tube impeller
- SLV sewage pumps with SuperVortex, free-flow impeller.

The pumps can be installed on an auto-coupling system or stand freely on the bottom of a tank.

Grundfos SL1 and SLV pumps are designed with an S-tube and SuperVortex impeller, respectively, to ensure reliable and optimum operation.

The booklet also includes specific instructions for the explosion-proof pumps.

2.1 Product drawing

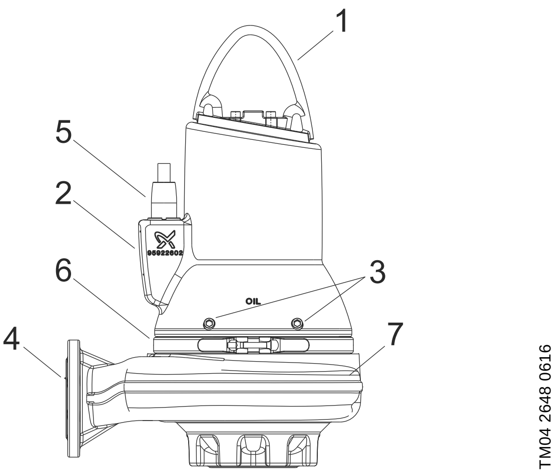

Fig. 1 SL1 pump

Pos.	Description
1	Lifting bracket
2	Nameplate
3	Oil screws
4	Discharge flange
5	Cable plug
6	Clamp
7	Pump housing

2.2 Control and monitoring

The pumps can be controlled via the Grundfos controllers LC, LCD and dedicated controls DC and DCD. See section *8.2 Pump controllers*.

Pumps with sensor are supplied together with an IO 113.

See section *8.6 IO 113*.

2.3 Applications

SL1 and SLV pumps are designed for pumping these liquids:

- large quantities of drainage and surface water
- domestic wastewater with discharge from toilets
- wastewater with a high content of fibres (SuperVortex impeller)
- municipal and commercial sewage and wastewater.

2.4 Operating conditions

The Grundfos SL1 and SLV pumps are suitable for the following operating situations:

- **S1 operation** (continuous operation), the pump must always be covered by the pumped liquid to the top of the motor. See fig. 2.
- **S3 operation** (intermittent operation), the pump must always be covered by the pumped liquid up to the top of the cable entry. See fig. 2.

For further information about S1 and S3 operation, see section *9.2 Operating modes*.

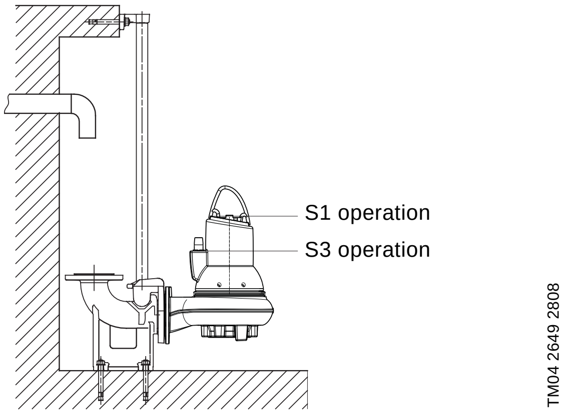

Fig. 2 Stop levels

pH value

SL1 and SLV pumps in permanent installations can be used for pumping liquids with the following pH values:

Pump type	Material variant	Material	pH value
SL1/SLV	Standard	Cast-iron impeller and pump housing	6.5 - 14[1)]
SLV	Q	Stainless-steel impeller and cast-iron pump housing	6-14[1)]

1) For fluctuating pH values, the range is pH 4 to 14.

Liquid temperature

0 °C - +40 °C.

For short periods (maximum 3 minutes) a temperature of up to +60 °C is permissible (non-Ex versions only).

Warning

Explosion-proof pumps must never pump liquids of a temperature higher than +40 °C.

Ambient temperature

Warning

For explosion-proof pumps, the ambient temperature on the installation site must be in the range from -20 °C to +40 °C.

For explosion-proof pumps with WIO sensor, the ambient temperature at the installation site must be in the range from 0 °C to +40 °C.

For non-explosion proof pumps, the ambient temperature may exceed +40 °C for a short period (max. 3 minutes).

Density and viscosity of pumped liquid

When pumping liquids with a density and/or a kinematic viscosity higher than that of water, use motors with correspondingly higher outputs.

Flow velocity

We recommend you to keep a minimum flow velocity to avoid sedimentations in the piping system. Recommended flow velocities:

- in vertical pipes: 1.0 m/s
- in horizontal pipes: 0.7 m/s

Free spherical passage

From 50 to 100 mm, depending on pump size.

Operating mode

Maximum 20 starts per hour.

3. Delivery and handling

The pump may be transported and stored in a vertical or horizontal position. Make sure that it cannot roll or fall over.

3.1 Transportation

All lifting equipment must be rated for the purpose and checked for damage before any attempts to lift the pump. The lifting equipment rating must under no circumstances be exceeded. The pump weight is stated on the pump nameplate.

Warning

Always lift the pump by its lifting bracket or by means of a fork-lift truck if the pump is fixed on a pallet. Never lift the pump by means of the motor cable or the hose/pipe.

3.2 Storage

During long periods of storage, the pump must be protected against moisture and heat.

Storage temperature: -30 °C - +60 °C

Warning

If the pump is stored for more than one year or it takes a long time before it is put into operation after the installation, the impeller must be turned at least once a month.

If the pump has been in use, the oil should be changed before storage.

After a long period of storage, the pump should be inspected before it is put into operation. Make sure that the impeller can rotate freely. Pay special attention to the condition of the shaft seal, O-rings, oil and the cable entry.

4. Identification

4.1 Nameplate

The nameplate states the operating data and approvals applying to the pump. The nameplate is fitted to the side of the motor housing close to the cable entry.

Fix the extra nameplate supplied with the pump to the cable end in the control cabinet.

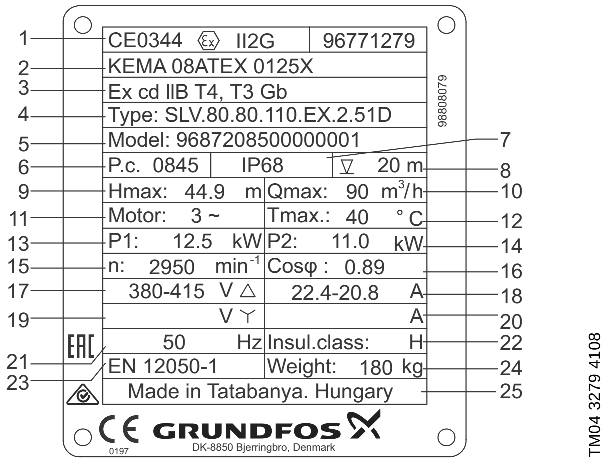

Fig. 3 Nameplate

Pos.	Description
1	Ex mark
2	Type designation
3	Model number
4	Production code (year/week)
5	Maximum head
6	Maximum installation depth
7	Number of phases
8	Rated voltage, D
9	Rated voltage, Y
10	Rated input power
11	Power factor
13	Country of production
14	CE mark
16	Maximum liquid temperature
17	Maximum flow rate
19	Enclosure class to IEC
20	Rated speed
21	Frequency
22	Rated current, D
23	Rated current, Y
24	Shaft power
25	Insulation class
27	Weight without cable

4.2 Type key

The pump can be identified by means of the type designation stated on the pump nameplate. See section *4.1 Nameplate*.

Code	Example	SL	V	.80	.80	.40	.A	.Ex	.4	.5	.OD		.Q	
	Pump type:													
SL	Grundfos wastewater pump													
	Impeller type:													
1	S-**tube** impeller													
V	SuperVortex (free-flow) impeller													
	Free spherical passage:													
50	50 mm													
65	65 mm													
80	80 mm													
100	100 mm													
	Pump discharge:													
65	DN 65													
80	DN 80													
100	DN 100													
150	DN 150													
	Motor power, P2 (motor output power P2/10 [kW]):													
40	4 kW													
	Sensor version:													
Blank	Standard													
A	Sensor version													
	Pump version:													
Blank	Non-explosion-proof pump (standard)													
Ex	Explosion-proof pump													
	Number of poles:													
2	2-pole													
4	4-pole													
	Frequency:													
50	50 Hz													
	Voltage and starting method:													
0B	3 x 400-415 V, direct-on-line starting													
0D	3 x 380-415 V, direct-on-line starting													
1D	3 x 380-415 V, star-delta starting													
0E	3 x 220-240 V, direct-on-line starting													
1E	3 x 220-240 V, star-delta starting													
	Generation:													
Blank	1st generation													
A	2nd generation													
B	3rd generation													
	Pump materials:													
Blank	Cast-iron impeller, pump housing and motor housing													
Q	Stainless-steel impeller, cast-iron pump housing and motor housing													
	Customisation:													
Blank	Pump in standard range													
Z	Custom-built pump													

5. Approvals

The SL1 and SLV pumps have been tested by KEMA.
The explosion-proof versions hold two examination certificates:

- ATEX (EU): KEMA08ATEX0125X
- IECEX: IECEX KEM08.0039X

Both certificates have been issued by KEMA according to the ATEX directive.

5.1 Approval standards

The standard variants are approved by LGA (notified body under the Construction Products Directive) according to EN 12050-1 or EN 12050-2 as specified on the pump nameplate.

5.2 Explanation to Ex approval

The SL1 and SLV pumps have the following explosion protection classifications:

Direct-drive pump, without sensor:	CE 0344 ⟨Ex⟩ II 2 G Ex c d IIB T4 Gb
Direct-drive pump, with sensor:	CE 0344 ⟨Ex⟩ II 2 G Ex c d mb IIB T4 Gb
Pump driven by frequency converter, without sensor:	CE 0344 ⟨Ex⟩ II 2 G Ex c d IIB T3 Gb
Pump driven by frequency converter, with sensor:	CE 0344 ⟨Ex⟩ II 2 G Ex c d mb IIB T3 Gb

5.2.1 Europe

Directive/standard	Code		Description
ATEX	CE 0344	=	CE marking of conformity according to the ATEX directive 94/9/EC, Annex X. 0344 is the number of the notified body which has certified the quality system for ATEX.
	⟨Ex⟩	=	Marking of explosion protection.
	II	=	Equipment group according to the ATEX directive, Annex II, point 2.2, defining the requirements applicable to the equipment in this group.
	2	=	Equipment category according to the ATEX directive, Annex II, point 2.2, defining the requirements applicable to the equipment in this category.
	G	=	Explosive atmosphere caused by gases or vapours.
Harmonized European standard EN 60079-0	Ex	=	The equipment conforms to harmonized European standard.
	c		Constructional safety according to EN 13463-5:2011 and EN 13463-1:2009.
	d	=	Flameproof enclosure according to EN 60079-1:2007.
	mb	=	Encapsulation according to EN 60079-18:2009.
	II	=	Suitable for use in explosive atmospheres (not mines).
	B	=	Classification of gases, see EN 60079-0:2012, Annex A. Gas group B includes gas group A.
	T4/T3	=	Maximum surface temperature is 135 °C / 200 °C according to EN 60079-0:2012.
	Gb	=	Equipment protection level.
	X	=	The letter X in the certificate number indicates that the equipment is subject to special conditions for safe use. The conditions are mentioned in the certificate and the installation and operating instructions.

5.2.2 Australia

Explosion proof variants for Australia are approved as Ex d IIB T3/T4 Gb or Ex d mb T3/T4 Gb.

Standard	Code		Description
IEC 60079-0 and IEC 60079-1	Ex	=	Area classification according to AS 2430.1.
	d	=	Flameproof enclosure according to IEC 60079-1:2007.
	mb	=	Encapsulation according to IEC 60079-18:2009.
	II	=	Suitable for use in explosive atmospheres (not mines).
	B	=	Classification of gases, see IEC 60079-0:2011, Annex A. Gas group B includes gas group A.
	T4/T3	=	Maximum surface temperature is 135 °C / 200 °C according to IEC 60079-0:2011.
	Gb	=	Equipment protection level.
	X	=	The letter X in the certificate number indicates that the equipment is subject to special conditions for safe use. The conditions are mentioned in the certificate and the installation and operating instructions.

6. Safety

Warning

Pump installation in tanks must be carried out by specially trained persons.

Work in or near tanks must be carried out according to local regulations.

Warning

Persons must not enter the installation area when the atmosphere is explosive.

Warning

It must be possible to lock the mains switch in position 0. Type and requirements as specified in EN 60204-1, 5.3.2.

For safety reasons, all work in tanks must be supervised by a person outside the pump tank.

Note

We recommend you to make all maintenance and service jobs when the pump is placed outside the tank.

Tanks for submersible sewage and wastewater pumps may contain sewage or wastewater with toxic and/or disease-causing substances. Therefore, all persons involved must wear appropriate personal protective equipment and clothing, and all work on and near the pump must be carried out under strict observance of the hygiene regulations in force.

Warning

Make sure that the lifting bracket is tightened before attempting to lift the pump. Tighten if necessary. Carelessness during lifting or transportation may cause injury to personnel or damage to the pump.

6.1 Potentially explosive environments

Use explosion-proof pumps for applications in potentially explosive environments. See section *5.2 Explanation to Ex approval*.

Warning

SL1 and SLV pumps must under no circumstances be used to pump explosive, flammable or combustible liquids.

Warning

The classification of the installation site must be approved by the local fire-fighting authorities in each individual case.

Special conditions for safe use of SL1 and SLV explosion-proof pumps:

1. Make sure the moisture switch and thermal switches are connected in the same circuit but have separate alarm outputs (motor stop) in case of high humidity or high temperature in the motor.
2. Bolts used for replacement must be class A2-70 or better according to EN/ISO 3506-1.
3. Contact the manufacturer for information on the dimensions of the flameproof joints.
4. The level of pumped liquid must be controlled by two level switches connected to the motor control circuit. The minimum level depends on the installation type and is specified in these installation and operating instructions.
5. Make sure the permanently attached cable is suitably mechanically protected and terminated in a suitable terminal board placed outside the potentially explosive area.
6. The sewage pumps have an ambient temperature range of -20 °C to +40 °C and a maximum process temperature of +40 °C. The minimum ambient temperature for a pump with a water-in-oil sensor is 0 °C.
7. The thermal protection in the stator windings has a nominal switch temperature of 150 °C and must guarantee the disconnection of the power supply; the power supply must be reset manually.
8. The control unit must protect the WIO sensor against short circuit current of the supply to which it is connected. The maximum current from the control unit must be limited to 350 mA.

7. Installation

Warning

During installation, always support the pump by means of lifting chains or place it in horizontal position to secure stability.

Caution: Prior to installation, make sure the tank bottom is even.

Warning

Before beginning the installation, switch off the power supply and lock the mains switch in position 0 with a padlock to ensure that the power supply cannot be accidentally switched on.

Any external voltage connected to the pump must be switched off before working on the pump.

Before beginning installation procedures, carry out these checks:

- Does the pump correspond to order?
- Is the pump suitable for the supply voltage and frequency available at the installation site?
- Are accessories and other equipment undamaged?

Note: Further details concerning accessories can be found in the data booklet on SL1, SLV pumps on www.grundfos.com.

Fix the extra nameplate supplied with the pump to the cable end in the control cabinet.

All safety regulations must be observed at the installation site, e.g. the use of blowers for fresh-air supply to the tank.

Prior to installation, check the oil level in the oil chamber. See section *10. Maintenance and service*.

Warning

Do not put your hands or any tool into the pump suction or discharge port after the pump has been connected to the power supply, unless the pump has been switched off by removing the fuses or switching off the mains switch. Make sure that the power supply cannot be accidentally switched on.

Caution: We recommend to always use Grundfos accessories to avoid malfunctions due to incorrect installation.

Warning

Only use the lifting bracket for lifting the pump. Do not use it to hold the pump when in operation.

Installation types

The SL1 and SLV pumps are designed for two installation types:

- submerged installation on auto-coupling
- free-standing submerged installation on ring stand.

7.1 Submerged installation on auto-coupling

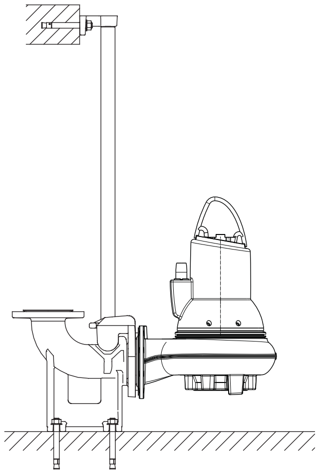

Fig. 4 Submerged installation on auto coupling

Pumps for permanent installation can be installed on a stationary auto-coupling guide rail system. The auto-coupling system facilitates maintenance and service as the pump can easily be lifted out of the tank.

Warning

Before beginning installation procedures, make sure that the atmosphere in the tank is not potentially explosive.

Caution: Make sure that the pipework is installed without the use of undue force. No loads from the pipework weight must be carried by the pump. We recommend the use of loose flanges to ease the installation and to avoid pipe tension at flanges and bolts.

Caution: Do not use elastic elements or bellows in the pipework; these elements should never be used as a means to align the pipework.

Proceed as follows:

1. Drill mounting holes for the guide rail bracket on the inside of the tank and fasten the guide rail bracket provisionally with two screws.
2. Place the auto-coupling base unit on the bottom of the tank. Use a plumb line to establish the correct positioning. Fasten the auto-coupling with expansion bolts. If the bottom of the tank is uneven, the auto-coupling base unit must be supported so that it is level when being fastened.
3. Assemble the discharge pipe in accordance with the generally accepted procedures and without exposing the pipe to distortion or tension.
4. Place the guide rails on the auto-coupling base unit and adjust the length of the rails accurately to the guide rail bracket at the top of the tank.
5. Unscrew the provisionally fastened guide rail bracket. Insert the upper guide rail bracket into the guide rails. Fasten the guide rail bracket on the inside of the tank.

Note: The guide rails must not have any axial play as this would cause noise during pump operation.

6. Clean out debris from the tank before lowering the pump into the tank.
7. Fit the guide claw to the discharge port of the pump.

8. Slide the guide claw of the pump between the guide rails and lower the pump into the tank by means of a chain secured to the lifting bracket of the pump. When the pump reaches the auto-coupling base unit, the pump will automatically connect tightly.
9. Hang up the end of the chain on a suitable hook at the top of the tank and in such a way that the chain cannot come into contact with the pump housing.
10. Adjust the length of the motor cable by coiling it up on a relief fitting to ensure that the cable is not damaged during operation. Fasten the relief fitting to a suitable hook at the top of the tank. Make sure that the cables are not sharply bent or pinched.
11. Connect the motor cable.

Note The free end of the cable must not be submerged, as water may penetrate into the cable .

7.2 Free-standing submerged installation on ring stand

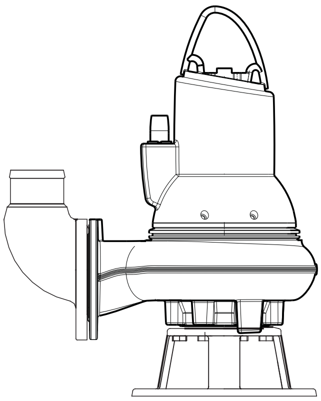

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Fig. 5 Free-standing submerged installation on a ring stand

Pumps for free-standing submerged installation can stand freely on the bottom of the tank. The pump must be installed on a ring stand. See fig. 5.

The ring stand is available as an accessory.

In order to facilitate service on the pump, fit a flexible union or coupling to the elbow on the discharge port for easy separation.

If a hose is used, make sure that the hose does not buckle and that the inside diameter of the hose matches that of the pump discharge port.

If a rigid pipe is used, fit the union or coupling, non-return valve and isolating valve in the order mentioned, when viewed from the pump.

If the pump is installed in muddy conditions or on uneven ground, support the pump on bricks or a similar support.

Proceed as follows:

1. Fit a 90 ° elbow to the pump discharge port and connect the discharge pipe/hose.
2. Lower the pump into the liquid by means of a chain secured to the lifting bracket of the pump. We recommend to place the pump on a plane, solid foundation. Make sure that the pump is hanging from the chain and **not** the cable. Make sure that the pump is standing securely.
3. Hang up the end of the chain on a suitable hook at the top of the tank and in such a way that the chain cannot come into contact with the pump housing.
4. Adjust the length of the motor cable by coiling it up on a relief fitting to ensure that the cable is not damaged during operation. Fasten the relief fitting to a suitable hook at the top of the tank. Make sure that the cable is not sharply bent or pinched.
5. Connect the motor cable.

Note The free end of the cable must not be submerged, as water may penetrate into the cable.

7.3 Torques for suction and discharge flanges

Grade 4.6 (5) galvanized steel screws and nuts

	Nominal diameter	Pitch circle diameter [mm]	Screws	Specified torques rounded off by ± 5 [Nm]	
				Slightly oiled	Well lubricated
Discharge and suction	DN 65	145	4 x M16	70	60
	DN 80	160	8 x M16	70	60
	DN 100	180	8 x M16	70	60
	DN 150	240	8 x M20	140	120

Grade A2.50 (AISI 304) steel screws and nuts

	Nominal diameter	Pitch circle diameter [mm]	Screws	Specified torques rounded off by ± 5 [Nm]	
				Slightly oiled	Well lubricated
Discharge and suction	DN 65	145	4 x M16	-	60
	DN 80	160	8 x M16	-	60
	DN 100	180	8 x M16	-	60
	DN 150	240	8 x M20	-	120

Caution The gasket must be a full face, reinforced paper gasket like Klingersil C4300. If softer gasket material is used, torques must be reconsidered.

8. Electrical connection

Warning

The pump must not run dry.

An additional level switch must be installed to ensure that the pump is stopped in case the stop level switch is not operating.

Warning

Connect the pump to an external mains switch which ensures all-pole disconnection with a contact separation according to EN 60204-1, 5.3.2.

It must be possible to lock the mains switch in position 0. Type and requirements as specified in EN 60204-1, 5.3.2.

The electrical connection must be carried out in accordance with local regulations.

Warning

The pumps must be connected to a control box with a motor protection relay with IEC trip class 10 or 15.

Warning

Power supply for motor protection circuit must be low voltage, Class 2.

See motor protection wiring diagram in section *8.1 Wiring diagrams*.

Warning

Pumps for hazardous locations must be connected to a control box with a motor protection relay with IEC trip class 10.

Warning

Do not install Grundfos control boxes, pump controllers, Ex barriers and the free end of the power cable in potentially explosive environments.

The classification of the installation site must be approved by the local fire-fighting authorities in each individual case.

On explosion-proof pumps, make sure that an external earth conductor is connected to the external earth terminal on the pump using a secure cable clamp. Clean the surface of the external earth connection and mount the cable clamp.

The cross section of the earth conductor must be at least 4 mm^2, e.g. type H07 V2-K (PVT 90 °) yellow/ green.

Make sure that the earth connection is protected from corrosion.

Make sure that all protective equipment has been connected correctly.

Float switches used in potentially explosive environments must be approved for this application. They must be connected to the Grundfos LC, LCD 108 pump controller via the intrinsically safe LC-Ex4 barrier to ensure a safe circuit.

Warning

If the supply cable is damaged, it must be replaced by the manufacturer, its service agent or similarly qualified persons.

Caution

Set the motor-protective circuit breaker to the rated current of the pump. The rated current is stated on the pump nameplate.

Caution

If the pump has an Ex mark on the nameplate, make sure that the pump is connected in accordance with the instructions given in this booklet.

The mains supply voltage and frequency are marked on the pump nameplate. The voltage tolerance must be within - 10 %/+ 10 % of the rated voltage. Make sure that the motor is suitable for the power supply available at the installation site.

All pumps are supplied with 10 m cable and a free cable end, except for pumps for Australia which have 15 m cable.

Pumps without sensor must be connected to one of these three controller types:

- a control box with motor-protective circuit breaker, such as a Grundfos CU 100
- a Grundfos LC, LCD 107, LC, LCD 108 or LC, LCD 110 pump controller
- a Grundfos DC, DCD pump controller.

Pumps with sensor must be connected to a Grundfos IO 113 and one of these three controller types:

- a control box with motor-protective circuit breaker, such as a Grundfos CU 100
- a Grundfos LC, LCD 107, LC, LCD 108 or LC, LCD 110 pump controller
- a Grundfos DC and DCD pump controller.

Warning

Before installation and the first startup of the pump, check the condition of the cable visually to avoid short circuits.

Pumps with WIO sensor

For safe installation and operation of pumps equipped with a WIO sensor, we recommend to install an RC filter between the power contactor and the pump.

Caution

If an RC filter is installed to avoid any kind of transients in the installation, the RC filter must be installed between the power contactor and the pump.

Please note that the following aspects may cause problems in case of transients in the power supply system:

- Motor power:
  – The bigger the motor, the higher the transients.
- Length of motor cable:
  – Where power and signal conductors are running in parallel close to each other, the risk of transients causing interference between power and signal conductors will increase with the length of the cable.
- Switchboard layout:
  – Power and signal conductors must be physically separated as much as possible. Close installation can cause interference in case of transients.
- Supply network "stiffness":
  – If a transformer station is located close to the installation, the supply network may be "stiff" and transient levels will be higher.

If combinations of the above aspects are present, it may be necessary to install RC filters for pumps with WIO sensors to protect against transients.

Transients can be completely eliminated if soft starters are used. But be aware that soft starters and variable speed drives have other EMC-related issues that must be taken into consideration.

For more information, see section *8.7 Frequency converter operation*

8.1 Wiring diagrams

The pumps are supplied via either a 7-core cable or a 10-core cable. See fig. 6 for wiring diagrams for 7-core cable connection or figures. 7, 8 and 9 for wiring diagrams for 10-core cable connection. For further information, see the installation and operating instructions for the selected control box or pump controller.

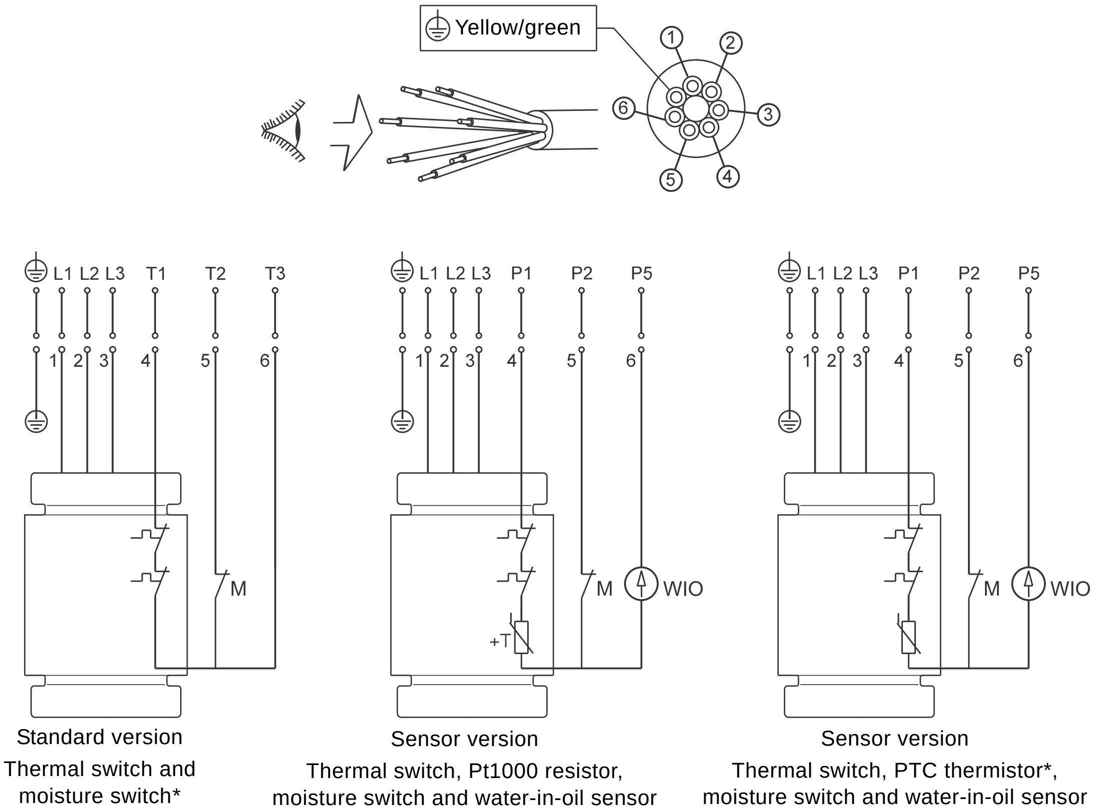


Fig. 6 Wiring diagram, 7-core cable, DOL

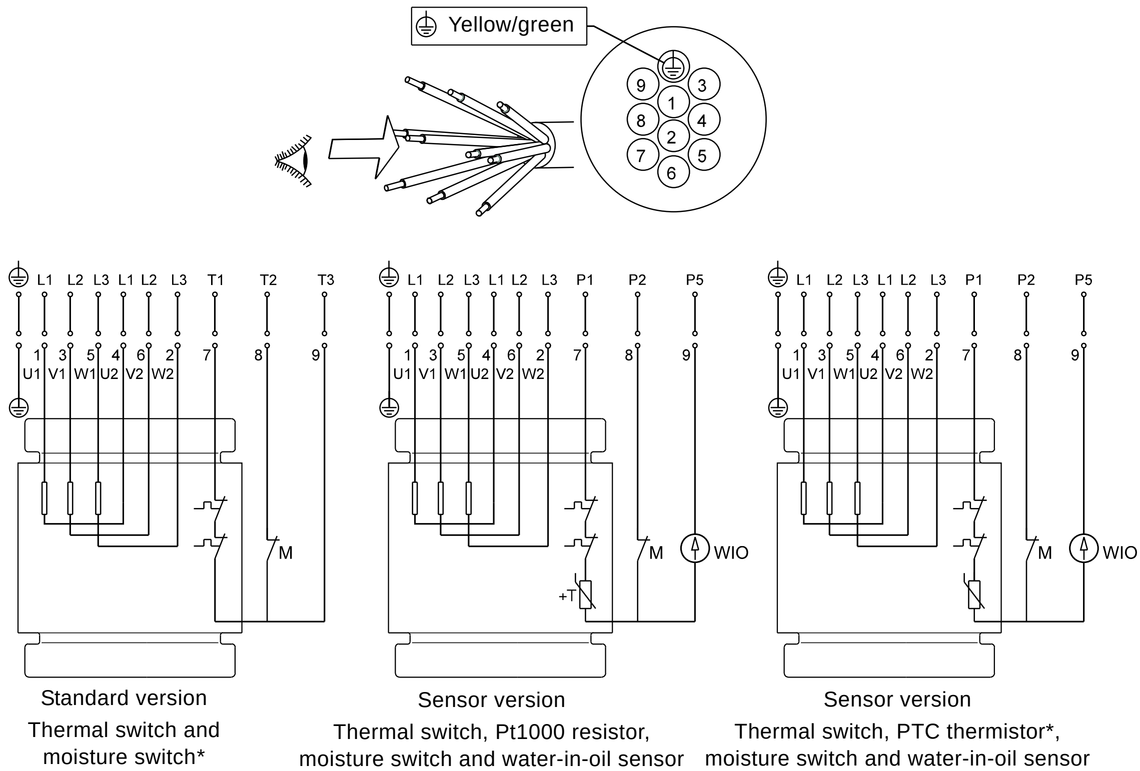
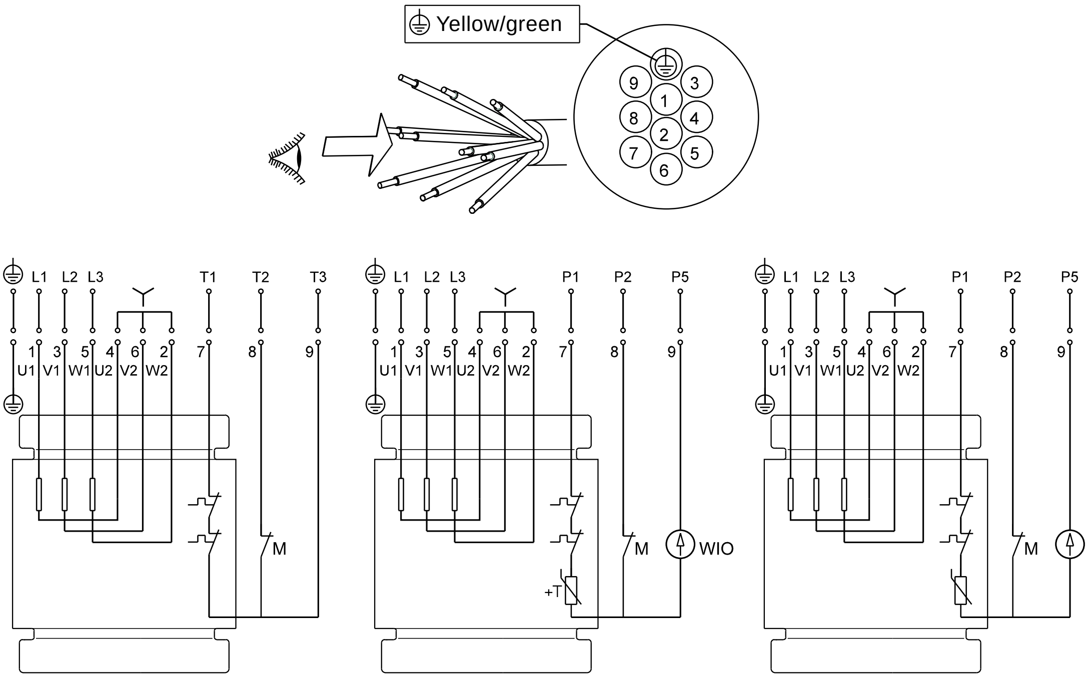
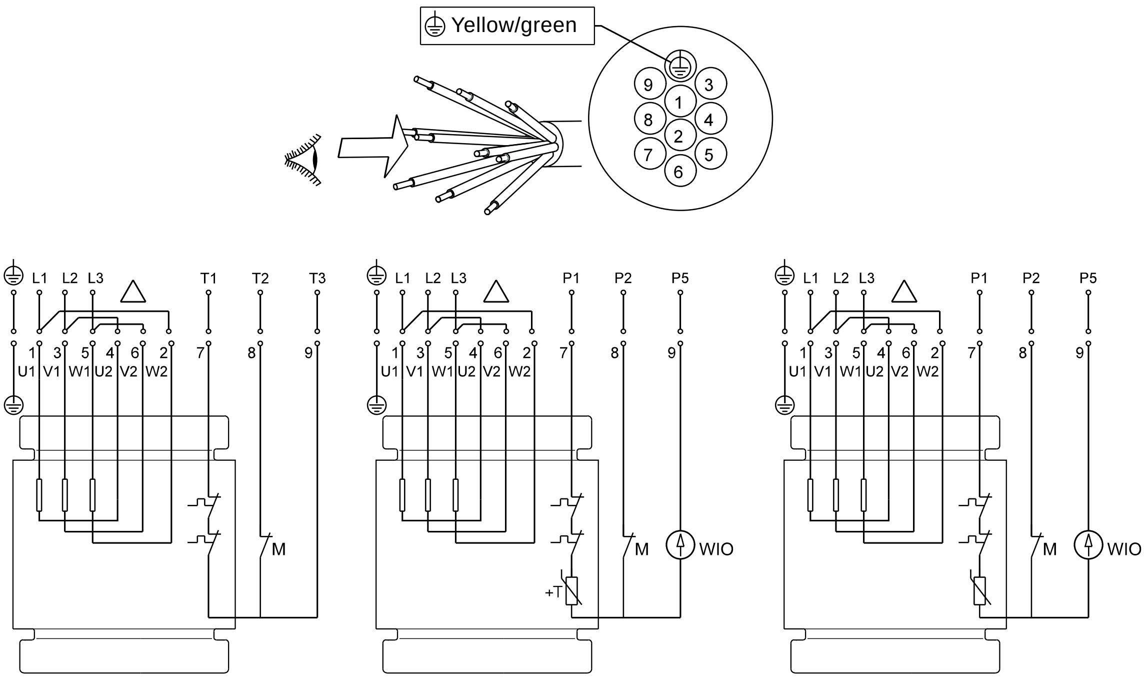


Fig. 7 Wiring diagram, 10-core cable, star/delta (Y/D)



* Pumps from 4 kW and up sold in Australia/New Zealand are fitted with a PTC thermistor.

Fig. 8 Wiring diagram, 10-core cable, star-connected (Y)



* Pumps from 4 kW and up sold in Australia/New Zealand are fitted with a PTC thermistor.

Fig. 9 Wiring diagram, 10-core cable, delta-connected (D)

To find out whether the pump is fitted with a thermal switch or a PTC thermistor, measure the motor winding resistance. See table below.

	Without cable	With 10 m cable	With 15 m cable
Thermal switch	< 50 mΩ	< 320 mΩ	< 390 mΩ
PTC thermistor	> 100 mΩ	> 370 mΩ	> 440 mΩ

8.2 Pump controllers

SL1 and SLV pumps can be connected to the following Grundfos pump controllers for level control:

LC controllers are for one-pump-installations and LCD controllers are for two-pump installations.

- LC 107 and LCD 107 with air bells
- LC 108 and LCD 108 with float switches
- LC 110 and LCD 110 with electrodes
- Grundfos DC and DCD.

For further information on controllers, please see the installation and operation instructions for the selected controller or go to www.grundfos.com.

8.3 Thermal switch, Pt1000 and PTC thermistor

All SL1 and SLV pumps have thermal protection incorporated in the stator windings.

Pumps without sensor

Pumps without sensor have a thermal switch or a PTC thermistor. Via the pump controller safety circuit, the thermal switch will stop the pump by breaking the circuit in case of overtemperature (approx. 150 °C). The thermal switch will reclose the circuit after cooling. For pumps equipped with a PTC thermistor, connect the thermistor to either the PTC relay or the I/O module to break the circuit at 150 °C.

The maximum operating current of the thermal switch is 0.5 A at 500 VAC and cos φ 0.6. The switch must be able to break a coil in the supply circuit.

Pumps with WIO sensor

Pumps with WIO sensor have either a thermal switch and a Pt1000 sensor or a PTC thermistor in the windings, depending on the installation site.

Via the pump controller safety circuit, the thermal switch or the thermistor will stop the pump by breaking the circuit in case of overtemperature (approx. 150 °C). The thermal switch or the thermistor will reclose the circuit after cooling.

The maximum operating current of both the Pt1000 and the thermistor is 1 mA at 24 VDC.

Non-explosion-proof pumps

When closing the circuit after cooling, the thermal protection can restart the pump automatically via the controller. Pumps from 4 kW and up sold in Australia/New Zealand are fitted with a PTC thermistor.

Explosion-proof pumps

Warning

The thermal protection of explosion-proof pumps must not restart the pump automatically.
This ensures protection against overtemperature in potentially explosive environments. In pumps with sensor this is done by removing the short circuit between terminals R1 and R2 in the IO 113. See Electrical data in the IO 113 installation and operating instructions.

Warning

The separate motor-protective circuit breaker/ controller must not be installed in potentially explosive environments.

8.4 WIO sensor (water-in-oil sensor)

The WIO sensor measures the water content in the oil and converts the value into an analogue current signal. The two sensor conductors are for power supply and for carrying the signal to the IO 113. The sensor measures the water content from 0 to 20 %. It also sends a signal if the water content is outside the normal range (warning), or if there is air in the oil chamber (alarm). The sensor is fitted in a stainless-steel tube for mechanical protection.

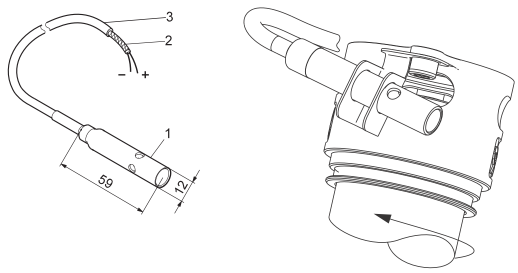


Fig. 10 WIO sensor

8.4.1 Fitting the WIO sensor

Fit the sensor next to one of the shaft seal openings. See fig. 10. The sensor must be tilted into the motor's direction of rotation to ensure that oil is led into the sensor. Make sure that the sensor is submerged in the oil.

8.4.2 Technical data

Input voltage:	12-24 VDC
Output current:	3.4 - 22 mA
Power input:	0.6 W
Ambient temperature:	0-70 °C

See also the installation and operating instructions for IO 113 on www.grundfos.com.

8.5 Moisture switch

All pumps are fitted with a moisture switch as standard with the moisture switch being connected via the supply cable, see section *8. Electrical connection*, and connected to a separate circuit breaker.

The moisture switch is positioned in the bottom of the motor. If there is moisture in the motor, the switch will break the circuit and send a signal to the IO 113.

The moisture switch is non-reversing and must be replaced after use.

The moisture switch is connected to the monitoring cable, and it must be connected to the safety circuit of the separate pump controller. See section *8. Electrical connection*.

Caution

The motor-protective circuit breaker of the pump controller must include a circuit which automatically disconnects the power supply in case the protective circuit for the pump is opened.

8.6 IO 113

IO 113 provides an interface between a Grundfos wastewater pump equipped with sensors and the pump controller(s). The most important sensor status information is indicated on the front panel.

One pump can be connected to one IO 113 module.

Together with the sensors, the IO 113 provides a galvanic isolation between the motor voltage in the pump and the connected controller(s).

IO 113 can do the following as standard:

- Protect the pump against overheating.
- Monitor the status of these items:
  - motor winding temperature
  - leakage (WIO)
  - moisture in pump.
- Measure the stator insulation resistance.
- Stop the pump in case of alarm.
- Remotely monitor the pump via RS-485 communication (Modbus or GENIbus).
- Control the pump via a frequency converter.

Warning
IO 113 must not be used for purposes other than those specified above.

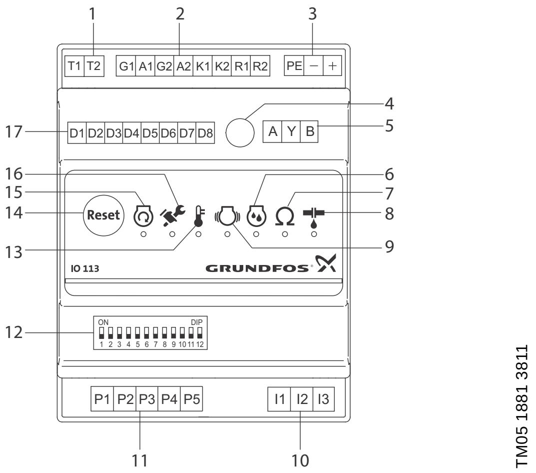


Fig. 11 IO 113 module

Pos.	Description
1	Terminals for alarm relay
2	Terminals for analog and digital inputs and outputs
3	Terminals for supply voltage
4	Potentiometer for setting the warning limit of stator insulation resistance
5	Terminals for RS-485 for GENIbus or Modbus
6	Indicator light for moisture measurement
7	Indicator light for stator insulation resistance
8	Indicator light for leakage (WIO)
9	Indicator light for vibration in pump
10	Terminals for measurement of stator insulation resistance
11	Terminals for connection of pump sensors
12	DIP switch for configuration
13	Indicator light for motor temperature
14	Button for resetting alarms
15	Indicator light for motor running
16	Indicator light for service
17	Terminals for digital outputs

8.7 Frequency converter operation

All SL1/SLV pump types are designed for frequency converter operation to keep the energy consumption at a minimum.

To avoid the risk of sedimentation in the pipes, we recommend that you operate the speed-controlled pump at a flow rate above 1 m/s.

For frequency converter operation, please observe the following information:

- Requirements must be fulfilled. See section *8.7.1 Requirements*.
- Recommendations ought to be fulfilled. See section *8.7.2 Recommendations*.
- Consequences should be considered. See section *8.7.3 Consequences*.

8.7.1 Requirements

- The thermal protection of the motor must be connected.
- Minimum switching frequency: 2.5 kHz.
- Peak voltage and dU/dt must be in accordance with the table below. The values stated are maximum values supplied to the motor terminals. The cable influence has not been taken into account. See the frequency converter data sheet regarding the actual values and the cable influence on the peak voltage and dU/dt.

Maximum repetitive peak voltage [V]	Maximum dU/dt U_N 400 V [V/µ sec.]
850	2000

- If the pump is an Ex-approved pump, check if the Ex certificate of the specific pump allows the use of a frequency converter.
- Set the frequency converter U/f ratio according to the motor data.
- Local regulations/standards must be fulfilled.

8.7.2 Recommendations

Before installing a frequency converter, calculate the lowest allowable frequency in the installation in order to avoid zero flow.

- Do not reduce the motor speed to less than 30 % of rated speed.
- Keep the flow velocity above 1 m/sec.
- Let the pump run at rated speed at least once a day in order to prevent sedimentation in the piping system.
- Do not exceed the frequency indicated on the nameplate. In this case there is risk of motor overload.
- Keep the motor cable as short as possible. The peak voltage will increase with the length of the motor cable. See data sheet for the frequency converter used.
- Use input and output filters on the frequency converter. See data sheet for the frequency converter used.
- Use screened motor cable if there is a risk that electrical noise can disturb other electrical equipment. See data sheet for the frequency converter used.

8.7.3 Consequences

When operating the pump via a frequency converter, please be aware of these possible consequences:

- The locked-rotor torque will be lower. How much lower will depend on the frequency converter type. See the installation and operating instructions for the frequency converter used for information on the locked-rotor torque available.
- The working condition of bearings and shaft seal may be affected. The possible effect will depend on the application. The actual effect cannot be predicted.
- The acoustic noise level may increase. See the installation and operating instructions for the frequency converter used for advice as to how to reduce the acoustic noise.

9. Startup

Warning

Before starting work on the pump, make sure that the fuses have been removed or the mains switch has been switched off. Make sure that the power supply cannot be accidentally switched on.

Make sure that all protective equipment has been connected correctly.

The pump must not run dry.

Warning

The pump must not be started if the atmosphere in the tank is potentially explosive.

Warning

It may lead to personal injuries or death to open the clamp while the pump is operating.

9.1 General startup procedure

This procedure applies to new installations as well as after service inspections if startup takes place some time after the pump was placed in the tank.

1. Remove the fuses and check that the impeller can rotate freely. Turn the impeller by hand.

Warning

The impeller can have sharp edges - wear protective gloves.

2. Check the condition of the oil in the oil chamber. See also section *10.1 Inspection*.
3. Check that the system, bolts, gaskets, pipework and valves etc. are in correct condition.
4. Mount the pump in the system.
5. Switch on the power supply.
6. Check whether the monitoring units, if used, are operating satisfactorily.
7. **For pumps with WIO sensor,** switch on the IO 113 and check that there are no alarms or warnings. See section *8.6 IO 113*.
8. Check the setting of air bells, float switches or electrodes.
9. Check the direction of rotation. See section *9.3 Direction of rotation*.
10. Open the isolating valves, if fitted.
11. Check that the liquid level is above the motor for S1 operation and above the cable entry for S3 operation. See fig. 14. If the minimum level is not reached do not start the pump.
12. Start the pump and let the pump run briefly, and check if the liquid level is falling.
13. Observe if the discharge pressure and input current are normal. If not there might be air trapped inside the pump.

Note

Trapped air can be removed from the pump housing by tilting the pump by means of the lifting chain when the pump is in operation.

Caution

In case of abnormal noise or vibrations from the pump, other pump failure or power supply failure or water supply failure, stop the pump immediately. Do not attempt to restart the pump until the cause of the fault has been found and the fault corrected.

After one week of operation or after replacement of the shaft seal, check the condition of the oil in the chamber. For pumps without sensor, this is done by taking a sample of the oil. See section *10. Maintenance and service* for procedure.

Every time the pump has been removed from the tank, go through the above procedure when starting up again.

9.2 Operating modes

The pumps are designed for intermittent operation (S3). When completely submerged, the pumps can also operate continuously (S1).

S3, intermittent operation:

Operating mode S3 means that within 10 minutes the pump must be in operation for 4 minutes and stopped for 6 minutes. See fig. 12.

In this operating mode, the pump is partly submerged in the pumped liquid, i.e. the liquid level reaches at minimum the top of the cable entry on the motor housing. See fig. 2.

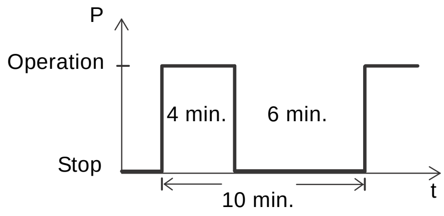


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Fig. 12 S3, intermittent operation

S1, continuous operation:

In this operating mode, the pump can operate continuously without being stopped for cooling. See fig. 13. Being completely submerged, the pump is sufficiently cooled by the surrounding liquid. See fig. 2.

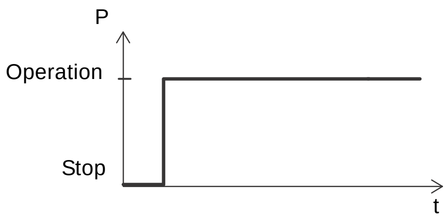

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Fig. 13 S1, continuous operation

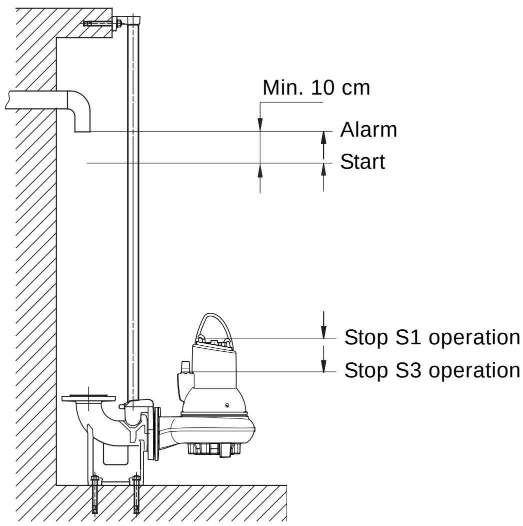

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Fig. 14 Start and stop levels

Make sure that the effective volume of the tank does not become so low that the number of starts per hour exceeds the maximum permissible number.

9.3 Direction of rotation

Note: The pump may be started for a very short period without being submerged to check the direction of rotation.

Check the direction of rotation before starting up the pump.

An arrow on the motor housing indicates the correct direction of rotation. Correct direction of rotation is clockwise when viewed from above.

Checking the direction of rotation

The direction of rotation should be checked in the following way every time the pump is connected to a new installation.

Procedure

1. Let the pump hang from a lifting device, e.g. the hoist used for lowering the pump into the tank.
2. Start and stop the pump while observing the movement (jerk) of the pump. If connected correctly, the pump will rotate clockwise, i.e. it will jerk counter-clockwise. See fig. 15.
3. If the direction of rotation is wrong, interchange any two of the phases in the power supply cable. See fig. 6 or 8.

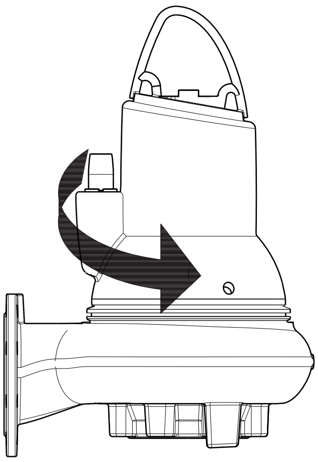

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Fig. 15 Jerk direction

10. Maintenance and service

Warning

During maintenance and service, including transportation to service workshop, always support the pump by means of lifting chains or place it in horizontal position to secure stability.

Warning

Before starting work on the pump, make sure that the fuses have been removed or the mains switch has been switched off. Make sure that the power supply cannot be accidentally switched on.

Make sure that all protective equipment has been connected correctly.

Warning

Before starting work on the pump, make sure that the mains switch has been locked in position 0.

All rotating parts must have stopped moving.

Warning

Maintenance work on explosion-proof pumps must be carried out by Grundfos or a service workshop authorized by Grundfos.

However, this does not apply to the hydraulic components, such as pump housing, impeller, etc.

Warning

The cable must only be replaced by Grundfos or a service workshop authorized by Grundfos.

Before carrying out maintenance and service, make sure that the pump has been thoroughly flushed with clean water. Rinse the pump parts in water after dismantling.

10.1 Inspection

Pumps running normal operation should be inspected every 3000 operating hours or at least once a year. If the pumped liquid is very muddy or sandy, inspect the pump at shorter intervals.

Check the following points:

- **Power consumption**
  See pump nameplate.
- **Oil level and oil condition**
  When the pump is new or after replacement of the shaft seal, check the oil level and water content after one week of operation. If there is more than 20 % extra liquid (water) in the oil chamber, the shaft seal is defective. The oil should be changed after 3000 operating hours or once a year.
  Use Shell Ondina 919 oil or similar type.
  See section *10.2.1 Oil change*.
- **Cable entry**
  Make sure that the cable entry is watertight (visual inspection) and that the cable is not sharply bent and/or pinched.
- **Pump parts**
  Check impeller, pump housing, etc. for possible wear.
  Replace defective parts.
  See section *10.2.2 Removing the pump housing and impeller*.

- **Ball bearings**
  Check the shaft for noisy or heavy operation (turn the shaft by hand). Replace defective ball bearings.
  A general overhaul of the pump is usually required in case of defective ball bearings or poor motor function. This work must be carried out by Grundfos or a service workshop authorized by Grundfos.

Warning
Defective bearings may reduce the Ex safety.

- **O-rings and similar parts**
  During service/replacement, make sure that the grooves for the O-rings as well as the seal faces have been cleaned before the new parts are fitted. Grease O-rings and recesses before assembly.

Note — Do not reuse rubber parts.

Warning
Explosion-proof pumps must be checked by an authorized Ex workshop once a year.

10.2 Dismantling the pump

Note — See www.grundfos.com for service videos.

10.2.1 Oil change

After 3000 operating hours or once a year, change the oil in the oil chamber as described below.

If the shaft seal has been replaced, the oil must be changed.

Warning
When loosening the screws of the oil chamber, note that pressure may have built up in the chamber. Do not remove the screws until the pressure has been fully relieved.

Draining of oil

1. Place the pump on a plane surface with one oil screw pointing downwards.
2. Place a suitable container (approx. 1 litre), for instance made of transparent plastic material, under the oil screw.

Note — Used oil must be disposed of in accordance with local regulations.

3. Remove the lower oil screw.
4. Remove the upper oil screw.
   If the pump has been in operation for a long period of time, if the oil is drained off shortly after the pump has been stopped, and if the oil is greyish white like milk, it contains water. If the oil contains more than 20 % water, it is an indication that the shaft seal is defective and must be replaced. If the shaft seal is not replaced, the motor will be damaged.
   If the quantity of oil is smaller than the quantity stated in section *10.4 Oil quantities*, the shaft seal is defective.
5. Clean the faces for the gaskets for oil screws.

Filling with oil

1. Turn the pump so that the oil filling holes are placed opposite to each other, pointing upwards.

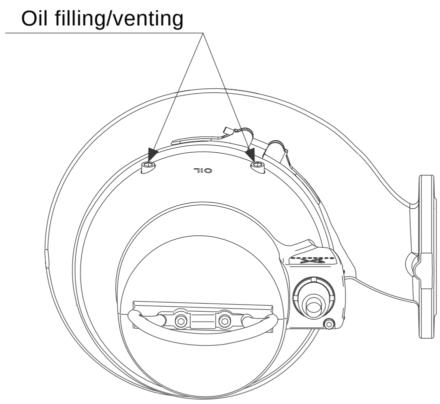

Fig. 16 Oil filling holes

2. Pour oil into the chamber.
   For oil quantity, see section *10.4 Oil quantities*.
3. Fit the oil screws with new gaskets.

10.2.2 Removing the pump housing and impeller

For position numbers, see pages 29 and 30.

Procedure

1. Loosen the clamp (pos. 92).
2. Remove the screw (pos. 92a) using your fingers.
3. Remove the pump housing (pos. 50) by inserting two screwdrivers between the cooling jacket and the pump housing.
4. Remove the screw (pos. 188a). Hold the impeller with a strap wrench.

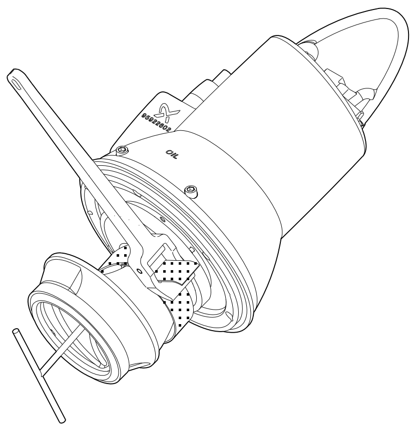

Fig. 17 Removing the impeller

5. Loosen the impeller (pos. 49) with a light blow on the edge. Pull it off.
6. Remove the key (pos. 9a) and the spring for impeller (pos. 157).

10.2.3 Removing the seal ring and wear ring

Procedure

1. Turn the pump housing upside-down.
2. Knock the seal ring (pos. 46) out of the pump housing using a punch.

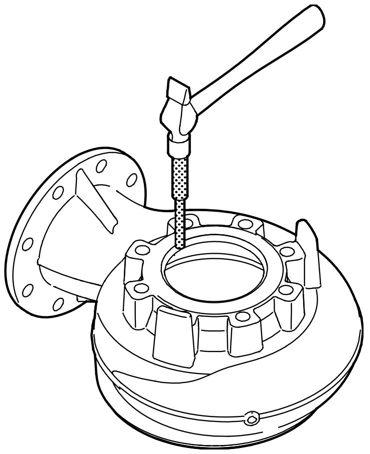

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Fig. 18 Removing the seal ring

3. Clean the pump housing where the seal ring was fitted.
4. Remove the wear ring (pos. 49c) using a screwdriver.

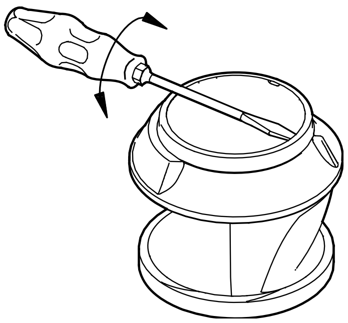

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Fig. 19 Removing the wear ring

5. Clean the impeller where the wear ring was fitted.

10.2.4 Removing the shaft seal

Procedure

1. Remove the screws (pos. 188).
2. Remove the cover for oil chamber (pos. 58) using a puller.
3. Remove the screws (pos. 186).
4. Remove the shaft seal (pos. 105) using the puller.
5. Remove the O-ring (pos. 153b).

Procedure (pump with WIO sensor)

1. Remove the screws (pos. 188).
2. Remove the cover for oil chamber (pos. 58) using a puller.
3. Remove the screws (pos. 186).
4. Remove the sensor (pos. 521) and holder (pos. 522) from the shaft seal.
5. Remove the shaft seal (pos. 105) using the puller.
6. Remove the O-ring (pos. 153b).

10.3 Assembling the pump

10.3.1 Tightening torques and lubricants

Pos.	Designation	Quantity	Dim.	Torque [Nm]	Lubricant
92a	Screw	1		12 ± 2	
118a	Screw	2	M8	20 ± 2	
			M10	30 ± 3	
174	Screw	1		4 ± 1	
181	Union nut	1	7-pole	50 ± 5	
			10-pole	75 ± 5	
186	Screw	2		7 + 2-0	
182	Screw	4		20 ± 2	
187	Screw	4		20 ± 2	
188	Screw	2	M8	20 ± 2	
			M10	30 ± 3	
188a	Screw	2	M10	50 + 5-0	
			M12	75 ± 5	
193	Screw	2		16 ± 2	
	O-rings	All			Rocol

Rocol Sapphire Aqua-Sil, product number RM2924 (1 kg).
Shell Ondina 919, product number 96001442 (1 l)

10.3.2 Fitting the shaft seal

Procedure

1. Fit and lubricate the O-ring (pos. 153b) with oil.
2. Slide the shaft seal (pos. 105) gently over the shaft.
3. Fit and tighten the screws (pos. 186).
4. Fit and lubricate the O-ring (pos. 107) in the cover for oil chamber (pos. 58) with oil.
5. Fit the cover for oil chamber.
6. Fit and tighten the screws (pos. 188).

Procedure (pump with WIO sensor)

1. Fit and lubricate the O-ring (pos. 153b) with oil.
2. Slide the shaft seal (pos. 105) gently over the shaft.
3. Fit the holder (pos. 522) and sensor (pos. 521) with one of the screws (pos. 186).
4. Fit the second screw and tighten both screws (pos. 186).
5. Fit and lubricate the O-ring (pos. 107) in the cover for oil chamber (pos. 58) with oil.
6. Check that the sensor is positioned correctly. See section *8.4.1 Fitting the WIO sensor* and fig. 10. This is of special importance in horizontal pumps.
7. Fit the cover for oil chamber.
8. Fit and tighten the screws (pos. 188).

10.3.3 Fitting the seal ring and wear ring

Procedure

1. Lubricate the seal ring (pos. 46) with soapy water.
2. Place the seal ring in the pump housing.
3. Knock the seal ring home in the pump housing using a punch or a wooden block.

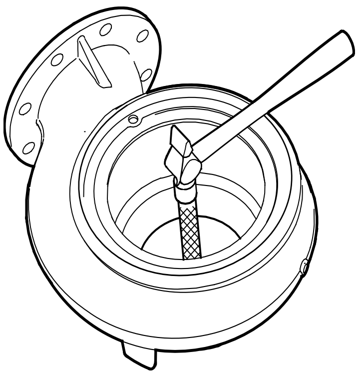


Fig. 20 Fitting the seal ring

4. Place the wear ring (pos. 49c) on the impeller.
5. Knock the wear ring home using a wooden block.

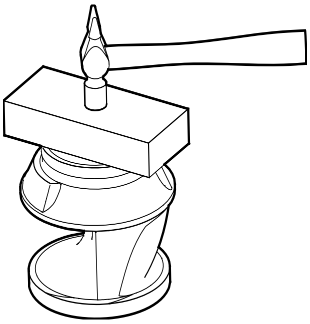


Fig. 21 Fitting the wear ring

10.3.4 Fitting the impeller and pump housing

Procedure

1. Fit the spring (pos. 157) and the key (pos. 9a).
   Keep the key in position while the impeller is fitted.
2. Fit the impeller (pos. 49).
3. Fit the washer (pos. 66) and the screw (pos. 188a).
4. Tighten the screw (pos. 188a) to 75 Nm. Hold the impeller with the strap wrench.
5. Mark the position of the pin on the pump housing.
6. Mark the position of the pin hole on the oil chamber.
7. Fit and lubricate the O-ring (pos. 37) with oil.
8. Fit the pump part in the pump housing (pos. 50).
9. Fit the clamp (pos. 92).
10. Tighten the screw (pos. 92a) to 12 Nm.
11. Check that the impeller rotates freely and without drag.

10.4 Oil quantities

The table shows the quantity of oil in the oil chamber of SL1 and SLV pumps. Oil type: Shell Ondina 919.

	Power [kW]	Oil quantity [l]
2-pole	2.2	0.6
	3.0	0.6
	4.0	1.0
	6.0	1.0
	7.5	1.0
	9.2	1.2
	11.0	1.2
4-pole	1.1	0.6
	1.3	0.6
	1.5	0.6
	2.2	0.6
	3.0	1.0
	4.0	1.0
	5.5	1.0
	7.5	1.2

Note: Used oil must be disposed of in accordance with local regulations.

10.5 Service kits

For service kits for SL1, SLV, see www.grundfos.com or Service Kit Catalogue.

10.6 Contaminated pumps

Note: If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

If Grundfos is requested to service the pump, Grundfos must be contacted with details about the pumped liquid, etc. *before* the pump is returned for service. Otherwise Grundfos can refuse to accept the pump for service.

Possible costs of returning the pump are to be paid by the customer.

However, any application for service (no matter to whom it may be made) must include details about the pumped liquid if the pump has been used for liquids which are injurious to health or toxic.

Before a pump is returned, it must be cleaned in the best possible way before it is returned.

Service instruction and service video can be found on www.grundfos.com.

11. Fault finding

Warning

Before attempting to diagnose any fault, make sure that the fuses have been removed or the mains switch has been switched off. Make sure that the power supply cannot be accidentally switched on.

All rotating parts must have stopped moving.

Warning

All regulations applying to pumps installed in potentially explosive environments must be observed.

Make sure that no work is carried out in potentially explosive atmosphere.

Note

For pumps with sensor, start fault finding by checking the status on the IO 113 front panel.

See installation and operating instructions for IO 113.

Fault	Cause	Remedy
1. Motor does not start. Fuses blow or motor-protective circuit breaker trips immediately. **Caution:** Do not start again!	a) Supply failure; short circuit; earth-leakage fault in cable or motor winding.	Have the cable and motor checked and repaired by a qualified electrician.
	b) Fuses blow due to use of wrong type of fuse.	Fit fuses of the correct type.
	c) Impeller blocked by impurities.	Clean the impeller.
	d) Air bells, float switches or electrodes out of adjustment or defective.	Readjust or replace the air bells, float switches or electrodes.
	e) Moisture in the stator housing (alarm). The IO 113 interrupts the supply voltage.*	Replace the O-rings, the shaft seal and moisture switch.
	f) The WIO sensor is not covered by oil (alarm). The IO 113 interrupts the supply voltage.*	Check, and possibly replace, the shaft seal, fill up with oil and reset the IO 113.
	g) Stator insulation resistance too low.*	Reset alarm on IO 113, see installation and operating instructions for IO 113.
2. Pump operates, but motor-protective circuit breaker trips after a short while.	a) Low setting of thermal relay in motor-protective circuit breaker.	Set the relay in accordance with the specifications on the nameplate.
	b) Increased current consumption due to large voltage drop.	Measure the voltage between two motor phases. Tolerance: - 10 %/+ 6 %. Reestablish correct voltage supply.
	c) Impeller blocked by impurities. Increased current consumption in all three phases.	Clean the impeller.
	d) Wrong direction of rotation.	Check the direction of rotation and possibly interchange any two of the phases in the incoming supply cable. See section *9.3 Direction of rotation*.
3. The thermal switch of the pump trips after a short while.	a) Too high liquid temperature.	Reduce the liquid temperature.
	b) Too high viscosity of the pumped liquid.	Dilute the pumped liquid.
	c) Wrong electrical connection. (If the pump is star-connected to a delta connection, the result will be very low undervoltage).	Check and correct the electrical installation.
4. Pump operates at below-standard performance and power consumption.	a) Impeller blocked by impurities.	Clean the impeller.
	b) Wrong direction of rotation.	Check the direction of rotation and possibly interchange any two of the phases in the incoming supply cable. See section *9.3 Direction of rotation*.
5. Pump operates, but gives no liquid.	a) Discharge valve closed or blocked.	Check the discharge valve and possibly open and/or clean it.
	b) Non-return valve blocked.	Clean the non-return valve.
	c) Air in pump.	Vent the pump.
6. High power consumption (SLV).	a) Wrong direction of rotation.	Check the direction of rotation and possibly interchange any two of the phases in the incoming supply cable. See section *9.3 Direction of rotation*.
	b) Impeller blocked by impurities.	Clean the impeller.
7. Noisy operation and excessive vibrations (SL1).	a) Wrong direction of rotation.	Check the direction of rotation and possibly interchange any two of the phases in the incoming supply cable. See section *9.3 Direction of rotation*.
	b) Impeller blocked by impurities.	Clean the impeller.
8. Pump clogged.	a) The liquid contains large particles.	Select a pump with a larger size of passage.
	b) A float layer has formed on the surface of the liquid.	Install a mixer in the tank.

* Applies only to pumps with sensor and with IO 113.

12. Technical data

Supply voltage

- 3 x 380-415 V - 10 %/+ 10 %, 50 Hz
- 3 x 400-415 V - 10 %/+ 10 %, 50 Hz.

Enclosure class

IP68. According to IEC 60529.

Insulation class

H (180 °C).

Operating pressure

All pump housings have a cast-iron PN 10 discharge flange.

Dimensions

Discharge flanges are DN 65, DN 80, DN 100 or DN 150 according to EN 1092-2.

Pump curves

Pump curves are available via the internet on **www.grundfos.com**.

The curves are to be considered as a guide. They must not be used as guarantee curves.

Test curves for the supplied pump are available on request.

Make sure that the pump does not operate outside the recommended operating range during normal operation.

Pump noise emission < 70 dB(A)

- Sound power measurements were carried out according to ISO 3743.
- Sound power was calculated at a distance of 1 metre according to ISO 11203.

The sound pressure level of the pump is lower than the limiting values stated in the EC Council Directive 2006/42/EC relating to machinery.

2-pole motor					Cable connection	
Power P_2 [kW]	Power P_1 [kW]	Voltage [V]	Starting method	Thermal protection	Cable cross section [mm^2]	Conductors / plug pins
2.2	2.8	3 x 380-415	DOL	Thermal switch	1.5	7/7
2.2	2.8	3 x 380-415	Y/D	Thermal switch	1.5	10/10
2.2	2.8	3 x 400-415	DOL	Thermal switch	1.5	7/7
3	3.8	3 x 380-415	DOL	Thermal switch	1.5	7/7
3	3.8	3 x 380-415	Y/D	Thermal switch	1.5	10/10
3	3.8	3 x 400-415	DOL	Thermal switch	1.5	7/7
4	4.8	3 x 380-415	Y/D	Thermal switch	2.5	10/10
4	4.8	3 x 400-415	DOL	Thermistor	2.5	7/10
6.0	7.1	3 x 380-415	Y/D	Thermal switch	2.5	10/10
6.0	7.1	3 x 400-415	DOL	Thermistor	2.5	7/10
7.5	8.9	3 x 380-415	Y/D	Thermal switch	2.5	10/10
7.5	8.9	3 x 400-415	DOL	Thermistor	2.5	7/10
9.2	10.5	3 x 380-415	Y/D	Thermal switch	2.5	10/10
9.2	10.5	3 x 400-415	DOL	Thermistor	2.5	7/10
11	12.6	3 x 380-415	Y/D	Thermal switch	2.5	10/10
11	12.6	3 x 400-415	DOL	Thermistor	2.5	7/10

The supply cable resistance depends on the cable diameter.
Resistance per running metre of cable: 1.5 mm^2 = 0.012 Ω.
Resistance per running metre of cable: 2.5 mm^2 = 0.007 Ω.

4-pole motor					Cable connection	
Power P_2 [kW]	Power P_1 [kW]	Voltage [V]	Starting method	Thermal protection	Cable cross section [mm^2]	Conductors / plug pins
1.1	1.5	3 x 380-415	DOL	Thermal switch	1.5	7/7
1.1	1.5	3 x 400-415	DOL	Thermal switch	1.5	7/7
1.3	1.8	3 x 380-415	DOL	Thermal switch	1.5	7/7
1.3	1.8	3 x 400-415	DOL	Thermal switch	1.5	7/7
1.5	2.1	3 x 380-415	DOL	Thermal switch	1.5	7/7
1.5	2.1	3 x 400-415	DOL	Thermal switch	1.5	7/7
2.2	2.9	3 x 380-415	DOL	Thermal switch	1.5	7/7
2.2	2.9	3 x 380-415	Y/D	Thermal switch	1.5	10/10
2.2	2.9	3 x 400-415	DOL	Thermal switch	1.5	7/7
3	3.7	3 x 380-415	DOL	Thermal switch	1.5	7/7
3	3.7	3 x 380-415	Y/D	Thermal switch	1.5	10/10
3	3.7	3 x 400-415	DOL	Thermal switch	2.5	7/7
4	4.9	3 x 380-415	Y/D	Thermal switch	2.5	10/10
4	4.9	3 x 400-415	DOL	Thermistor	2.5	7/10
5.5	6.5	3 x 380-415	Y/D	Thermal switch	2.5	10/10
5.5	6.5	3 x 400-415	DOL	Thermistor	2.5	7/10
7.5	9.0	3 x 380-415	Y/D	Thermal switch	2.5	10/10
7.5	9.0	3 x 400-415	DOL	Thermistor	2.5	7/10

The supply cable resistance depends on the cable diameter.
Resistance per running metre of cable: 1.5 mm^2 = 0.012 Ω.
Resistance per running metre of cable: 2.5 mm^2 = 0.007 Ω.

13. Disposal

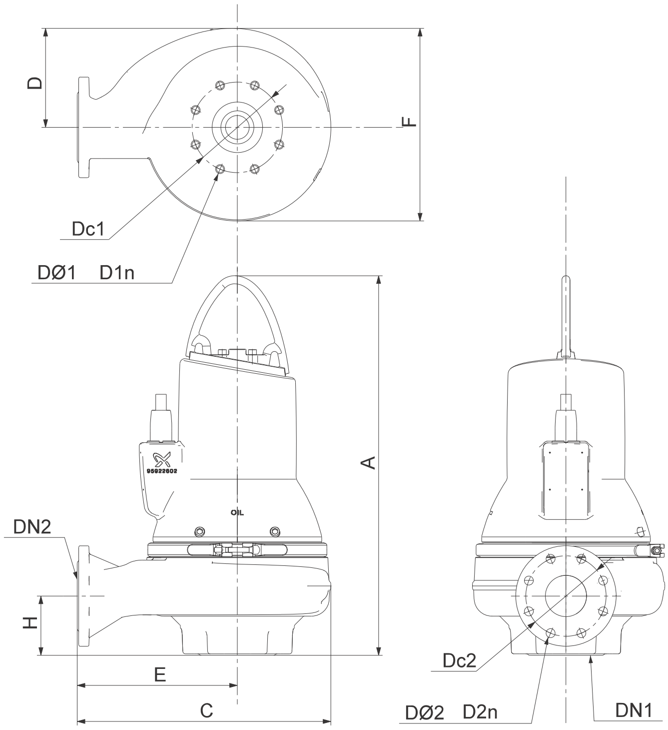
This product or parts of it must be disposed of in an environmentally sound way:

1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Subject to alterations.

1. Dimensions and weights

1.1 Pumps without accessories



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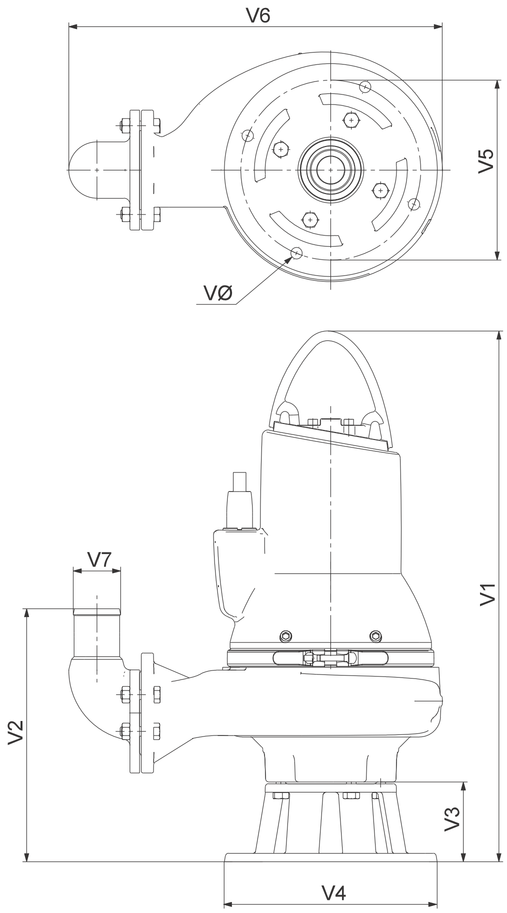
Pump type	A	C	D	E	F	H	DN1	Dc1	D1n-D∅1	DN2	Dc2	D2n-D∅2	Weight [kg]
SL1.50.65.22.2	641	366	171	216	321	93	65	145	4 x M16	65	145	4 x 18	86
SL1.50.65.30.2	641	366	171	216	321	93	65	145	4 x M16	65	145	4 x 18	89
SL1.50.65.40.2	677	407	200	227	379	93	65	145	4 x M16	65	145	4 x 18	115
SL1.50.80.22.2	641	366	171	216	321	100	65	145	4 x M16	80	160	8 x 18	87
SL1.50.80.30.2	641	366	171	216	321	100	65	145	4 x M16	80	160	8 x 18	90
SL1.50.80.40.2	677	407	200	227	379	100	65	145	4 x M16	80	160	8 x 18	116
SL1.80.80.15.4	682	435	171	272	347	100	100	180	8 x M16	80	160	8 x 18	95
SL1.80.80.22.4	682	435	171	272	347	100	100	180	8 x M16	80	160	8 x 18	107
SL1.80.80.30.4	711	505	200	319	397	118	100	180	8 x M16	80	160	8 x 18	137
SL1.80.80.40.4	748	505	200	319	397	118	100	180	8 x M16	80	160	8 x 18	142
SL1.80.80.55.4	755	505	200	319	397	118	100	180	8 x M16	80	160	8 x 18	149
SL1.80.80.75.4	818	530	217	328	423	118	100	180	8 x M16	80	160	8 x 18	193
SL1.80.100.15.4	682	435	171	272	347	112	100	180	8 x M16	100	180	8 x 19	96
SL1.80.100.22.4	682	435	171	272	347	112	100	180	8 x M16	100	180	8 x 19	108
SL1.80.100.30.4	726	505	200	319	397	118	100	180	8 x M16	100	180	8 x 19	139
SL1.80.100.40.4	748	505	200	319	397	118	100	180	8 x M16	100	180	8 x 19	143
SL1.80.100.55.4	755	505	200	319	397	118	100	180	8 x M16	100	180	8 x 19	150
SL1.80.100.75.4	818	530	217	328	423	118	100	180	8 x M16	100	180	8 x 19	194
SL1.100.100.40.4	754	541	200	320	438	115	150	240	8 x M20	100	180	8 x 22	155
SL1.100.100.55.4	762	541	200	320	438	115	150	240	8 x M20	100	180	8 x 22	161
SL1.100.100.75.4	827	541	217	312	462	115	150	240	8 x M20	100	180	8 x 22	202
SL1.100.150.40.4	755	541	200	320	440	143	150	240	8 x M20	150	240	8 x 22	157
SL1.100.150.40.4	755	541	200	320	440	143	150	240	8 x M20	150	240	8 x 22	157
SL1.100.150.55.4	762	541	200	320	440	143	150	240	8 x M20	150	240	8 x 22	163
SL1.100.150.75.4	827	541	217	306	472	143	150	240	8 x M20	150	240	8 x 22	204
SLV.65.65.22.2	684	396	171	246	321	102	80	160	8 x M16	65	145	4 x 18	88
SLV.65.65.30.2	684	396	171	246	321	102	80	160	8 x M16	65	145	4 x 18	91
SLV.65.65.40.2	718	456	200	276	380	106	80	160	8 x M16	65	145	4 x 18	117
SLV.65.80.22.2	685	397	171	247	321	103	80	160	8 x M16	80	160	8 x 18	89
SLV.65.80.30.2	685	397	171	247	321	103	80	160	8 x M16	80	160	8 x 18	92
SLV.65.80.40.2	718	455	200	276	379	106	80	160	8 x M16	80	160	8 x 18	117
SLV.80.80.11.4	711	409	171	241	339	109	80	160	8 x M16	80	160	8 x 18	94
SLV.80.80.13.4	711	409	171	241	339	109	80	160	8 x M16	80	160	8 x 18	94
SLV.80.80.15.4	711	409	171	241	339	109	80	160	8 x M16	80	160	8 x 18	94
SLV.80.80.110.2	782	489	217	293	413	123	80	160	8 x M16	80	160	8 x 18	183
SLV.80.80.22.4	711	409	171	241	339	109	80	160	8 x M16	80	160	8 x 18	106
SLV.80.80.40.4	748	460	200	267	393	109	80	160	8 x M16	80	160	8 x 18	134
SLV.80.80.60.2	751	456	200	276	380	104	80	160	8 x M16	80	160	8 x 18	140
SLV.80.80.75.2	751	456	200	276	380	104	80	160	8 x M16	80	160	8 x 18	140
SLV.80.80.92.2	782	489	217	293	413	123	80	160	8 x M16	80	160	8 x 18	183
SLV.80.100.11.4	711	407	171	241	337	109	80	160	8 x M16	100	180	8 x 18	95
SLV.80.100.13.4	711	407	171	241	337	109	80	160	8 x M16	100	180	8 x 18	95
SLV.80.100.15.4	711	407	171	241	337	109	80	160	8 x M16	100	180	8 x 18	95
SLV.80.100.110.2	782	499	217	303	413	123	80	160	8 x M16	100	180	8 x 18	184
SLV.80.100.22.4	711	407	171	241	337	109	80	160	8 x M16	100	180	8 x 18	107
SLV.80.100.40.4	748	458	200	267	391	109	80	160	8 x M16	100	180	8 x 18	135
SLV.80.100.60.2	751	466	200	286	380	108	80	160	8 x M16	100	180	8 x 18	141
SLV.80.100.75.2	751	466	200	286	380	108	80	160	8 x M16	100	180	8 x 18	141
SLV.80.100.92.2	782	499	217	303	413	123	80	160	8 x M16	100	180	8 x 18	184
SLV.100.100.30.4	737	457	200	277	380	134	100	180	8 x M16	100	160	8 x 18	125
SLV.100.100.40.4	759	457	200	277	380	134	100	180	8 x M16	100	160	8 x 18	130
SLV.100.100.55.4	766	457	200	277	380	134	100	180	8 x M16	100	160	8 x 18	136
SLV.100.100.75.4	842	490	217	294	413	145	100	180	8 x M16	100	180	8 x 22	179

1.2 Pumps with ring stand



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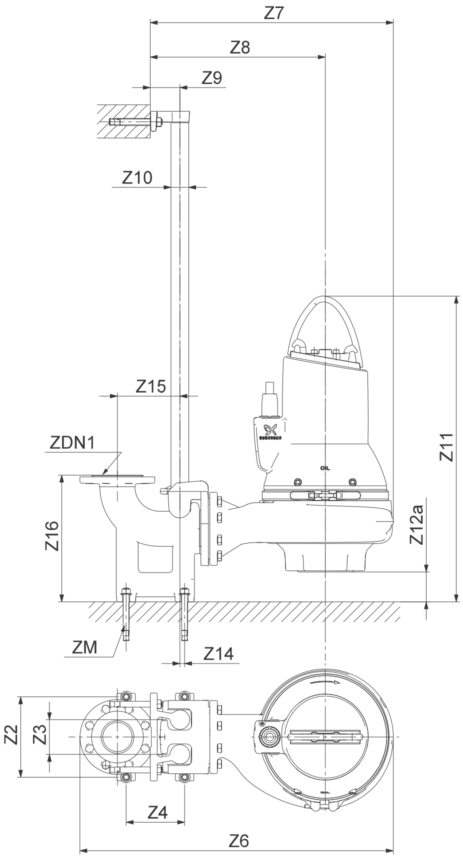
Pump type	V1	V2	V3	V4	V5	V6	V7	VØ
SL1.50.65.22.2	771	339	130	325	270	491	65	18
L1.50.65.30.2	771	339	130	325	270	491	65	18
SL1.50.65.40.2	807	341	130	325	270	519	65	18
SL1.50.80.22.2	771	339	130	325	270	496	80	18
SL1.50.80.30.2	771	339	130	325	270	496	80	18
SL1.50.80.40.2	807	341	130	325	270	525	80	18
SL1.80.80.15.4	812	364	130	355	300	567	80	19
SL1.80.80.22.4	812	364	130	355	300	567	80	19
SL1.80.80.30.4	841	390	130	355	300	623	80	19
SL1.80.80.40.4	878	390	130	355	300	623	80	19
SL1.80.80.55.4	885	390	130	355	300	623	80	19
SL1.80.80.75.4	948	390	130	355	300	648	80	19
SL1.80.100.15.4	812	369	130	355	300	591	100	19
SL1.80.100.22.4	812	369	130	355	300	591	100	19
SL1.80.100.30.4	856	395	130	355	300	647	100	19
SL1.80.100.40.4	878	395	130	355	300	647	100	19
SL1.80.100.55.4	885	395	130	355	300	647	100	19
SL1.80.100.75.4	948	395	130	355	300	672	100	19
SL1.100.100.40.4	941	445	186	450	400	711	100	22
SL1.100.100.55.4	948	445	186	450	400	711	100	22
SL1.100.100.75.4	1.013	445	186	450	400	706	100	22
SL1.100.150.40.4	941	555	186	450	400	807	150	22
SL1.100.150.40.4	941	555	186	450	400	807	150	22
SL1.100.150.55.4	948	555	186	450	400	807	150	22
SL1.100.150.75.4	1.013	555	186	450	400	803	150	22
SLV.65.65.22.2	812	372	128	330	280	524	65	18
SLV.65.65.30.2	812	372	128	330	280	524	65	18
SLV.65.65.40.2	846	376	128	330	280	568	65	18
SLV.65.80.22.2	813	373	128	330	280	530	80	18
SLV.65.80.30.2	813	373	128	330	280	530	80	18
SLV.65.80.40.2	846	376	128	330	280	573	80	18
SLV.80.80.11.4	839	379	128	330	280	527	80	18
SLV.80.80.13.4	839	379	128	330	280	527	80	18
SLV.80.80.15.4	839	379	128	330	280	527	80	18
SLV.80.80.110.2	910	393	128	330	280	607	80	18
SLV.80.80.22.4	839	379	128	330	280	527	80	18
SLV.80.80.40.4	876	379	128	330	280	578	80	18
SLV.80.80.60.2	879	374	128	330	280	574	80	18
SLV.80.80.75.2	879	374	128	330	280	574	80	18
SLV.80.80.92.2	910	393	128	330	280	607	80	18
SLV.80.100.11.4	840	354	128	330	280	549	100	18
SLV.80.100.13.4	840	354	128	330	280	549	100	18
SLV.80.100.15.4	840	354	128	330	280	549	100	18
SLV.80.100.110.2	910	368	128	330	280	641	100	18
SLV.80.100.22.4	840	354	128	330	280	549	100	18
SLV.80.100.40.4	876	354	128	330	280	600	100	18
SLV.80.100.60.2	879	353	128	330	280	598	100	18
SLV.80.100.75.2	879	353	128	330	280	598	100	18
SLV.80.100.92.2	910	368	128	330	280	641	100	18
SLV.100.100.30.4	867	411	130	355	300	599	100	19
SLV.100.100.40.4	889	411	130	355	300	599	100	19
SLV.100.100.55.4	896	411	130	355	300	599	100	19
SLV.100.100.75.4	972	422	130	355	300	632	100	19

1.3 Pumps on auto coupling



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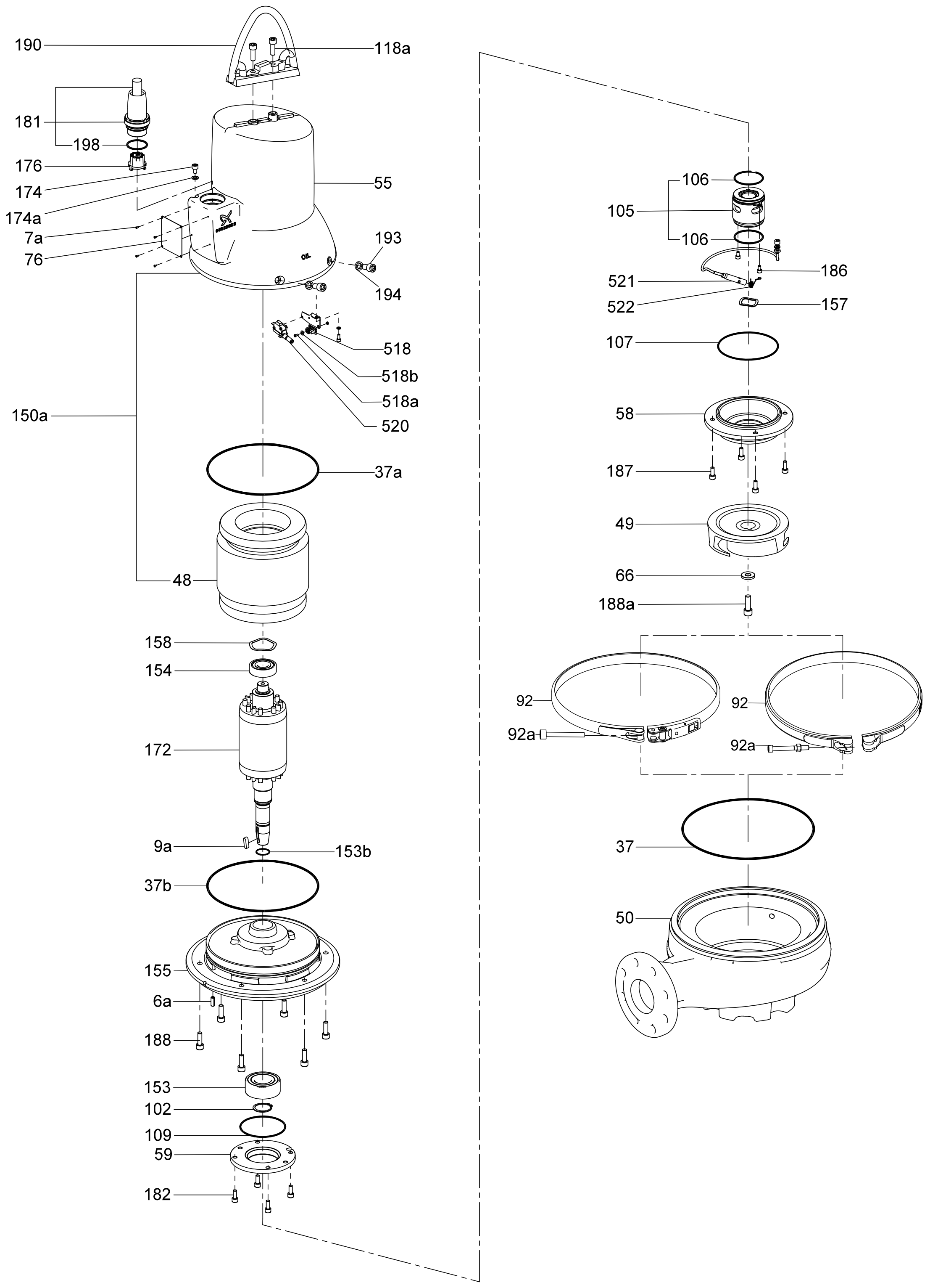
Pump type	Z2	Z3	Z4	Z6	Z7	Z8	Z9	Z10 ["]	Z11	Z12a	Z14	Z15	Z16	Dc1	DN1	ZM
SL1.50.65.22.2	210	95	140	700	513	363	81	1.5	740	99	1	175	266	145	65	4 x M16
L1.50.65.30.2	210	95	140	700	513	363	81	1.5	740	99	1	175	266	145	65	4 x M16
SL1.50.65.40.2	210	95	140	741	554	375	81	1.5	775	97	1	175	266	145	65	4 x M16
SL1.50.80.22.2	220	95	160	719	526	376	81	1.5	774	133	13	171	345	145	65	4 x M16
SL1.50.80.30.2	220	95	160	719	526	376	81	1.5	774	133	13	171	345	145	65	4 x M16
SL1.50.80.40.2	220	95	160	760	567	387	81	1.5	808	132	13	171	345	145	65	4 x M16
SL1.80.80.15.4	220	95	160	788	595	432	81	1.5	790	108	13	171	345	180	100	4 x M16
SL1.80.80.22.4	220	95	160	788	595	432	81	1.5	790	108	13	171	345	180	100	4 x M16
SL1.80.80.30.4	220	95	160	858	666	480	81	1.5	793	82	13	171	345	180	100	4 x M16
SL1.80.80.40.4	220	95	160	858	666	480	81	1.5	830	82	13	171	345	180	100	4 x M16
SL1.80.80.55.4	220	95	160	858	666	480	81	1.5	837	82	13	171	345	180	100	4 x M16
SL1.80.80.75.4	220	95	160	883	690	489	81	1.5	900	82	13	171	345	180	100	4 x M16
SL1.80.100.15.4	260	110	270	878	652	489	110	2.0	830	148	0	220	413	180	100	4 x M16
SL1.80.100.22.4	260	110	270	878	652	489	110	2.0	830	148	0	220	413	180	100	4 x M16
SL1.80.100.30.4	260	110	270	948	722	536	110	2.0	848	122	0	220	413	180	100	4 x M16
SL1.80.100.40.4	260	110	270	948	722	536	110	2.0	870	122	0	220	413	180	100	4 x M16
SL1.80.100.55.4	260	110	270	948	722	536	110	2.0	877	122	0	220	413	180	100	4 x M16
SL1.80.100.75.4	260	110	270	972	747	545	110	2.0	940	122	0	220	413	180	100	4 x M16
SL1.100.100.40.4	260	110	270	983	758	537	110	2.0	880	125	0	220	413	240	150	4 x M16
SL1.100.100.55.4	260	110	270	983	758	537	110	2.0	886	125	0	220	413	240	150	4 x M16
SL1.100.100.75.4	260	110	270	983	758	529	110	2.0	951	125	0	220	413	240	150	4 x M16
SL1.100.150.40.4	300	110	280	1,093	780	559	110	2.0	919	164	0	280	450	240	150	4 x M16
SL1.100.150.40.4	300	110	280	1,093	780	559	110	2.0	919	164	0	280	450	240	150	4 x M16
SL1.100.150.55.4	300	110	280	1,093	780	559	110	2.0	926	164	0	280	450	240	150	4 x M16
SL1.100.150.75.4	300	110	280	1,093	780	545	110	2.0	990	164	0	280	450	240	150	4 x M16
SLV.65.65.22.2	210	95	140	730	543	394	81	1.5	747	63	1	175	266	160	80	4 x M16
SLV.65.65.30.2	210	95	140	730	543	394	81	1.5	747	63	1	175	266	160	80	4 x M16
SLV.65.65.40.2	210	95	140	790	604	424	81	1.5	778	60	1	175	266	160	80	4 x M16
SLV.65.80.22.2	220	95	160	750	557	408	81	1.5	782	97	13	171	345	160	80	4 x M16
SLV.65.80.30.2	220	95	160	750	557	408	81	1.5	782	97	13	171	345	160	80	4 x M16
SLV.65.80.40.2	220	95	160	808	616	437	81	1.5	812	94	13	171	345	160	80	4 x M16
SLV.80.80.11.4	220	95	160	762	569	402	81	1.5	802	91	13	171	345	160	80	4 x M16
SLV.80.80.13.4	220	95	160	762	569	402	81	1.5	802	91	13	171	345	160	80	4 x M16
SLV.80.80.15.4	220	95	160	762	569	402	81	1.5	802	91	13	171	345	160	80	4 x M16
SLV.80.80.110.2	220	95	160	842	650	454	81	1.5	859	77	13	171	345	160	80	4 x M16
SLV.80.80.22.4	220	95	160	762	569	402	81	1.5	802	91	13	171	345	160	80	4 x M16
SLV.80.80.40.4	220	95	160	813	620	428	81	1.5	840	91	13	171	345	160	80	4 x M16
SLV.80.80.60.2	220	95	160	809	617	437	81	1.5	847	96	13	171	345	160	80	4 x M16
SLV.80.80.75.2	220	95	160	809	617	437	81	1.5	847	96	13	171	345	160	80	4 x M16
SLV.80.80.92.2	220	95	160	842	650	454	81	1.5	859	77	13	171	345	160	80	4 x M16
SLV.80.100.11.4	260	110	270	850	624	458	110	2.0	842	131	0	220	413	160	80	4 x M16
SLV.80.100.13.4	260	110	270	850	624	458	110	2.0	842	131	0	220	413	160	80	4 x M16
SLV.80.100.15.4	260	110	270	850	624	458	110	2.0	842	131	0	220	413	160	80	4 x M16
SLV.80.100.110.2	260	110	270	942	716	520	110	2.0	899	117	0	220	413	160	80	4 x M16
SLV.80.100.22.4	260	110	270	850	624	458	110	2.0	842	131	0	220	413	160	80	4 x M16
SLV.80.100.40.4	260	110	270	901	675	484	110	2.0	857	109	0	220	413	160	80	4 x M16
SLV.80.100.60.2	260	110	270	909	683	503	110	2.0	883	132	0	220	413	160	80	4 x M16
SLV.80.100.75.2	260	110	270	909	683	503	110	2.0	883	132	0	220	413	160	80	4 x M16
SLV.80.100.92.2	260	110	270	942	716	520	110	2.0	899	117	0	220	413	160	80	4 x M16
SLV.100.100.30.4	260	110	270	900	674	494	110	2.0	844	106	0	220	413	180	100	4 x M16
SLV.100.100.40.4	260	110	270	900	674	494	110	2.0	865	106	0	220	413	180	100	4 x M16
SLV.100.100.55.4	260	110	270	900	674	494	110	2.0	873	106	0	220	413	180	100	4 x M16
SLV.100.100.75.4	260	110	270	933	707	511	110	2.0	938	95	0	220	413	180	100	4 x M16

2. Exploded drawings

SLV



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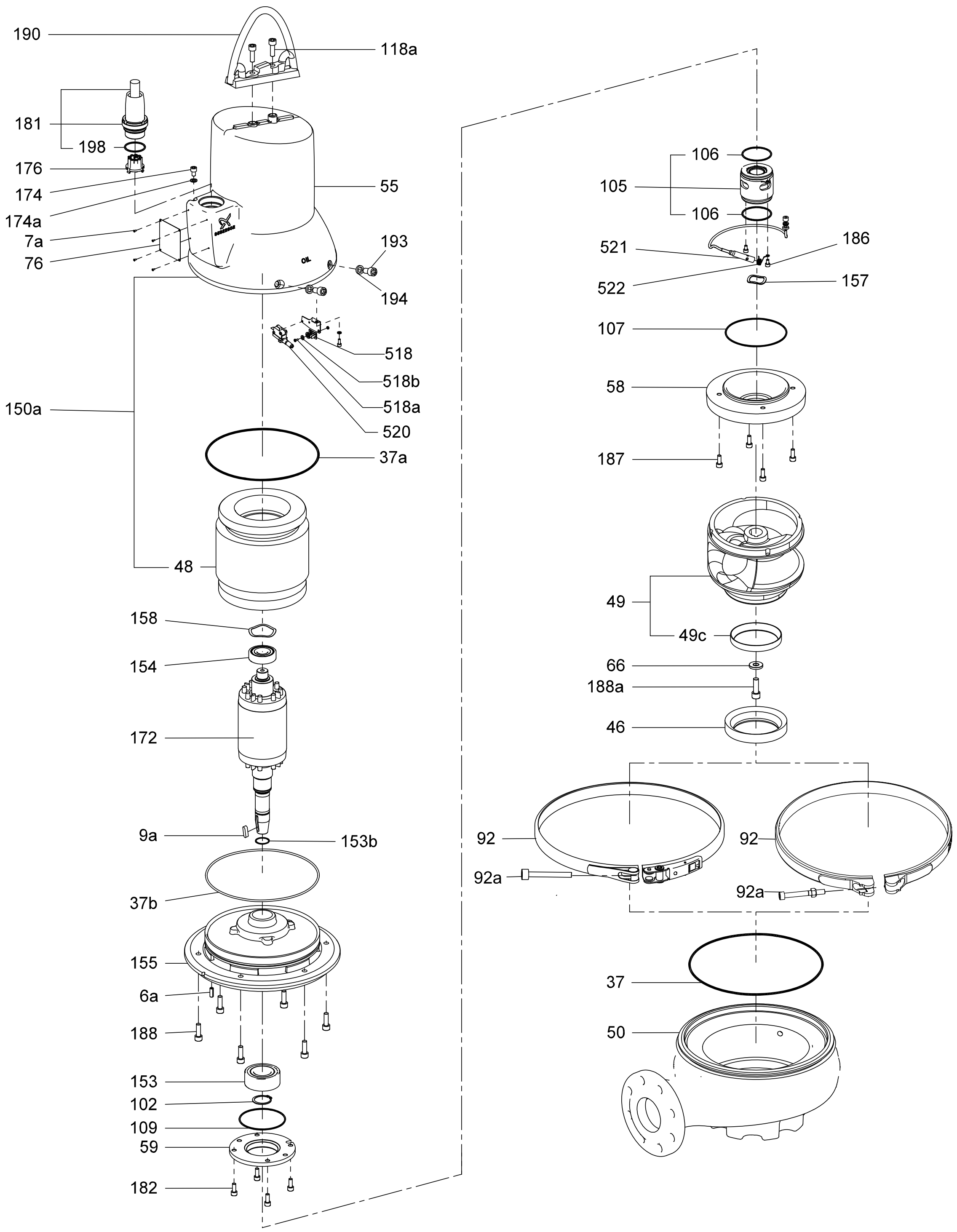
SL1



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GB: EC/EU declaration of conformity

We, Grundfos, declare under our sole responsibility that the product SL1, SLV, to which the declaration below relates, is in conformity with the Council Directives listed below on the approximation of the laws of the EC/EU member states.
Note: There are two sets of Council Directives and standards listed below. One set applies until and including 19th April 2016. The other set applies from 20th April 2016 and onwards.

BG: Декларация за съответствие на EC/EO

Ние, фирма Grundfos, заявяваме с пълна отговорност, че продуктът SL1, SLV, за който се отнася настоящата декларация, отговаря на следните директиви на Съвета за уеднаквяване на правните разпоредби на държавите-членки на ЕС/ЕО.
Забележка: По-долу има изброени две групи директиви и стандарти на Съвета. Едната група е в сила до 19 април 2016 г. включително. Другата група е в сила от 20 април 2016 г.

CZ: Prohlášení o shodě EU

My firma Grundfos prohlašujeme na svou plnou odpovědnost, že výrobek SL1, SLV, na který se toto prohlášení vztahuje, je v souladu s níže uvedenými ustanoveními směrnice Rady pro sblížení právních předpisů členských států Evropského společenství.
Poznámka: Níže jsou uvedeny dvě sady směrnic Rady a standardů. První sada je platná do 19. dubna 2016 (včetně). Druhá sada platí od 20. dubna 2016.

DE: EG-/EU-Konformitätserklärung

Wir, Grundfos, erklären in alleiniger Verantwortung, dass das Produkt SL1, SLV, auf das sich diese Erklärung bezieht, mit den folgenden Richtlinien des Rates zur Angleichung der Rechtsvorschriften der EG-/EU-Mitgliedsstaaten übereinstimmt.
Hinweis: Nachfolgend sind zwei Gruppen aus Richtlinien des Rates und Standards aufgeführt. Eine Gruppe gilt bis einschließlich 19. April 2016. Die andere Gruppe gilt ab dem 20. April 2016.

DK: EF/EU-overensstemmelseserklæring

Vi, Grundfos, erklærer under ansvar at produktet SL1, SLV som erklæringen nedenfor omhandler, er i overensstemmelse med Rådets direktiver der er nævnt nedenfor, om indbyrdes tilnærmelse til EF/EU-medlemsstaternes lovgivning.
Bemærk: Der er angivet to sæt af Rådets direktiver og standarder nedenfor. Det ene sæt gælder til og med 19. april 2016. Det andet sæt gælder fra og med 20. april 2016.

EE: EÜ/ELi vastavusdeklaratsioon

Meie, Grundfos, kinnitame ja kanname ainuisikulist vastutust selle eest, et toode SL1, SLV, mille kohta all olev deklaratsioon käib, on kooskõlas Nõukogu Direktiividega, mis on nimetatud all pool vastavalt vastuvõetud õigusaktidele ühtlustamise kohta EÜ / EL liikmesriikides.
Märkus: Allpool onloetletud kaks nõukogu direktiive ja standardeid. Ühed kehtivad kuni 19. aprill 2016 (kaasa arvatud). Teised kehtivad alates 20.04.2016 ja edasi.

ES: Declaración de conformidad de la CE/UE

Grundfos declara, bajo su exclusiva responsabilidad, que el producto SL1, SLV al que hace referencia la siguiente declaración cumple lo establecido por las siguientes Directivas del Consejo sobre la aproximación de las legislaciones de los Estados miembros de la CE/UE.
Nota: A continuación se recogen dos conjuntos de normas y Directivas del Consejo. Uno de ellos es válido hasta el 19 de abril de 2016. El otro es válido a partir del 20 de abril de 2016.

FI: EY/EU-vaatimustenmukaisuusvakuutus

Grundfos vakuuttaa omalla vastuullaan, että tuote SL1, SLV, jota tämä vakuutus koskee, on EY/EU:n jäsenvaltioiden lainsäädännön lähentämiseen tähtäävien Euroopan neuvoston direktiivien vaatimusten mukainen seuraavasti.
Huomautus: Seuraavassa on lueteltu kaksi erilaista neuvoston direktiivien ja standardien sarjaa. Yhden sarjan viimeinen voimassaolopäivä on 19. huhtikuuta 2016. Toinen sarja on voimassa 20. huhtikuuta 2016 alkaen.

FR: Déclaration de conformité CE/UE

Nous, Grundfos, déclarons sous notre seule responsabilité, que le produit SL1, SLV, auquel se réfère cette déclaration, est conforme aux Directives du Conseil concernant le rapprochement des législations des États membres CE/UE relatives aux normes énoncées ci-dessous.
Remarque : Deux groupes de Directives du Conseil et normes sont énoncés ci-dessous. Un groupe s'applique jusqu'au 19 avril 2016 inclus. L'autre groupe entrera en vigueur le 20 avril 2016.

GR: Δήλωση συμμόρφωσης ΕΚ/ΕΕ

Εμείς, η Grundfos, δηλώνουμε με αποκλειστικά δική μας ευθύνη ότι το προϊόν SL1, SLV, στο οποίο αναφέρεται η παρακάτω δήλωση, συμμορφώνεται με τις παρακάτω Οδηγίες του Συμβουλίου περί προσέγγισης των νομοθεσιών των κρατών μελών της ΕΚ/ΕΕ.
Σημείωση: Υπάρχουν δύο σετ Οδηγιών Συμβουλίου και προτύπων που παρατίθενται παρακάτω. Το ένα σετ ισχύει μέχρι και την 19η Απριλίου 2016. Το άλλο σετ ισχύει από την 20η Απριλίου 2016 και μετέπειτα.

HR: EC/EU deklaracija sukladnosti

Mi, Grundfos, izjavljujemo s punom odgovornošću da je proizvod SL1, SLV, na koja se izjava odnosi u nastavku, u skladu s direktivama Vijeća dolje navedenih o usklađivanju zakona država članica EZ-a / EU-a.
Napomena: Postoje dva seta direktiva vijeća i standarda navedenih dolje. Jedan set se odnosi do, i uključujući 19 Travanja 2016. Drugi set se odnosi na datume od 20 travnja 2016 i naprijed.

HU: EC/EU megfelelőségi nyilatkozat

Mi, a Grundfos vállalat, teljes felelősséggel kijelentjük, hogy a(z) SL1, SLV termék, amelyre az alábbi nyilatkozat vonatkozik, megfelel az Európai Közösség/Európai Unió tagállamainak jogi irányelveit összehangoló tanács alábbi előírásainak.
Megjegyzés: Az alábbiakban a Tanács irányelvei és szabványai közül két csomagot ismertetünk. Az egyik csomag 2016. április 19-ével bezárólag érvényes. A másik csomag 2016. április 20-tól érvényes.

IT: Dichiarazione di conformità CE/UE

Grundfos dichiara sotto la sua esclusiva responsabilità che il prodotto SL1, SLV, al quale si riferisce questa dichiarazione, è conforme alle seguenti direttive del Consiglio riguardanti il riavvicinamento delle legislazioni degli Stati membri CE/UE.
Nota: Di seguito sono elencate due serie di direttive del Consiglio e norme. Una serie si applca fino al19 aprile 2016 (incluso). La seconda serie si applica a partire dal 20 aprile 2016.

LT: EB/ES atitikties deklaracija

Mes, Grundfos, su visa atsakomybe pareiškiame, kad produktas SL1, SLV, kuriam skirta ši deklaracija, atitinka žemiau nurodytas Tarybos Direktyvas dėl EB/ES šalių narių įstatymų suderinimo.
Pastaba. Žemiau nurodytos dvi Tarybos Direktyvų ir standartų grupės. Viena grupė galioja iki 2016 m. balandžio 19 d. imtinai. Kita grupė galioja nuo 2016 m. balandžio 20 d.

LV: EK/ES atbilstības deklarācija

Sabiedrība Grundfos ar pilnu atbildību paziņo, ka produkts SL1, SLV, uz kuru attiecas tālāk redzamā deklarācija, atbilst tālāk norādītajām Padomes direktīvām par EK/ES dalībvalstu normatīvo aktu tuvināšanu.
Piezīme: Tālāk norādīti divi Padomes direktīvu un standartu krājumi. Viens krājums ir piemērojams līdz 2016. gada 19. aprīlim (ieskaitot). Otrs krājums ir piemērojams no 2016. gada 20. aprīļa.

NL: EG/EU-conformiteitsverklaring

Wij, Grundfos, verklaren geheel onder eigen verantwoordelijkheid dat product SL1, SLV, waarop de onderstaande verklaring betrekking heeft, in overeenstemming is met de onderstaande Richtlijnen van de Raad inzake de onderlinge aanpassing van de wetgeving van de EG-/EU-lidstaten.
Opmerking: Hieronder worden twee reeksen Richtlijnen van de Raad en normen weergegeven. De ene set geldt tot en met 19 april 2016. De andere set is vanaf 20 april 2016 van kracht.

PL: Deklaracja zgodności WE/UE

My, Grundfos, oświadczamy z pełną odpowiedzialnością, że nasz produkt SL1, SLV, którego deklaracja niniejsza dotyczy, jest zgodny z następującymi dyrektywami Rady w sprawie zbliżenia przepisów prawnych państw członkowskich.
Uwaga: Poniżej podano dwa zestawy dyrektyw i norm. Pierwszy zestaw obowiązuje do 19 kwietna 2016 r. włącznie. Drugi zacznie obowiązywać 20 kwietnia 2016 r.

PT: Declaração de conformidade CE/UE

A Grundfos declara sob sua única responsabilidade que o produto SL1, SLV, ao qual diz respeito a declaração abaixo, está em conformidade com as Directivas do Conselho sobre a aproximação das legislações dos Estados Membros da CE/UE.
Nota: Abaixo estão listados dois grupos de Directivas do Conselho e normas. Um dos grupos é aplicável até 19 de Abril de 2016, inclusive. O outro grupo é aplicável a partir de 20 de Abril de 2016, inclusive.

RO: Declaraţia de conformitate CE/UE

Noi Grundfos declarăm pe propria răspundere că produsul SL1, SLV, la care se referă această declaraţie, este în conformitate cu Directivele de Consiliu specificate mai jos privind armonizarea legilor statelor membre CE/UE.
Notă: Există două seturi de directive și standarde ale Consiliului specificate mai jos. Un set se aplică până la, și inclusiv în 19 aprilie 2016. Celălalt set se aplică de la 20 aprilie 2016 și în continuare.

RS: Deklaracija o usklađenosti EC/EU

Mi, kompanija Grundfos, izjavljujemo pod punom vlastitom odgovornošću da je proizvod SL1, SLV, na koji se odnosi deklaracija ispod, u skladu sa dole prikazanim direktivama Saveta za usklađivanje zakona država članica EC/EU.
Napomena: Ispod su navedena dva seta direktiva Saveta. Jedan set se odnosi na vreme do i uključuje 19. april 2016. Drugi set se odnosi na vreme od 20. aprila 2016. pa nadalje.

RU: Декларация о соответствии нормам ЕЭС/ЕС

Мы, компания Grundfos, со всей ответственностью заявляем, что изделие SL1, SLV, к которому относится нижеприведённая декларация, соответствует нижеприведённым Директивам Совета Евросоюза о тождественности законов стран-членов ЕЭС/ЕС.
Примечание: Существует два комплекта Директив Совета Евросоюза и стандартов, перечисленных ниже. Один комплект применяется до 19 апреля 2016 г. включительно. Второй комплект применяется начиная с 20 апреля 2016 г.

SE: EG/EU-försäkran om överensstämmelse

Vi, Grundfos, försäkrar under ansvar att produkten SL1, SLV, som omfattas av nedanstående försäkran, är i överensstämmelse med de rådsdirektiv om inbördes närmande till EG/EU-medlemsstaternas lagstiftning som listas nedan.
Obs! Det finns två uppsättningar rådsdirektiv och standarder listade nedan. En uppsättning gäller till och med den 19 april 2016. Den andra uppsättningen gäller från den 20 april 2016 och tills vidare.

SI: Izjava o skladnosti ES/EU

V Grundfosu s polno odgovornostjo izjavljamo, da je izdelek SL1, SLV,na katerega se spodnja izjava nanaša, v skladu s spodnjimi direktivami Sveta o približevanju zakonodaje za izenačevanje pravnih predpisov držav članic ES/EU.
Opomba: Spodaj sta navedeni dve skupini direktiv Sveta o približevanju zakonodaje. Ena skupina se nanaša na obdobje do in vključno z 19. aprilom 2016. Druga skupina se nanaša na obdobje od 20. aprila 2016 naprej.

SK: ES vyhlásenie o zhode

My, spoločnosť Grundfos, vyhlasujeme na svoju plnú zodpovednosť, že produkt SL1, SLV, na ktorý sa vyhlásenie uvedené nižšie vzťahuje, je v súlade s ustanoveniami nižšie uvedených smerníc Rady pre zblíženie právnych predpisov členských štátov Európskeho spoločenstva/EÚ.
Poznámka: Existujú dva súbory smerníc a noriem Rady uvedené nižšie. Jeden súbor platí do a vrátane 19.4.2016. Druhý súbor platí od 20.4.2016 ďalej.

TR: EC/AB uygunluk bildirgesi

Grundfos olarak, aşağıdaki bildirim konusu olan SL1, SLV ürünlerinin, EC/AB üye ülkelerinin direktiflerinin yakınlaştırılmasıyla ilgili durumun aşağıdaki Konsey Direktifleriyle uyumlu olduğunu ve bununla ilgili olarak tüm sorumluluğun bize ait olduğunu beyan ederiz.
Not: Aşağıda belirtilen iki küme Konsey Direktifleri ve Standartları bulunmaktadır. Bir küme 19 Nisan 2016 dahil bu tarihe kadar geçerlidir. Diğer küme 20 Nisan 2016 sonrası için geçerlidir.

UA: Декларація відповідності директивам ЕС/EU

Ми, компанія Grundfos, під нашу одноосібну відповідальність заявляємо, що виріб SL1, SLV, до якого відноситься нижченаведена декларація, відповідає директивам ЕС/EU, переліченим нижче, щодо тотожності законів країн-членів ЄС.
Примітка: Існує два комплекти директив та стандартів ЕС/EU, перелічених нижче. Один комплект застосовується до 19 квітня 2016 р. Другий комплект застосовується з 20 квітня 2016 р.

CN: 欧共体 / 欧盟符合性声明

我们，格兰富，在我们的全权责任下声明，产品 SL1, SLV，即该合格证所指之产品，符合欧共体 / 欧盟使其成员国法律趋于一致的以下理事会指令。
注意：有两套理事会指令和标准，如下所示。一套将于 2016 年 4 月 19 日失效。另一套将自 2016 年 4 月 20 日起生效。

KZ: Сәйкестік жөніндегі ЕҚ/ЕО декларациясы

Біз, Grundfos, ЕҚ/ЕО мүше елдерінің заңдарына жақын төменде көрсетілген Кеңес директиваларына сәйкес төмендегі декларацияға қатысты SL1, SLV өнімі біздің жеке жауапкершілігімізде екенін мәлімдейміз.
Ескертпе: Кеңес директивалары мен стандарттарының төменде көрсетілгендей екі жиынтығы бар. Бірінші жиынтық 2016 жылдың 19-шы сәуіріне дейін қолданылады. Ал басқа жиынтық 2016 жылдың 20-шы сәуірінен бастап қолданылады.

VI: Tuyên bố tuân thủ EC/EU

Chúng tôi, Grundfos, tuyên bố trong phạm vi trách nhiệm duy nhất của mình rằng sản phẩm SL1, SLV mà tuyên bố dưới đây có liên quan tuân thủ các Chỉ thị Hội đồng sau về việc áp dụng luật pháp của các nước thành viên EC/EU.
Lưu ý: Có hai bộ Chỉ thị Hội đồng và tiêu chuẩn được nêu dưới đây. Một bộ áp dụng cho đến khi và bao gồm ngày 19 tháng 4 năm 2016. Bộ còn lại áp dụng từ này 20 tháng 4 năm 2016 trở đi.

AL: Deklara e konformitetit të BE

Ne, Grundfos, deklarojmë vetëm nën përgjegjësinë tonë se produktet SL1, SLV, me të cilat lidhet kjo deklaratë, janë në pajtueshmëri me direktivat e Këshillit të renditura më poshtë për përafrimin e ligjeve të shteteve anëtare të BE-së.

These Directives and standards apply until and including 19th April 2016:

- Machinery Directive (2006/42/EC)
  Standards used: EN 809: 1998 + A1: 2009, EN 60204-1: 2006 + A1:2009
- Low Voltage Directive (2006/95/EC)
  Applicable when the rated power is lower than 2.2 kW.
  Standards used: EN 60335-1:2002 + A1:2004, A2:2006, A11:2004, A12:2006, A13:2008, A14:2010, A15:2011 and EN 60335-2-41:2003 except clause 25.8. + A1:2004, A2:2010
- EMC Directive (2004/108/EC)
  For sensor versions the following standards are used:
  EN 61326-1:2013
- ATEX Directive (94/9/EC)
  Applies only to products intended for use in potentially explosive environments, Ex II 2G, equipped with the separate ATEX approval plate and EC-type examination certificate.
  Further information, see below.

These Directives and standards apply from 20th April 2016 and onwards:

- Machinery Directive (2006/42/EC)
  Standards used: EN 809: 1998 + A1: 2009, EN 60204-1: 2006 + A1:2009
- Low Voltage Directive (2014/35/EU)
  Applicable when the rated power is lower than 2.2 kW.
  Standards used: EN 60335-1:2002 + A1:2004, A2:2006, A11:2004, A12:2006, A13:2008, A14:2010, A15:2011 and EN 60335-2-41:2003 except clause 25.8. + A1:2004, A2:2010
- EMC Directive (2014/30/EU)
  For sensor versions the following standards are used:
  EN 61326-1:2013
- ATEX Directive (2014/34/EU)
  Applies only to products intended for use in potentially explosive environments, Ex II 2G, equipped with the separate ATEX approval plate and EC-type examination certificate.
  Further information, see below.

This EC/EU declaration of conformity is only valid when published as part of the Grundfos installation and operating instructions (publication number 96771279 0316).

Székesfehérvár, 15 February 2016

Kis Róbert

Róbert Kis
Engineering Manager
GRUNDFOS Holding A/S
Poul Due Jensens Vej 7
8850 Bjerringbro, Denmark

Person authorised to compile the technical file and empowered to sign the EC/EU declaration of conformity.

Certificate No: KEMA 08ATEX0125X
Standards used: EN 60079-0:2012, EN 60079-1:2007, EN 13463-1:2009, EN 13463-5:2011.
For sensor versions the following standards is also used: EN 60079-18:2009.
Notified body: DEKRA Certification B.V. Meander 1051, 6825 MJ Arnhem, The Netherlands

RU

SL1, SLV 1.1-11 кВт
Руководство по эксплуатации

Руководство по эксплуатации на данное изделие является составным и включает в себя несколько частей:

Часть 1: настоящее «Руководство по эксплуатации».

Часть 2: электронная часть «Паспорт. Руководство по монтажу и эксплуатации» размещенная на сайте компании Грундфос:

http://net.grundfos.com/qr/i/98947334

Часть 3: информация о сроке изготовления, размещенная на фирменной табличке изделия.

Сведения о сертификации:
Насосы типа SL1, SLV сертифицированы на соответствие требованиям Технических регламентов Таможенного союза: ТР ТС 004/2011 «О безопасности низковольтного оборудования»; ТР ТС 010/2011 «О безопасности машин и оборудования»; ТР ТС 020/2011 «Электромагнитная совместимость технических средств».

Сертификат соответствия:
№ ТС RU C-DK.АИ30.В.01357, срок действия до 18.02.2020 г.

Выдан:
Органом по сертификации продукции «ИВАНОВО-СЕРТИФИКАТ» ООО «Ивановский Фонд Сертификации». Адрес: 153032, Российская Федерация, г. Иваново, ул. Станкостроителей, д.1.

KZ

SL1, SLV 1.1-11 кВт
Пайдалану бойынша нұсқаулық

Атаулы өнімге арналған пайдалану бойынша нұсқаулық құрамалы болып келеді және келесі бөлімдерден тұрады:

1 бөлім: атаулы «Пайдалану бойынша нұсқаулық»

2 бөлім: Грундфос компаниясының сайтында орналасқан электронды бөлім «Төлқұжат, Құрастыру және пайдалану бойынша нұсқаулық»:

http://net.grundfos.com/qr/i/98947334

3 бөлім: өнімнің фирмалық тақташасында орналасқан шығарылған уақыты жөніндегі мәлімет.

Сертификаттау туралы ақпарат:
SL1, SlV типті сорғылары «Төмен вольтты жабдықтардың қауіпсіздігі туралы» (ТР ТС 004/2011), «Машиналар және жабдықтар қауіпсіздігі туралы» (ТР ТС 010/2011) «Техникалық заттардың электрлі магниттік сәйкестілігі» (ТР ТС 020/2011) Кеден Одағының техникалық регламенттерінің талаптарына сәйкес сертификатталды.

Сәйкестік сертификат:
№ ТС RU C-DK.АИ30.В.01357, жарамдылық мерзімі 18.02.2020 жылға дейін.

«Иваново Сертификаттау Қоры» ЖШҚ «ИВАНОВО-СЕРТИФИКАТ» өнімді сертификациялау бойынша органымен берілген.
Мекен-жайы: 153032, Ресей Федерациясы, Иванов облысы, Иваново қ., Станкостроителей көш., 1 үй.

GB:

EU declaration of performance in accordance with Annex III of Regulation (EU) No 305/2011 (Construction Product Regulation)

1. Unique identification code of the product type:
   – EN 12050-1 or EN 12050-2 (SL1.50).
2. Type, batch or serial number or any other element allowing identification of the construction product as required pursuant to Article 11(4):
   – SL1, SLV pumps marked with EN 12050-1 or EN 12050-2 (SL1.50) on the nameplate.
3. Intended use or uses of the construction product, in accordance with the applicable harmonised technical specification, as foreseen by the manufacturer:
   – Pumps for pumping of wastewater containing faecal matter marked with EN 12050-1 on the nameplate.
   – SL1.50 pumps for pumping of faecal-free wastewater marked with EN 12050-2 on the nameplate.
4. Name, registered trade name or registered trade mark and contact address of the manufacturer as required pursuant to Article 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Denmark.
5. NOT RELEVANT.
6. System or systems of assessment and verification of constancy of performance of the construction product as set out in Annex V:
   – System 3.
7. In case of the declaration of performance concerning a construction product covered by a harmonised standard:
   – TÜV Rheinland LGA Products GmbH, identification number: 0197. Performed test according to EN 12050-1 or EN 12050-2 (SL1.50) under system 3.
   (description of the third party tasks as set out in Annex V)
   – Certificate number: LGA-Certificate No 7381115. Type-tested and monitored.
8. NOT RELEVANT.
9. Declared performance:
   The products covered by this declaration of performance are in compliance with the essential characteristics and the performance requirements as described in the following:
   – Standards used: EN 12050-1:2001 or EN 12050-2:2000 (SL1.50).
10. The performance of the product identified in points 1 and 2 is in conformity with the declared performance in point 9.

BG:

Декларация на ЕС за изпълнение съгласно Анекс III на регламент (ЕС) № 305/2011 (Регламент за строителните продукти)

1. Уникален идентификационен код на типа продукт:
   – EN 12050-1 или EN 12050-2 (SL1.50).
2. Типов, партиден или сериен номер на всеки друг елемент, позволяващ идентификация на строителния продукт, изисквана съгласно Член 11(4):
   – Помпи SL1, SLV, означени с EN 12050-1 или EN 12050-2 (SL1.50) на табелата с данни.
3. Употреба или употреби по предназначение на строителния продукт, в съответствие с приложимата хармонизирана техническа спецификация, както е предвидено от производителя:
   – Помпи за изпомпване на отпадни води, съдържащи фекални вещества, означени с EN 12050-1 на табелата с данни.
   – Помпи SL1.50 за изпомпване на отпадни води без фекални вещества, означени с EN 12050-2 на табелата с данни.
4. Име, запазено търговско име или запазена търговска марка и адрес за контакт на производителя, както се изисква съгласно Член 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Дания.
5. НЕ СЕ ОТНАСЯ ЗА СЛУЧАЯ.
6. Система или системи за оценка и проверка на устойчивостта на изпълнението на строителния продукт, както е изложено в Анекс V:
   – Система 3.
7. В случай на декларация за изпълнение, отнасяща се за строителен продукт, който попада в обсега на хармонизиран стандарт:
   – TÜV Rheinland LGA Products GmbH, идентификационен номер: 0197.
   Изпълнен тест в съответствие с EN 12050-1 или EN 12050-2 (SL1.50) съгласно система 3.
   (описание на задачи на трети лица, както е изложено в Анекс V)
   – Номер на сертификат: LGA сертификат № 7381115. Тестван за тип и наблюдаван.
8. НЕ СЕ ОТНАСЯ ЗА СЛУЧАЯ.
9. Декларирано изпълнение:
   Продуктите, предмет на тази декларация за изпълнение, са в съответствие с основните характеристики и изисквания за изпълнение, описани по-долу:
   – Приложени стандарти: EN 12050-1:2001 или EN 12050-2:2000.
10. Изпълнението на продукта, посочен в точки 1 и 2, е в съответствие с декларираното изпълнение в точка 9.

CZ:

Prohlášení o vlastnostech EU v souladu s Dodatkem III předpisu (EU) č. 305/2011 (Předpis pro stavební výrobky)

1. Jedinečný identifikační kód typu výrobku:
   – EN 12050-1 nebo EN 12050-2 (SL1.50).
2. Typ, dávka nebo výrobní číslo nebo jakýkoliv prvek umožňující identifikaci stavebního výrobku podle požadavku Článku 11(4):
   – Čerpadla SL1, SLV s označením EN 12050-1 nebo EN 12050-2 (SL1.50) na typovém štítku.
3. Zamýšlená použití stavebního výrobku v souladu s příslušnou harmonizovanou technickou specifikací výrobce:
   – Čerpací stanice odpadních vod s fekáliemi s označením EN 12050-1 na typovém štítku.
   – Čerpací stanice SL1.50 odpadních vod s fekáliemi s označením EN 12050-2 na typovém štítku.
4. Název, registrovaný obchodní název nebo registrovaná ochranná známka a kontaktní adresa výrobce podle požadavku Článku 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dánsko.
5. NESOUVISÍ.
6. Systém nebo systémy posuzování a ověřování stálosti vlastností stavebního výrobku podle ustanovení Dodatku V:
   – Systém 3.
7. V případě prohlášení o vlastnostech stavebního výrobku zahrnutého v harmonizované normě:
   – TÜV Rheinland LGA Products GmbH, identifikační číslo: 0197. Proveden test podle EN 12050-1 nebo EN 12050-2 (SL1.50) v systému 3.
   (popis úkolů třetí strany podle ustanovení Dodatku V)
   – Číslo certifikátu: Certifikát LGA č. 7381115. Typ testován a monitorován.
8. NESOUVISÍ.
9. Prohlašované vlastnosti:
   Výrobky uvedené v tomto Prohlášení o vlastnostech jsou v souladu se základními charakteristikami a požadavky na vlastnosti, jak je popsáno níže:
   – Použité normy: EN 12050-1:2001 nebo EN 12050-2:2000 (SL1.50).
10. Vlastnosti výrobku uvedeného v bodech 1 a 2 v souladu s prohlašovanými vlastnostmi v bodě 9.

DK:

EU-ydeevnedeklaration i henhold til bilag III af forordning (EU) nr. 305/2011 (Byggevareforordningen)

1. Varetypens unikke identifikationskode:
   – EN 12050-1 eller EN 12050-2 (SL1.50).
2. Type-, parti- eller serienummer eller en anden form for angivelse ved hjælp af hvilken byggevaren kan identificeres som krævet i henhold til artikel 11, stk. 4:
   – SL1-, SLV-pumper der er mærket med EN 12050-1 eller EN 12050-2 (SL1.50) på typeskiltet.
3. Byggevarens tilsigtede anvendelse eller anvendelser i overensstemmelse med den gældende harmoniserede tekniske specifikation som påtænkt af fabrikanten:
   – Pumper til pumpning af spildevand med fækalier der er mærket med EN 12050-1 på typeskiltet.
   – SL1.50-pumper til pumpning af fækaliefrit spildevand der er mærket med EN 12050-2 på typeskiltet.
4. Fabrikantens navn, registrerede firmabetegnelse eller registrerede varemærke og kontaktadresse som krævet i henhold til artikel 11, stk. 5:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danmark.
5. IKKE RELEVANT.
6. Systemet eller systemerne til vurdering og kontrol af at byggevarens ydeevne er konstant, jf. bilag V:
   – System 3.
7. Hvis ydeevnedeklarationen vedrører en byggevare der er omfattet af en harmoniseret standard:
   – TÜV Rheinland LGA Products GmbH, identifikationsnummer: 0197. Udført test i henhold til EN 12050-1 eller EN 12050-2 (SL1.50) efter system 3
   (beskrivelse af tredjepartsopgaverne, jf. bilag V).
   – Certifikatnummer: LGA-certifikat nr. 7381115. Typetestet og overvåget.
8. IKKE RELEVANT.
9. Deklareret ydeevne:
   De produkter der er omfattet af denne ydeevnedeklaration, er i overensstemmelse med de væsentlige egenskaber og ydelseskrav der er beskrevet i følgende:
   – Anvendte standarder: EN 12050-1:2001 eller EN 12050-2:2000 (SL1.50).
10. Ydeevnen for den byggevare der er anført i punkt 1 og 2, er i overensstemmelse med den deklarerede ydeevne i punkt 9.

DE:

EU-Leistungserklärung gemäß Anhang III der Verordnung (EU) Nr. 305/2011 (Bauprodukte-Verordnung)

1. Einmalige Kennnummer des Produkttyps:
   – EN 12050-1 oder EN 12050-2 (SL1.50).
2. Typ, Charge, Seriennummer oder jedes andere Element, das eine Identifizierung des Bauprodukts erlaubt, wie in Artikel 11 (4) vorgeschrieben.
   – SL1-, SLV-Pumpen, auf dem Typenschild mit EN 12050-1 oder EN 12050-2 (SL1.50) gekennzeichnet.
3. Verwendungszweck oder Verwendungszwecke des Bauprodukts, gemäß den geltenden harmonisierten technischen Spezifikationen, wie vom Hersteller vorgesehen:
   – Pumpen für die Förderung von fäkalienhaltigem Abwasser, auf dem Typenschild mit EN 12050-1 gekennzeichnet.
   – SL1.50-Pumpen für die Förderung von fäkalienfreiem Abwasser, auf dem Typenschild mit EN 12050-2 gekennzeichnet.
4. es Warenzeichen und Kontaktanschrift des Herstellers, wie in Artikel 11(5) vorgeschrieben.
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dänemark
5. NICHT RELEVANT.
6. System oder Systeme zur Bewertung und Überprüfung der Leistungsbeständigkeit des Bauprodukts gemäß Anhang V:
   – System 3.
7. Bei der Leistungserklärung bezüglich eines von einer harmonisierten Norm erfassten Bauprodukts:
   – TÜV Rheinland LGA Products GmbH, Kennnummer: 0197.
   Vorgenommene Prüfung gemäß EN 12050-1 oder EN 12050-2 (SL1.50) unter Anwendung von System 3.
   (Beschreibung der Aufgaben von unabhängigen Dritten gemäß Anhang V)
   – Zertifikatnummer: LGA-Zertifikatnr. 7381115. Typgeprüft und überwacht.
8. NICHT RELEVANT.
9. Erklärte Leistung:
   Die von dieser Leistungserklärung erfassten Produkte entsprechen den grundlegenden Charakteristika und Leistungsanforderungen, wie im Folgenden beschrieben:
   – Angewendete Normen: EN 12050-1:2001 oder EN 12050-2:2000 (SL12.50).
10. Die Leistung des in Punkt 1 und 2 genannten Produkts entspricht der in Punkt 9 erklärten Leistung.

EE:

EU toimivusdeklaratsioon on kooskõlas EU normatiivi nr. 305/2011 Lisa III (Ehitustoote normid)

1. Toote tüübi ainulaadne identifiseerimis kood:
   – EN 12050-1 või EN 12050-2 (SL1.50).
2. Tüübi-, partii- või tootenumber või mõni teine element mis võimaldab kindlaks teha, et ehitustoode vastab artikli 11(4):
   – SL1, SLV pumpadel on andmeplaadil märgistus EN 12050-1 või EN 12050-2 (SL1.50).
3. Ehitustooted on ettenähtud kasutamiseks vastavalt tootja poolt etteantud kasutusaladel järgides tehnilisi ettekirjutusi.
   – Andmeplaadil märgitud EN 12050-1 pumbad on mõeldud fekaale sisaldava heitvee pumpamiseks.
   – Andmeplaadil märgitud EN 12050-2 (SL1.50) pumplad on mõeldud fekaale mittesisaldava heitvee pumpamiseks.
4. Nimetus, registreeritud kaubamärk või registreeritud kaubamärk ja kontaktaadress tootjafirmast peavad olema vastavuses Artikkel 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Taani.
5. POLE OLULINE.
6. Süsteemi või süsteemi hindamine ja kinnitamine püsiva jõudlusega ehitustooteks nagu on kirjas Lisa V:
   – Süsteem 3.
7. Toimivusdeklaratsioon järgib ehitustoodete standarditest:
   – TÜV Rheinland LGA Products GmbH, indentifitseerimis number: 0197.
   Testitud vastavalt EN 12050-1 või EN 12050-2 (SL1.50) järgi süsteem 3.
   (kolmandate osapoolte ülesanded nagu on kirjas Lisa V)
   – Sertifikaadi number: LGA-Sertifikaadi Nr 7381115. Tüüptestitud ja jälgitud.
8. POLE OLULINE.
9. Avaldatud jõudlus:
   Toode, mille kohta antud toimivusdeklaratsioon kehtib, on vastavuses põhiomadustega ja jõudlus vajadustega nagu järgnevalt kirjutatud:
   – Kasutatud standardid: EN 12050-1:2001 või EN 12050-2:2000 (SL1.50).
10. Toote tuvastatud jõudlus punktides 1 ja 2 on vastavuses toimivusdeklaratsiooni punkti 9.

GR:

Δήλωση απόδοσης ΕΕ σύμφωνα με το Παράρτημα III του Κανονισμού (ΕΕ) Αρ. 305/2011 (Κανονισμός για Προϊόντα του Τομέα Δομικών Κατασκευών)

1. Μοναδικός κωδικός ταυτοποίησης του τύπου του προϊόντος:
   – EN 12050-1 ή EN 12050-2 (SL1.50).
2. Αριθμός τύπου, παρτίδας ή σειράς ή οποιοδήποτε άλλο στοιχείο επιτρέπει την ταυτοποίηση του προϊόντος του τομέα των δομικών κατασκευών όπως απαιτείται δυνάμει του Άρθρου 11(4):
   – Αντλίες SL1, SLV με σήμανση EN 12050-1 ή EN 12050-2 (SL1.50) στην πινακίδα.
3. Προτεινόμενη χρήση ή χρήσεις του προϊόντος του τομέα δομικών κατασκευών, σύμφωνα με την ισχύουσα εναρμονισμένη τεχνική προδιαγραφή, όπως προβλέπεται από τον κατασκευαστή:
   – Αντλίες για άντληση ακάθαρτων υδάτων που περιέχουν περιττώματα με σήμανση EN 12050-1 στην πινακίδα.
   – Αντλίες SL1.50 για άντληση ακάθαρτων υδάτων χωρίς περιττώματα με σήμανση EN 12050-2 στην πινακίδα.
4. Όνομα, εμπορική επωνυμία ή σήμα κατατεθέν και διεύθυνση επικοινωνίας του κατασκευαστή όπως απαιτείται δυνάμει του Άρθρου 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Δανία.
5. ΜΗ ΣΧΕΤΙΚΟ.
6. Σύστημα ή συστήματα αξιολόγησης και επαλήθευσης της σταθερότητας της απόδοσης του προϊόντος του τομέα δομικών κατασκευών όπως καθορίζεται στο Παράρτημα V:
   – Σύστημα 3.
7. Σε περίπτωση δήλωσης απόδοσης που αφορά προϊόν του τομέα δομικών κατασκευών το οποίο καλύπτεται από ?εναρμονισμένο πρότυπο:
   – TÜV Rheinland LGA Products GmbH, αριθμός ταυτοποίησης: 0197. Διενήργησε δοκιμή σύμφωνα με τα EN 12050-1 ή EN 12050-2 (SL1.50) βάσει του συστήματος 3.
   (περιγραφή των καθηκόντων του τρίτου μέρους όπως καθορίζονται στο Παράρτημα V)
   – Αριθμός πιστοποιητικού: Πιστοποιητικό LGA Αρ. 7381115. Έχει υποβληθεί σε δοκιμή τύπου και παρακολουθείται.
8. ΜΗ ΣΧΕΤΙΚΟ.
9. Δηλωθείσα απόδοση:
   Τα προϊόντα που καλύπτονται από την παρούσα δήλωση απόδοσης συμμορφώνονται με τα ουσιώδη χαρακτηριστικά και τις απαιτήσεις απόδοσης όπως περιγράφεται στα ακόλουθα:
   – Πρότυπα που χρησιμοποιήθηκαν: EN 12050-1:2001 ή EN 12050-2:2000 (SL1.50).
10. Η απόδοση του προϊόντος που ταυτοποιήθηκε στα σημεία 1 και 2 συμμορφώνεται με τη δηλωθείσα απόδοση στο σημείο 9.

ES:

Declaración UE de prestaciones conforme al Anexo III del Reglamento (UE) n.° 305/2011 (Reglamento de productos de construcción)

1. Código de identificación único del tipo de producto:
   – EN 12050-1 o EN 12050-2 (SL1.50).
2. Tipo, lote o número de serie, o cualquier otro elemento que facilite la identificación del producto de construcción de acuerdo con los requisitos establecidos en el Artículo 11(4):
   – Bombas SL1, SLV en cuya placa de características figure la norma EN 12050-1 o EN 12050-2 (SL1.50).
3. Uso o usos previstos del producto de construcción, conforme a la especificación técnica armonizada correspondiente, según lo previsto por el fabricante:
   – Bombas para el bombeo de aguas residuales que contengan materia fecal en cuya placa de características figure la norma EN 12050-1.
   – Bombas SL1.50 para el bombeo de aguas residuales que contengan materia fecal en cuya placa de características figure la norma EN 12050-2.
4. Nombre, nombre comercial registrado o marca comercial registrada y domicilio de contacto del fabricante de acuerdo con los requisitos establecidos en el Artículo 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dinamarca.
5. NO CORRESPONDE.
6. Sistema o sistemas de evaluación y verificación de la continuidad de las prestaciones del producto de construcción, de acuerdo con lo establecido en el Anexo V.
   – Sistema 3.
7. Si la declaración de prestaciones concierne a un producto de construcción cubierto por una norma armonizada:
   – TÜV Rheinland LGA Products GmbH, número de identificación: 0197.
   Ensayo ejecutado según las normas EN 12050-1 o EN 12050-2 (SL1.50), sistema 3.
   (Descripción de las tareas de las que deben responsabilizarse otras partes de acuerdo con lo establecido en el Anexo V).
   – Número de certificado: Certificado LGA n.° 7381115. Tipo sometido a ensayo y monitorizado.
8. NO CORRESPONDE.
9. Prestaciones declaradas:
   Los productos que cubre esta declaración de prestaciones satisfacen las características fundamentales y requisitos en materia de prestaciones descritos en:
   – Normas aplicadas: EN 12050-1:2001 o EN 12050-2:2000 (SL1.50).
10. Las prestaciones del producto indicado en los puntos 1 y 2 cumplen lo declarado en el punto 9.

FR:

Déclaration des performances UE conformément à l'Annexe III du Règlement (UE) n° 305/2011 (Règlement Produits de Construction)

1. Code d'identification unique du type de produit :
   – EN 12050-1 ou EN 12050-2 (SL1.50).
2. Numéro de type, de lot ou de série ou tout autre élément permettant l'identification du produit de construction comme l'exige l'Article 11(4) :
   – Pompes SL1, SLV marquées EN 12050-1 ou EN 12050-2 (SL1.50) sur la plaque signalétique.
3. Usage(s) prévu(s) du produit de construction conformément à la spécification technique harmonisée applicable comme indiqué par le fabricant :
   – Pompe pour la collecte des effluents contenant des matières fécales marquées EN 12050-1 sur la plaque signalétique.
   – Pompe SL1.50 pour la collecte des effluents exempts de matières fécales marquées EN 12050-2 sur la plaque signalétique.
4. Nom, nom de commerce déposé ou marque commerciale déposée et adresse du fabricant comme l'exige l'Article 11(5) :
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danemark.
5. NON APPLICABLE.
6. Système ou systèmes d'attestation et de vérification de la constance des performances du produit de construction comme stipulé dans l'Annexe V :
   – Système 3.
7. En cas de déclaration des performances d'un produit de construction couvert par une norme harmonisée :
   – TÜV Rheinland LGA Products GmbH, numéro d'identification : 0197.
   Test effectué conformément aux normes EN 12050-1 ou EN 12050-2 (SL1.50) selon le système 3.
   (description des tâches de tierce partie comme stipulé dans l'Annexe V)
   – Numéro de certificat : Certificat LGA n° 7381115. Contrôlé et homologué.
8. NON APPLICABLE.
9. Performances déclarées :
   Les produits couverts par cette déclaration des performances sont conformes aux caractéristiques essentielles et aux exigences de performances décrites par la suite :
   – Normes utilisées : EN 12050-1:2001 ou EN 12050-2:2000 (SL1.50).
10. Les performances du produit identifié aux points 1 et 2 sont conformes aux performances déclarées au point 9.

HR:

Izjava EU o izjavi u skladu s aneksom III uredbe (EU) br. 305/2011 (Uredba za građevinske proizvode)

1. Jedinstveni identifikacijski kod vrste proizvoda:
   – EN 12050-1 ili EN 12050-2 (SL1.50).
2. Vrsta, broj serije, serijski broj ili bilo koji drugi element koji omogućuje identificiranje građevinskog proizvoda u skladu sa člankom 11(4):
   – SL1, SLV crpke označene s EN 12050-1 ili EN 12050-2 (SL1.50) na natpisnoj pločici.
3. Namjena ili uporabe građevinskog proizvoda u skladu s primjenjivim harmoniziranim tehničkim specifikacijama, kao što je predvidio proizvođač:
   – Crpke za ispumpavanje otpadnih voda s fekalijama, označene s EN 12050-1 na natpisnoj pločici.
   – SL1.50 crpke za ispumpavanje otpadnih voda bez fekalija, označene s EN 12050-2 na natpisnoj pločici.
4. Naziv, registrirani trgovački naziv ili registrirani zaštitni znak i adresa za kontaktiranje proizvođača u skladu sa člankom 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danska.
5. NIJE RELEVANTNO.
6. Procjena jednog ili više sustava i provjera stalnosti rada građevinskog proizvoda, kao što je određeno aneksom V:
   – Sustav 3.
7. U slučaju izjave o izvedbi za građevinski proizvod pokriven harmoniziranim standardom:
   – TÜV Rheinland LGA Products GmbH, identifikacijski broj: 0197.
   Izvršite ispitivanje u skladu s EN 12050-1 ili EN 12050-2 (SL1.50) u okviru sustava 3.
   (Opis zadataka trećih strana, kao što je definirano aneksom V)
   – Broj certifikata: Br. LGA certifikata 7381115. Ispitana vrsta i nadzirano.
8. NIJE RELEVANTNO.
9. Izjavljena izvedba:
   Proizvodi obuhvaćeni ovom izjavom o izvedbi u skladu su s osnovnim karakteristikama i zahtjevima za izvedbu, kao što je definirano u nastavku:
   – Uporabljeni standardi: EN 12050-1:2001 ili EN 12050-2:2000 (SL1.50).
10. Izvedba proizvoda identificirana u točkama 1 i 2 u skladu je s izjavljenom izvedbom u točki 9.

IT:

Dichiarazione UE di prestazioni in conformità all'all. III del Regolamento (UE) n. 305/2011 (regolamento sui prodotti da costruzione)

1. Codice identificativo esclusivo del tipo di prodotto:
   – EN 12050-1 oppure EN 12050-2 (SL1.50).
2. Tipo, lotto o numero di serie o qualsiasi altro elemento che consenta l'identificazione del prodotto da costruzione come necessario secondo l'art. 11(4):
   – Pompe SL1, SLV, marcate con EN 12050-1 oppure EN 12050-2 (SL1.50) sulla targa dei dati identificativi.
3. Utilizzo o utilizzi previsti del prodotto da costruzione, in accordo alla specifica tecnica armonizzata pertinente, come previsto dal fabbricante:
   – Pompe per il pompaggio di acque reflue contenenti materie fecali, marcate con EN 12050-1 sulla targa dei dati identificativi.
   – Pompe SL1.50 per il pompaggio di acque reflue non contenenti materiali fecali, marcate con EN 12050-2 sulla targa dei dati identificativi.
4. Denominazione, denominazione commerciale registrata o marchio registrato e indirizzo di contatto del fabbricante secondo l'art. 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danimarca.
5. NON RILEVANTE.
6. Sistema o sistemi di valutazione e verifica della costanza delle prestazioni del prodotto da costruzione come definito sub all. V:
   – Sistema 3.
7. In caso di dichiarazione di prestazioni concernente un prodotto da costruzione conforme a una norma armonizzata:
   – TÜV Rheinland LGA Products GmbH, numero d'identificazione: 0197.
   Test eseguito secondo EN 12050-1 oppure EN 12050-2 (SL1.50) con il sistema 3.
   (descrizione delle mansioni di terzi come definito sub all. V)
   – Numero certificato: N. certificato LGA 7381115. Testato per il tipo e monitorato.
8. NON RILEVANTE.
9. Prestazioni dichiarate:
   I prodotti coperti dalla presente dichiarazione di prestazione sono conformi alle caratteristiche essenziali ed ai requisiti di prestazioni descritti dove segue:
   – Norme applicate: EN 12050-1:2001 oppure EN 12050-2:2000 (SL1.50).
10. Le prestazioni del prodotto identificato ai punti 1 e 2 sono conformi alle prestazioni dichiarate al punto 9.

KZ:

305/2011 ережесінің (ЕО) III қосымшасына сай ЕО өнімділік туралы декларациясы (Құрылыс өнімдері туралы ереже)

1. Өнім түрінің бірегей идентификациялық коды:
   – EN 12050-1 немесе EN 12050-2 (SL1.50).
2. Түр, бума, сериялық нөмір немесе құрылыс өнімін 11(4) тармағына сай талап етілетіндей құрылыс өнімін идентификациялауға мүмкіндік беретін кез келген басқа элемент:
   – Зауыттық тақтайшасында EN 12050-1 немесе EN 12050-2 (SL1.50) деп белгіленген SL1, SLV сораптары.
3. Құрылыс өнімін мақсатты пайдалану немесе пайдалану өндіруші көздегендей тиісті үйлестірілген техникалық сипаттамаларға сай:
   – Зауыттық тақтайшасында EN 12050-1 деп белгіленген нәжісті қамтитын ағынды суды айдамалауға арналған сораптар.
   – Зауыттық тақтайшасында EN 12050-2 (SL1.50) деп белгіленген нәжіс жоқ ағынды суды айдамалауға арналған сораптар.
4. 11(5) тармаққа сай талап етілетіндей атау, тіркелген сауда атауы немесе тіркелген сауда белгісі және байланыс мекенжайы:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Дания.
5. ТИІСТІ ЕМЕС.
6. V қосымшасында белгіленгендей жүйені немесе жүйелерді бағалау және құрылыс өнімінің өнімділігінің тұрақтылығын тексеру:
   – 3-жүйе.
7. Құрылыс өніміне қатысты өнімділік туралы декларация үйлестірілген стандартпен қамтылған болса:
   – TÜV Rheinland LGA Products GmbH, идентификациялық нөмір: 0197.
   EN 12050-1 немесе EN 12050-2 (SL1.50) стандартына сай 3-жүйесімен сынақ орындалған.
   (V қосымшасында белгіленгендей үшінші тарап тапсырмаларының сипаттамасы)
   – Сертификат нөмірі LGA-сертификатының нөмірі: 7381115. Сыналған және бақыланған түр.
8. ТИІСТІ ЕМЕС.
9. Жарияланған өнімділік:
   Осы өнімділік туралы декларациямен қамтылған өнімдер төменде сипатталғандай маңызды сипаттамалар және өнімділік туралы талаптарға сай:
   – Қолданылған стандарттар: EN 12050-1:2001 немесе EN 12050-2:2000 (SL1.50).
10. 1 және 2 бөлімдерінде көрсетілген өнім өнімділігі 9-бөлімде жарияланған өнімділікке сай.

LV:

EK ekspluatācijas īpašību deklarācija saskaņā ar Regulas (ES) Nr. 305/2011 III pielikumu (Būvizstrādājumu regula)

1. Unikāls izstrādājuma tipa identifikācijas numurs:
   – EN 12050-1 vai EN 12050-2 (SL1.50).
2. Tips, partijas vai sērijas numurs vai kāds cits būvizstrādājuma identifikācijas elements, kā noteikts 11. panta 4. punktā:
   – SL1, SLV sūkņi ar EN 12050-1 vai EN 12050-2 (SL1.50) apzīmējumu uz datu plāksnītes.
3. Būvizstrādājuma paredzētais izmantojums vai izmantojumi saskaņā ar piemērojamo saskaņoto tehnisko specifikāciju, kā paredzējis ražotājs:
   – Izkārnījumus saturošo notekūdeņu sūknēšanai paredzētie sūkņi ar EN 12050-1 apzīmējumu uz datu plāksnītes.
   – Izkārnījumus nesaturošo notekūdeņu sūknēšanai paredzētie SL1.50 sūkņi ar EN 12050-2 apzīmējumu uz datu plāksnītes.
4. Ražotāja nosaukums, reģistrētais komercnosaukums vai reģistrētā preču zīme un kontaktadrese, kā noteikts 11. panta 5. punktā:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dānija.
5. NAV ATTIECINĀMS.
6. Ekspluatācijas īpašību noturības novērtējuma un pārbaudes sistēma vai sistēmas, kā noteikts V pielikumā:
   – 3. sistēma.
7. Gadījumā, ja ekspluatācijas īpašību deklarācija attiecas uz būvizstrādājumu, kuram ir saskaņotais standarts:
   – TÜV Rheinland LGA Products GmbH, identifikācijas numurs: 0197. Pārbaudi veica saskaņā ar EN 12050-1 vai EN 12050-2 (SL1.50) atbilstoši 3. sistēmai.
   (V pielikumā izklāstīto trešo personu uzdevumu apraksts)
   – Sertifikāta numurs: LGA sertifikāts Nr. 7381115. Pārbaudīts un kontrolēts atbilstoši tipam.
8. NAV ATTIECINĀMS.
9. Deklarētās ekspluatācijas īpašības
   Izstrādājumi, uz kuriem attiecas šī ekspluatācijas īpašību deklarācija, atbilst būtiskiem raksturlielumiem un prasībām pret ekspluatācijas īpašībām, kas aprakstītas tālākminētajos dokumentos.
   – Piemērotie standarti: EN 12050-1:2001 vai EN 12050-2:2000 (SL1.50).
10. Pielikuma 1. un 2. punktā norādītā izstrādājuma ekspluatācijas īpašības atbilst 9. punktā norādītajām deklarētajām ekspluatācijas īpašībām.

LT:

EB eksploatacinių savybių deklaracija pagal reglamento (ES) Nr. 305/2011 III priedą (Statybos produktų reglamentas)

1. Unikalus produkto tipo identifikacinis kodas:
   – EN 12050-1 arba EN 12050-2 (SL1.50).
2. Tipo, partijos ar serijos numeris ar bet koks kitas elementas, pagal kurį galima identifikuoti statybos produktą, kaip reikalaujama pagal 11 straipsnio 4 dalį:
   – SL1, SLV siurbliai, vardinėje plokštelėje pažymėti EN 12050-1 arba EN 12050-2 (SL1.50).
3. Gamintojo numatyta statybos produkto naudojimo paskirtis ar paskirtys pagal taikomą darniąją techninę specifikaciją:
   – Siurbliai, skirti išsiurbti nuotekas, kurių sudėtyje yra fekalijų, vardinėje plokštelėje pažymėti EN 12050-1.
   – SL1.50 siurbliai, skirti išsiurbti nuotekas, kurių sudėtyje nėra fekalijų, vardinėje plokštelėje pažymėti EN 12050-2.
4. Gamintojo pavadinimas, registruotas komercinis pavadinimas arba registruotas prekės ženklas ir kontaktinis adresas, kaip reikalaujama pagal 11 straipsnio 5 dalį:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danija.
5. NETAIKYTINA.
6. Statybos produkto eksploatacinių savybių pastovumo vertinimo ir tikrinimo sistema ar sistemos, kaip nustatyta V priede:
   – Sistema 3.
7. Eksploatacinių savybių deklaracijos, susijusios su statybos produktu, kuriam taikomas darnusis standartas, atveju:
   – „TÜV Rheinland LGA Products GmbH", identifikacinis numeris: 0197.
   atliko EN 12050-1 arba EN 12050-2 (SL1.50) reikalavimus atitinkantį bandymą pagal sistemą 3.
   (trečiosios šalies užduočių, kaip nustatyta V priede, aprašymas)
   – Sertifikato numeris: LGA sertifikatas Nr. 7381115. Tipas patikrintas ir stebimas.
8. NETAIKYTINA.
9. Deklaruojamos eksploatacinės savybės:
   Produktai, kuriuos apima ši eksploatacinių savybių deklaracija, atitinka esmines charakteristikas ir eksploatacinių savybių reikalavimus, kaip aprašyta:
   – Taikomi standartai: EN 12050-1:2001 arba EN 12050-2:2000 (SL1.50).
10. 1 ir 2 punktuose nurodyto produkto eksploatacinės savybės atitinka 9 punkte deklaruojamas eksploatacines savybes.

HU:

EU teljesítménynyilatkozat a 305/2011 számú EU rendelet III. mellékletének megfelelően (Építési termék rendelet)

1. A terméktípus egyedi azonosító kódja:
   – EN 12050-1 vagy EN 12050-2 (SL1.50).
2. Típus, adag, sorozatszám, vagy bármilyen más olyan elem, amely lehetővé teszi az építési terméknek a 11. cikk (4) bekezdése alapján megkövetelt azonosítását:
   – SL1, SLV szivattyúk, EN 12050-1 vagy EN 12050-2 (SL1.50) jelöléssel az adattáblán.
3. Az építési termék tervezett felhasználása vagy felhasználásai, a vonatkozó harmonizált műszaki előírásoknak megfelelően, a gyártó szándéka szerint:
   – Fekáliatartalmú szennyvíz szivattyúzására szolgáló szivattyúk, EN 12050-1 jelöléssel az adattáblán.
   – Fekáliamentes szennyvíz szivattyúzására szolgáló SL1.50 szivattyúk, EN 12050-2 jelöléssel az adattáblán.
4. A gyártó neve, védjegye, bejegyzett kereskedelmi neve és értesítési címe a 11. cikk (5) bekezdése alapján megkövetelt módon:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dánia.
5. NEM RELEVÁNS.
6. Az építési termék teljesítmény állandóságának értékelésére és ellenőrzésére vonatkozó rendszer vagy rendszerek, az V. mellékeltben meghatározott módon:
   – 3-as rendszer.
7. Olyan építési termékre vonatkozó teljesítménynyilatkozat esetén, amelyre kiterjed egy harmonizált szabvány:
   – TÜV Rheinland LGA Products GmbH, azonosító szám: 0197.
   Az EN 12050-1 vagy EN 12050-2 (SL1.50) szerint elvégzett teszt, a 3-as rendszer keretében.
   (harmadik fél feladatainak leírása az V. mellékletben meghatározott módon)
   – Tanúsítvány száma: LGA-Tanúsítvány száma 7381115.
   Típustesztelve és felügyelve.
8. NEM RELEVÁNS.
9. Megadott teljesítmény:
   Azok a termékek, amelyekre ez a teljesítménynyilatkozat vonatkozik, rendelkeznek azokkal az alapvető jellemzőkkel és kielégítik azokat a teljesítményre vonatkozó követelményeket, amelyeket alább ismertetünk:
   – Alkalmazott szabványok: EN 12050-1:2001 vagy EN 12050-2:2000 (SL1.50).
10. Az 1-es és 2-es pontban azonosított termék teljesítménye összhangban van a 9. pontban megadott teljesítménnyel.

NL:

Prestatieverklaring van EU in overeenstemming met Bijlage III van verordening (EU) nr. 305/2011 (Bouwproductenverordening)

1. Unieke identificatiecode van het producttype:
   – EN 12050-1 of EN 12050-2 (SL1.50).
2. Type-, batch- of serienummer of enig ander element dat identificatie van het bouwproduct mogelijk maakt zoals vereist conform artikel 11(4):
   – SL1, SLV pompen gemarkeerd met EN 12050-1 of EN 12050-2 (SL1.50) op het typeplaatje.
3. Beoogde toepassing of toepassingen van het bouwproduct, in overeenstemming met de van toepassing zijnde geharmoniseerde technische specificatie, zoals voorzien door de fabrikant:
   – Pompen voor het verpompen van afvalwater dat fecale materie bevat gemarkeerd met EN 12050-1 op het typeplaatje.
   – SL1.50 pompen voor het verpompen van afvalwater dat geen fecale materie bevat gemarkeerd met EN 12050-2 op het typeplaatje.
4. Naam, gedeponeerde handelsnaam of gedeponeerd handelsmerk en contactadres van de fabrikant zoals vereist conform artikel 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Denemarken.
5. NIET RELEVANT.
6. Systeem of systemen voor beoordeling en verificatie van constantheid van prestaties van het bouwproduct zoals beschreven in Bijlage V:
   – Systeem 3.
7. In het geval van de prestatieverklaring voor een bouwproduct dat onder een geharmoniseerde norm valt:
   – TÜV Rheinland LGA Products GmbH, identificatienummer: 0197.
   Uitgevoerde test conform EN 12050-1 of EN 12050-2 (SL1.50) onder systeem 3.
   (beschrijving van de externe taken zoals beschreven in Bijlage V)
   – Certificaatnummer: LGA-certificaatnr. 7381115. Type getest en bewaakt.
8. NIET RELEVANT.
9. Verklaarde prestatie:
   De producten die vallen onder deze prestatieverklaring zijn in overeenstemming met de essentiële eigenschappen en de prestatievereisten zoals beschreven in het volgende:
   – Gebruikte normen: EN 12050-1:2001 of EN 12050-2:2000 (SL1.50).
10. De prestaties van het product dat is geïdentificeerd in punten 1 en 2 zijn in overeenstemming met de verklaarde prestaties in punt 9.

UA:

Декларація ЄС щодо технічних характеристик згідно з Додатком III Регламенту (ЄС) № 305/2011 (Регламент на конструкційні будівничі матеріали і продукцію)

1. Код однозначної ідентифікації типу продукту:
   – EN 12050-1 або EN 12050-2 (SL1.50).
2. Тип, номер партії, номер серії або інший параметр, що дозволяє ідентифікувати продукт для встановлення в будівлях згідно Статті 11(4):
   – Насоси SL1, SLV мають на фірмовій табличці позначення EN 12050-1 або EN 12050-2 (SL1.50).
3. Цільове використання продукту для встановлення в будівлях згідно застосовних погоджених технічних умов, зазначених виробником:
   – Насоси для перекачування стічних вод з фекаліями мають позначення EN 12050-1 на фірмовій табличці.
   – Насоси SL1.50 для перекачування стічних вод без фекалій мають позначення EN 12050-2 на фірмовій табличці.
4. Назва, зареєстроване торгове ім'я або зареєстрована торгова марка та контактна адреса виробника згідно Статті 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Данія.
5. НЕ ЗАСТОСОВУЄТЬСЯ.
6. Система або системи оцінки і перевірки постійності робочих характеристик продукту для встановлення в будівлях згідно Додатку V:
   – Система 3.
7. Якщо декларація щодо робочих характеристик стосується продукту для встановлення в будівлях, що підпадає під узгоджений стандарт:
   – TÜV Rheinland LGA Products GmbH, ідентифікаційний номер: 0197.
   Перевірка виконана згідно EN 12050-1 або EN 12050-2 (SL1.50) за системою 3.
   (опис завдань третьої сторони відповідно до Додатку V)
   – Номер свідоцтва: LGA-Свідоцтво № 7381115. Перевірка типу і контроль пройдені.
8. НЕ ЗАСТОСОВУЄТЬСЯ.
9. Зазначені технічні характеристики:
   Продукти, що підпадають під цю декларацію, відповідають основним характеристикам і вимогам до робочих характеристик, зазначеним нижче:
   – Стандарти, що застосовувалися: EN 12050-1:2001 або EN 12050-2:2000 (SL1.50).
10. Технічні характеристики продукту, вказані у пунктах 1 і 2, відповідають зазначеним технічним характеристикам з пункту 9.

PL:

Deklaracja właściwości użytkowych UE według załącznika III do dyrektywy (UE) nr 305/2011 w/s wprowadzania do obrotu wyrobów budowlanych

1. Niepowtarzalny kod identyfikacyjny typu wyrobu:
   – EN 12050-1 lub EN 12050-2 (SL1.50).
2. Numer typu, partii lub serii lub jakikolwiek inny element umożliwiający identyfikację wyrobu budowlanego, wymagany zgodnie z art. 11 ust. 4:
   – Pompy SL1, SLV oznaczone na tabliczce znamionowej kodem EN 12050-1 lub EN 12050-2 (SL1.50).
3. Przewidziane przez producenta zamierzone zastosowanie lub zastosowania wyrobu budowlanego zgodnie z mającą zastosowanie zharmonizowaną specyfikacją techniczną:
   – Pompy do pompowania ścieków zawierających fekalia, oznaczone na tabliczce znamionowej kodem EN 12050-1.
   – Pompy SL1.50 do pompowania ścieków bez zawartości fekaliów, oznaczone na tabliczce znamionowej kodem EN 12050-2.
4. Nazwa, zastrzeżona nazwa handlowa lub zastrzeżony znak towarowy oraz adres kontaktowy producenta, wymagany zgodnie z art. 11 ust. 5:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dania.
5. NIE DOTYCZY.
6. System lub systemy oceny i weryfikacji stałości właściwości użytkowych wyrobu budowlanego określone w załączniku V:
   – System 3.
7. W przypadku deklaracji właściwości użytkowych dotyczącej wyrobu budowlanego objętego normą zharmonizowaną:
   – Jednostka certyfikująca TÜV Rheinland LGA Products GmbH, numer identyfikacyjny: 0197.
   przeprowadziła badanie określone w EN 12050-1 lub EN 12050-2 (SL1.50), w systemie 3 i wydała certyfikat
   (opis zadań strony trzeciej, określonych w załączniku V)
   – Nr certyfikatu: certyfikat LGA nr 7381115 (certyfikat badania typu i stałości właściwości użytkowych).
8. NIE DOTYCZY.
9. Deklarowane właściwości użytkowe:
   Wyroby, których dotyczy niniejsza deklaracja właściwości użytkowych są zgodne z zasadniczymi charakterystykami i wymaganiami określonymi w następujących normach:
   – Zastosowane normy: EN 12050-1:2001 lub EN 12050-2:2000 (SL1.50).
10. Właściwości użytkowe wyrobu określone w pkt 1 i 2 są zgodne z właściwościami użytkowymi deklarowanymi w pkt 9.

PT:

Declaração de desempenho UE, em conformidade com o Anexo III do Regulamento (UE) N.° 305/2011 (Regulamento de Produtos da Construção)

1. Código de identificação exclusivo do tipo de produto:
   – EN 12050-1 ou EN 12050-2 (SL1.50).
2. Tipo, lote ou número de série ou qualquer outro elemento que permita a identificação do produto de construção, em conformidade com o Artigo 11(4):
   – Bombas SL1, SLV com a indicação EN 12050-1 ou EN 12050-2 (SL1.50) na chapa de características.
3. Utilização ou utilizações prevista(s) do produto de construção, em conformidade com a especificação técnica harmonizada aplicável, conforme previsto pelo fabricante:
   – Bombas para bombeamento de águas residuais com conteúdo de matéria fecal com a indicação EN 12050-1 na chapa de características.
   – Bombas SL1.50 para bombeamento de águas residuais sem matéria fecal com a indicação EN 12050-2 na chapa de características.
4. Nome, nome comercial registado ou marca registada e endereço de contacto do fabricante, em conformidade com o Artigo 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dinamarca.
5. NÃO RELEVANTE.
6. Sistema ou sistemas de avaliação e verificação da regularidade do desempenho do produto de construção, conforme definido no Anexo V:
   – Sistema 3.
7. Em caso de declaração de desempenho referente a um produto de construção abrangido por uma norma harmonizada:
   – TÜV Rheinland LGA Products GmbH, número de identificação: 0197.
   Teste realizado em conformidade com EN 12050-1 ou EN 12050-2 (SL1.50) ao abrigo do sistema 3.
   (descrição das tarefas de partes terceiras, conforme definido no Anexo V)
   – Número do certificado: Certificado LGA N.° 7381115. Testado e monitorizado.
8. NÃO RELEVANTE.
9. Desempenho declarado:
   Os produtos abrangidos por esta declaração de desempenho cumprem as características essenciais e os requisitos de desempenho conforme descritos em:
   – Normas utilizadas: EN 12050-1:2001 ou EN 12050-2:2000 (SL1.50).
10. O desempenho do produto identificado nos pontos 1 e 2 encontra-se em conformidade com o desempenho declarado no ponto 9.

RU:

Декларация ЕС о рабочих характеристиках согласно Приложению III Регламента (ЕС) № 305/2011 (Регламент на конструкционные, строительные материалы и продукцию)

1. Код однозначной идентификации типа продукции:
   – EN 12050-1 или EN 12050-2 (SL1.50).
2. Тип, номер партии, серийный номер или любой другой параметр, обеспечивающий идентификацию строительного оборудования согласно Статье 11(4):
   – Насосы SL1, SLV имеют обозначение EN 12050-1 или EN 12050-2 (SL1.50) на фирменной табличке.
3. Целевое применение или применения строительного оборудования в соответствии с применимыми согласованными техническими условиями, предусмотренными производителем:
   – Насосы для перекачки сточных вод с фекалиями имеют обозначение EN 12050-1 на фирменной табличке.
   – Насосы SL1, SLV для перекачки сточных вод без фекалий имеют обозначение EN 12050-2 на фирменной табличке.
4. Название, зарегистрированное торговое имя или зарегистрированная торговая марта и контактный адрес производителя согласно Статье 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Дания.
5. НЕ ИСПОЛЬЗУЕТСЯ.
6. Система или системы оценки и проверки постоянства рабочих характеристик строительного оборудования согласно Приложению V:
   – Система 3.
7. Если декларация о рабочих характеристиках касается строительного оборудования, предусмотренного согласованным стандартом:
   – TÜV Rheinland LGA Products GmbH, идентификационный номер: 0197.
   Испытание выполнено согласно EN 12050-1 или EN 12050-2 (SL1.50) по системе 3.
   (описание задач третьей стороны согласно Приложению V)
   – Номер сертификата: LGA-Сертификат № 7381115. Прошёл типовые испытания и контроль.
8. НЕ ИСПОЛЬЗУЕТСЯ.
9. Заявленные технические характеристики:
   Оборудование, подпадающее под настоящую декларацию о технических характеристиках, соответствует существенным характеристикам и требованиям к рабочим характеристикам, указанным ниже:
   – Применяемые стандарты: EN 12050-1:2001 или EN 12050-2:2000 (SL1.50).
10. Технические характеристики оборудования, указанные в пунктах 1 и 2, соответствуют заявленным техническим характеристикам из пункта 9.

RO:

Declarație UE de performanță în conformitate cu anexa III a Regulamentului (UE) nr 305/2011 (reglementare privind produsele pentru construcţii)

1. Cod unic de identificare a tipului de produs:
   – EN 12050-1 sau EN 12050-2 (SL1.50).
2. Tipul, lotul sau seria, sau orice alt element care permite identificarea produsului pentru construcții după cum este necesar în conformitate cu articolul 11 (4):
   – Pompe SL1, SLV marcate cu EN 12050-1 sau EN 12050-2 (SL1.50) pe placa de identificare.
3. Utilizarea sau utilizările preconizate ale produsului pentru construcții, în conformitate cu specificația tehnică armonizată aplicabilă, astfel cum este prevăzut de către producător:
   – Pompe pentru pomparea apei uzate conținând materii fecale, marcate cu EN 12050-1 pe placa de identificare.
   – Pompe SL1.50 pentru pomparea apei uzate fără materii fecale, marcate cu EN 12050-2 pe placa de identificare.
4. înregistrată și adresa de contact a fabricantului cerute conform cu articolului 11 (5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danemarca.
5. NU ESTE RELEVANT.
6. Sistemul sau sistemele de evaluare și verificare a constanței performanței produsului pentru construcții astfel cum este prevăzut în anexa V:
   – Sistemul 3.
7. În cazul declarației de performanță pentru un produs pentru construcții specificat într-un standard armonizat:
   – TÜV Rheinland LGA Products GmbH, număr de identificare: 0197. Test efectuat conform EN 12050-1 sau EN 12050-2 (SL1.50) potrivit sistemului 3.
   (descrierea sarcinilor terței părți așa cum este prevăzut în anexa V)
   – Numărul certificatului: LGA-Certificat nr. 7381115. Tip testat și monitorizat.
8. NU ESTE RELEVANT.
9. Performanță declarată:
   Produsele specificate de această declarație de performanță sunt în conformitate cu caracteristicile esențiale și cerințele de performanță descrise în cele ce urmează:
   – Standarde utilizate: EN 12050-1:2001 sau EN 12050-2:2000 (SL1.50).
10. Performanța produsului identificat la punctele 1 și 2 este în conformitate cu performanța declarată la punctul 9.

SK:

Vyhlásenie o parametroch EU v súlade s prílohou III nariadenia (EÚ) č. 305/2011 (Nariadenie o stavebných výrobkoch)

1. Jedinečný identifikačný kód typu výrobku:
   – EN 12050-1 alebo EN 12050-2 (SL1.50).
2. Typ, číslo výrobnej dávky alebo sériové číslo, alebo akýkoľvek iný prvok umožňujúci identifikáciu stavebného výrobku, ako sa vyžaduje podľa článku 11 ods. 4:
   – Čerpadlá SL1, SLV s označením EN 12050-1 alebo EN 12050-2 (SL1.50) na typovom štítku.
3. Zamýšľané použitia stavebného výrobku, ktoré uvádza výrobca, v súlade s uplatniteľnou harmonizovanou technickou špecifikáciou:
   – Čerpadlá určené na čerpanie splaškov s obsahom fekálií s označením EN 12050-1 na typovom štítku.
   – Čerpadlá SL1.50 určené na čerpanie splaškov bez obsahu fekálií s označením EN 12050-2 na typovom štítku.
4. Názov, registrovaný obchodný názov alebo registrovaná obchodná značka a kontaktná adresa výrobcu podľa požiadaviek článku 11, ods. 5:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Dánsko.
5. NEVZŤAHUJE SA.
6. Systém alebo systémy posudzovania a overovania nemennosti parametrov stavebného výrobku podľa ustanovení prílohy V:
   – Systém 3.
7. V prípade vyhlásenia o parametroch týkajúceho sa stavebného výrobku, na ktorý sa vzťahuje harmonizovaná norma:
   – TÜV Rheinland LGA Products GmbH, identifikačné číslo: 0197. Vykonal skúšku podľa EN 12050-1 alebo EN 12050-2 (SL1.50) v systéme 3.
   (popis úloh tretej strany, ako sa uvádzajú v prílohe V)
   – Číslo certifikátu: Certifikát LGA č. 7381115. Typovo skúšaný a monitorovaný.
8. NEVZŤAHUJE SA.
9. Deklarované parametre:
   Výrobky, na ktoré sa vzťahuje toto vyhlásenie o parametroch, vyhovujú podstatným vlastnosťami a parametrami nasledovne:
   – Použité normy: EN 12050-1:2001 alebo EN 12050-2:2000 (SL1.50).
10. Parametre výrobku uvedené v bodoch 1 a 2 sú v zhode s deklarovanými parametrami v bode 9.

SI:

Izjava EU o delovanju v skladu z Dodatkom III Uredbe (EU) št. 305/2011 (uredba o gradbenih proizvodih)

1. Edinstvena identifikacijska koda za tip izdelka:
   – EN 12050-1 ali EN 12050-2 (SL1.50).
2. Tip, serijska številka ali kateri koli drug element, ki dovoljuje identifikacijo gradbenega proizvoda, kot to zahteva člen 11(4):
   – Črpalke SL1, SLV z oznako EN 12050-1 ali EN 12050-2 (SL1.50) na tipski ploščici.
3. Predvidena uporaba gradbenega proizvoda v skladu z veljavnimi harmoniziranimi tehničnimi specifikacijami, kot jo predvideva proizvajalec:
   – Črpalke za črpanje odpadne vode, ki vsebuje fekalije, z oznako EN 12050-1 na tipski ploščici.
   – Črpalke SL1.50 za črpanje odpadne vode, ki ne vsebuje fekalij, z oznako EN 12050-2 na tipski ploščici.
4. Ime, registrirano trgovsko ime ali registrirana blagovna znamka in naslov proizvajalca, kot zahteva člen 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danska.
5. NI POMEMBNO.
6. Sistem ali sistemi ocenjevanja in preverjanja stalnosti delovanja gradbenega proizvoda, kot je opredeljeno v Dodatku V:
   – Sistem 3.
7. Če izjavo o delovanju gradbenega proizvoda pokriva harmonizirani standard:
   – TÜV Rheinland LGA Products GmbH, identifikacijska številka: 0197.
   Test izveden v skladu z EN 12050-1 ali EN 12050-2 (SL1.50) v sklopu sistema 3.
   (opis nalog tretje osebe, kot to določa Dodatek V)
   – Številka certifikata: Certifikat LGA št. 7381115. Testirano glede tipa in nadzorovano.
8. NI POMEMBNO.
9. Deklarirano delovanje:
   Proizvodi, ki jih krije ta izjava o delovanju, so skladni z bistvenimi lastnostmi in zahtevami delovanja, kot je opisano v nadaljevanju:
   – Uporabljeni standardi: EN 12050-1:2001 ali EN 12050-2:2000 (SL1.50).
10. Delovanje proizvoda, identificiranega pod točkama 1 in 2, je skladno z deklariranim delovanjem pod točko 9.

RS:

EU deklaracija o performansama u skladu sa Aneksom III propisa (EU) br. 305/2011 (propis o konstrukciji proizvoda)

1. Jedinstvena identifikaciona šifra tipa proizvoda:
   – EN 12050-1 ili EN 12050-2 (SL1.50).
2. Tip, serija ili serijski broj ili neki drugi element koji omogućava identifikaciju konstrukcije proizvoda, kako je propisano shodno Članu 11(4):
   – Pumpe SL1, SLV označene su sa EN 12050-1 ili EN 12050-2 (SL1.50) na natpisnoj pločici.
3. Predviđena namena ili predviđene namene konstruisanog proizvoda u skladu sa važećim i usklađenim tehničkim specifikacijama, kako je predvideo proizvođač:
   – Pumpe za pumpanje otpadnih voda sa fekalnim materijama na natpisnoj pločici imaju oznaku EN 12050-1.
   – Pumpe SL1.50 za pumpanje otpadnih voda bez fekalnih materija na natpisnoj pločici imaju oznaku EN 12050-2.
4. Naziv, registrovana trgovačka marka ili registrovani zaštitni znak i kontakt adresa proizvođača kako je propisano na osnovu Člana 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danska.
5. NIJE RELEVANTNO.
6. Sistem ili sistemi za procenu i verifikaciju konstantnosti performansi konstruisanog proizvoda, kako je predviđeno u Aneksu V:
   – Sistem 3.
7. U slučaju deklaracije o performansama koja se odnosi na konstruisani proizvod koji je obuhvaćen usklađenim standardom:
   – TÜV Rheinland LGA Products GmbH, identifikacioni broj: 0197.
   Izvršeno ispitivanje u skladu sa EN 12050-1 ili EN 12050-2 (SL1.50) na osnovu sistema 3
   (opis zadataka treće strane kako je opisano u Aneksu V).
   – Broj sertifikata: LGA-sertifikat br. 7381115. Ispitivanje i praćenje tipa.
8. NIJE RELEVANTNO.
9. Deklarisane performanse:
   Proizvodi koji su obuhvaćeni ovom deklaracijom o performansama usklađeni su sa osnovnim karakteristikama i zahtevima za performansama, kako je nadalje opisano:
   – Korišćeni standardi: EN 12050-1:2001 ili EN 12050-2:2000 (SL1.50).
10. Performanse proizvoda identifikovanog u tačkama 1 i 2 u saglasnosti su s deklarisanim performansama u tački 9.

FI:

EU-suoritustasoilmoitus laadittu asetuksen 305/2011/EU liitteen III mukaisesti (Rakennustuoteasetus)

1. Tuotetyypin yksilöllinen tunniste:
   – EN 12050-1 tai EN 12050-2 (SL1.50).
2. Tyyppi-, erä- tai sarjanumero tai muu merkintä, jonka ansiosta rakennustuotteet voidaan tunnistaa, kuten 11 artiklan 4 kohdassa edellytetään:
   – SL1-, SLV-pumput, joiden arvokilvessä on merkintä EN 12050-1 tai EN 12050-2 (SL1.50).
3. Valmistajan ennakoima, sovellettavan yhdenmukaistetun teknisen eritelmän mukainen rakennustuotteen aiottu käyttötarkoitus tai -tarkoitukset:
   – Pumput ulosteperäistä materiaalia sisältävien jätevesien pumppaukseen. Arvokilvessä on merkintä EN 12050-1.
   – SL1.50 pumput sellaisten jätevesien pumppaukseen, jotka eivät sisällä ulosteperäistä materiaalia. Arvokilvessä on merkintä EN 12050-2.
4. Valmistajan nimi, rekisteröity kauppanimi tai tavaramerkki sekä osoite, josta valmistajaan saa yhteyden, kuten 11 artiklan 5 kohdassa edellytetään:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Tanska.
5. EI TARVITA.
6. Rakennustuotteen suoritustason pysyvyyden arviointi- ja varmennusjärjestelmä(t) liitteen V mukaisesti:
   – Järjestelmä 3.
7. Kun kyse on yhdenmukaistetun standardin piiriin kuuluvan rakennustuotteen suoritustasoilmoituksesta:
   – TÜV Rheinland LGA Products GmbH, tunnistenumero: 0197.
   Testaus suoritettu standardien EN 12050-1 tai EN 12050-2 (SL1.50) ja järjestelmän 3 mukaisesti.
   (Liitteessä V esitettyjä kolmannen osapuolen tehtävien kuvauksia noudattaen.)
   – Sertifikaatin numero: LGA-sertifikaatti nro 7381115.
   Tyyppitestattu ja valvottu.
8. EI TARVITA.
9. Ilmoitetut suoritustasot:
   Tähän suoritustasoilmoitukseen kuuluvien tuotteiden perusominaisuudet ja suoritustasovaatimukset:
   – Sovellettavat standardit: EN 12050-1:2001 tai EN 12050-2:2000 (SL1.50).
10. Kohdissa 1 ja 2 yksilöidyn tuotteen suoritustasot ovat kohdassa 9 ilmoitettujen suoritustasojen mukaiset.

SE:

EU prestandadeklaration enligt bilaga III till förordning (EU) nr 305/2011 (byggproduktförordningen)

1. Produkttypens unika identifikationskod:
   – EN 12050-1 eller EN 12050-2 (SL1.50).
2. Typ-, parti- eller serienummer eller någon annan beteckning som möjliggör identifiering av byggprodukter i enlighet med artikel 11.4:
   – SL1-, SLV-pumpar märkta med EN 12050-1 eller EN 12050-2 (SL1.50) på typskylten.
3. Byggproduktens avsedda användning eller användningar i enlighet med den tillämpliga, harmoniserade tekniska specifikationen, såsom förutsett av tillverkaren:
   – Pumpar för pumpning av avloppsvatten innehållande fekalier märkta med EN 12050-1 på typskylten.
   – SL1.50-pumpar för pumpning av fekaliefritt avloppsvatten märkta med EN 12050-2 på typskylten.
4. Tillverkarens namn, registrerade företagsnamn eller registrerade varumärke samt kontaktadress enligt vad som krävs i artikel 11.5:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danmark.
5. EJ TILLÄMPLIGT.
6. Systemet eller systemen för bedömning och fortlöpande kontroll av byggproduktens prestanda enligt bilaga V:
   – System 3.
7. För det fall att prestandadeklarationen avser en byggprodukt som omfattas av en harmoniserad standard:
   – TÜV Rheinland LGA Products GmbH, identifikationsnummer: 0197.
   Utförde provning enligt EN 12050-1 eller EN 12050-2 (SL1.50) under system 3.
   (beskrivning av tredje parts uppgifter såsom de anges i bilaga V)
   – Certifikat nummer: LGA-certifikat nr 7381115. Typprovad och övervakad.
8. EJ TILLÄMPLIGT.
9. Angiven prestanda:
   Produkterna som omfattas av denna prestandadeklaration överensstämmer med de väsentliga egenskaperna och prestandakraven i följande:
   – Tillämpade standarder: EN 12050-1:2001 eller EN 12050-2:2000 (SL1.50).
10. Prestandan för den produkt som anges i punkterna 1 och 2 överensstämmer med den prestanda som anges i punkt 9.

TR:

305/2011 sayılı AB Yönetmeliği Ek III'e uygun olarak performans beyanı
(İnşaat Ürünü Yönetmeliği)

1. Ürün tipi özel tanımlama kodu:
   – EN 12050-1 veya EN 12050-2 (SL1.50).
2. Gereken şekil inşaat ürününün Madde 11(4)'e göre tanımlanmasına izin veren tip, parti, seri numarası veya başka bir öğe:
   – Etiketinde EN 12050-1 veya EN 12050-2 (SL1.50) ifadesi yer alan SL1, SLV pompaları.
3. Üretici tarafından öngörülen biçimde ilgili uyumlu teknik özelliklere uygun olarak inşaat ürününün amaçlanan kullanımı ve kullanımları:
   – Dışkı içeren atık suların pompalanmasına yönelik, etiketinde EN 12050-1 bilgisi bulunan pompalar.
   – Dışkı içermeyen atık suların pompalanmasına yönelik, etiketinde EN 12050-2 bilgisi bulunan SL1.50 pompalar.
4. Madde 11(5)'e göre gereken şekilde üreticinin adı, tescilli ticari adı veya tescilli ticari markası ve iletişim adresi:
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Danimarka.
5. İLGİLİ DEĞİL.
6. Ek V'te belirtilen şekilde inşaat ürününün performansının tutarlılığının değerlendirilmesi ve doğrulanmasına yönelik sistem veya sistemler:
   – Sistem 3.
7. Uyumlu bir standart kapsamındaki bir inşaat ürünüyle ilgili performans beyanı durumunda:
   – TÜV Rheinland LGA Products GmbH, tanımlama numarası: 0197. EN 12050-1 veya EN 12050-2 (SL1.50)'e göre sistem 3 altında gerçekleştirilen test.
   (Ek V'te belirtilen şekilde üçüncü taraf işlemlerin açıklaması)
   – Sertifika numarası: LGA Sertifika No. 7381115. Tip test edilmiş ve izlenmiştir.
8. İLGİLİ DEĞİL.
9. Beyan edilen performans:
   Bu performans beyanı kapsamına giren ürünler, aşağıda belirtilen şekilde temel özelliklere ve performans gereksinimlerine uygundur:
   – Kullanılan standartlar: EN 12050-1:2001 veya EN 12050-2:2000 (SL1.50).
10. 1. ve 2. noktalarda belirtilen ürünün performansı, 9. noktada beyan edilen performansa uygundur.

CN:

根據法規 (EU) 第 305/2011 號附錄 III 之 EU 性能聲明
(營建產品法規)

1. 產品型式之唯一識別碼
   – EN 12050-1 或 EN 12050-2 (SL1.50)。
2. 根據第 11 (4) 條規定之型式、批次或序號，或任何其他可識別營建產品的元素：
   – SL1, SLV 泵浦於銘牌上標註 EN 12050-1 或 EN 12050-2 (SL1.50)。
3. 依照可適用之調合技術規格，如製造商所預期的目的性使用或使用於營建產品：
   – 用於抽取內含排泄物之廢水的泵浦，於銘牌上標註 EN 12050-1。
   – 用於抽取不含排泄物之廢水的泵浦，於銘牌上標註 EN 12050-2 (SL1.50)。
4. 根據第 11 (5) 條規定之製造商的名稱、註冊商號或註冊商標及聯絡地址：
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   丹麥。
5. 不相關。
6. 附錄 V 制定之營建產品性能穩定性評估與驗證系統：
   – 系統 3。
7. 若性能聲明與調和標準涵蓋之營建產品相關：
   – TÜV Rheinland LGA 產品 GmbH，識別號：0197.
   根據 EN 12050-1 或 EN 12050-2 (SL1.50) 以系統 3 進行的測試。
   (附錄 V 制定之第三方工作說明)
   – 證書號碼：LGA 證書號碼 7381115。型式測試與監測。
8. 不相關。
9. 聲明之性能：
   本性能聲明涵蓋之產品符合如下所述之基本特性及性能需求：
   – 採用之標準：EN 12050-1:2001 或 EN 12050-2:2000 (SL1.50)。
10. 於第 1 點與第 2 點識別之產品性能符合第 9 點所述之性能聲明。

VI:

Công bố của EC về đặc tính hoạt động theo Phụ lục III của Quy định (EU) Số 305/2011 (Quy Định Sản Phẩm Xây Dựng)

1. Mã nhận dạng riêng của loại sản phẩm:
   – EN 12050-1 hoặc EN 12050-2 (SL1.50).
2. Loại, lô hoặc số sêri hoặc bất kỳ yếu tố khác cho phép nhận dạng sản phẩm xây dựng chiếu theo yêu cầu trong Điều 11(4):
   – Bơm SL1, SLV được đánh dấu là EN 12050-1 hoặc EN 12050-2 (SL1.50) trên tấm nhãn.
3. Việc sử dụng hay dự tính sử dụng sản phẩm, tương ứng với ứng dụng phù hợp theo đặc điểm kỹ thuật, như dự kiến của nhà sản xuất:
   – Bơm để bơm nước thải có chứa phân được đánh dấu là EN 12050-1 trên tấm nhãn.
   – Bơm SL1.50 để bơm nước thải không chứa phân được đánh dấu là EN 12050-2 trên tấm nhãn.
4. Tên, tên thương mại đã đăng ký hoặc thương hiệu đã đăng ký và địa chỉ liên lạc của nhà sản xuất chiếu theo yêu cầu trong Điều 11(5):
   – Grundfos Holding A/S
   Poul Due Jensens Vej 7
   8850 Bjerringbro
   Đan Mạch.
5. KHÔNG LIÊN QUAN.
6. Hệ thống hoặc các hệ thống đánh giá và thẩm tra sự ổn định của đặc tính hoạt động của sản phẩm quy định tại Phụ lục V:
   – Hệ thống 3.
7. Trong trường hợp bản công bố đặc tính hoạt động liên quan đến một sản phẩm xây dựng được bao gồm bởi một tiêu chuẩn hài hòa:
   – TÜV Rheinland LGA Products GmbH, số nhận diện: 0197.
   Thực hiện kiểm tra theo tiêu chuẩn EN 12050-1 hoặc EN 12050-2 (SL1.50) theo hệ thống 3.
   (mô tả những nhiệm vụ của bên thứ ba như quy định tại Phụ lục V)
   – Giấy chứng nhận số: Giấy chứng nhận LGA Số 7381115. Được kiểm tra mẫu và được theo dõi.
8. KHÔNG LIÊN QUAN.
9. Đặc tính hoạt động đã công bố:
   Các sản phẩm được bao gồm trong bản công bố đặc tính hoạt động này phù hợp với các đặc điểm thiết yếu và các yêu cầu đặc tính hoạt động được mô tả trong các tài liệu sau:
   – Tiêu chuẩn được sử dụng: EN 12050-1:2001 hoặc EN 12050-2:2000 (SL1.50).
10. Đặc tính của sản phẩm được xác định trong mục 1 và 2 phù hợp với đặc tính hoạt động đã công bố tại mục 9.

EU declaration of performance reference number: 96771279.

Székesfehérvár, 15th of February 2016

Kis Róbert

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Addresses Revised 25.01.2016

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ECM: 1179710

APPENDIX C

Resource Consent [105684]

Resource Consent Index

C1 – Resource Consent No. 105684 [Discharge Permit: Discharge to Land]

Summary of Resource Consent 105684

Department of Conservation (DOC) Discharge Permit No. 105684 [To authorise the discharge of treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu]

- Expiry Date: 31 December 2014
- Map reference: NZMS260 S19:296-201
  NZTopo50 BH34:196-585
- Address for activity: Whakapapa Village, State Highway 48, Mount Ruapehu

- Discharge up to 700 cubic metres per day (700 m^3/day) of UV treated wastewater to land via drip irrigation at a rate of 3.5 litres per hour (3.5 L/hr) over a total land disposal area of 2.96 hectares.
- The average annual discharge of wastewater into and onto land shall not exceed 170 cubic metres per day (170 m^3/day).
- Discharge up to 12,000 cubic metres per year of wastewater and stormwater from the emergency overflow pond (old oxidation pond) into land via a series of ground soakage trenches;
- Discharge contaminants into land through the base and sides of the unlined emergency overflow pond;
- The discharge of treated wastewater to land via subsurface irrigation shall not exceed a hydraulic loading rate of 1litre per hour per square metre of land (1 L/hr/m^2).
- The discharges into and onto land authorised by this consent shall comply with the
- following separation distances:
  - 20 metres from bores, surface water bodies and/or artificial watercourses; and
  - 20 metres from any residential buildings, public places and amenity areas where people congregate, education facilities and public roads.

- The WWTP shall be operated in a manner that "***shall not cause any objectionable odour to the extent where it causes an adverse effect beyond the bounds of the wastewater treatment plant*** *and land disposal area site.*"

Recording and Monitoring requirements:

- Daily:
  - Volume entering the wastewater treatment plant and
  - Volumes discharged to land via subsurface irrigation/wetland
  - Record the volume and treatment level; of wastewater entering the tertiary treated lagoon and infiltration trenches/wetland

- Monthly:
  - sample of the tertiary treated wastewater in the 'wet well'
  - collect an instream sample both upstream and downstream of the wastewater treatment plant in the unnamed tributary of the Wairere Stream and in the Wairere Stream and analyse for the following:
    - pH
    - Dissolved Oxygen;
    - Dissolved Carbonaceous BOD5;
    - Total Suspended Solids;
    - Dissolved Reactive Phosphorus;
    - Dissolved inorganic nitrogen (i.e. sum of nitrate, nitrite and ammoniacal nitrogen);
    - Total ammoniacal nitrogen; and

        - E-coli
- Yearly (between August and October):
    - Macro-invertebrate sampling

- Seasonally (only 2012 and 2013):
    - Assessment of the percentage cover, biomass, chlorophyll a, AFDW and community composition of periphyton, filamentous algae and cyanobacterial mats in riffle habitat

RECEIVED

1 9 JAN 2012

Department of Conservation
Ruapehu Area Office
Tongariro Taupo Conservancy

horizons
regional council

Private Bag 11025
Manawatu Mail Centre
Palmerston North 4442

P 06 952 2800
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17 January 2012

Department of Conservation
P O Box 71029
MT RUAPHEU 3951

File ref: 7/5/DOC
MET:MET

Attention Mere Mokoraka

Dear Mere

DECISION – RESOURCE CONSENT NO. 105684 – DISCHARGE PERMIT – WHAKAPAPA VILLAGE, STATE HIGHWAY 48, MOUNT REUAPEHU

We are pleased to advise that your resource consent application has been granted. The decision is enclosed and because it is a legal document we urge you to keep it in a safe place.

Please find enclosed for your convenience a plain copy of your consent conditions for ease of reference. Please make sure you read and understand the consent conditions. As a resource consent holder you are responsible for complying with these conditions. Failure to do so will result in enforcement action.

Rights of Objection
Under to section 357A of the Resource Management 1991 (RMA), the applicant has the right to object to the decision made, including conditions. Any such objection must be made in writing to Horizons Regional Council, outlining the reasons for the objection and must be made within 15 working days from the decision.

Compliance Monitoring
In accordance with Regional Council policy, staff from our Environmental Protection Team will monitor your resource consent, to ensure that you are complying with the consent conditions. The Environmental Protection Team can be contacted during normal office hours on freephone 0508 800 800.

On-going Charges
The Regional Council sets fees for the monitoring of resource consents, which are reviewed annually and presented in the Long Term Council Community Plan (LTCCP). As the consent holder you are responsible for payment of these fees over the lifetime of your consent.

Annual charges for the cost of research associated with the resources used or impacted upon by your activity will also be invoiced to you. These annual charges are also set annually and presented in the LTCCP.

Transfer of your Consent
Please be aware that if the property to which your consent relates is sold you will need to transfer this consent to the new owner(s). There is no cost involved. A transfer form, which must be completed by both the current and future owner, can be obtained from Horizons Regional Council, by contacting the Consents Team or from our website www.horizons.govt.nz.

horizons
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Change of Contact Details
If at any time your contact details change (eg postal address, telephone numbers (landline, fax or mobile) and/or email address), please advise the Regional Council in writing so that we can update our records.

Surrender of your Consent
If you no longer undertake the activity authorised by your resource consent you can surrender your consent by confirming so in writing.

Expiry
Your consent will expire on 1 December 2014.

Customer Survey
Please also find attached our customer survey. We appreciate you taking the time to complete this survey and we have attached a self addressed envelope for ease of return. Your thoughts and comments on the consent process are a valued source of on-going feedback and improvement.

If you are uncertain about any aspects of the consent or your rights of appeal please do not hesitate to call us.

Yours sincerely

Michelle Tucker
CONSENTS ADMINISTRATOR

Encls Decision and consent conditions
Customer survey form and self addressed envelope

File Ref: 7/5/DOC
LMS:MET

Discharge Permit - 105684

CONSENT GRANTED

To

Department of Conservation

To

discharge treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu

SUBJECT TO THE ATTACHED CONSENT CONDITIONS

Location

Address for activity:	Whakapapa Village, State Highway 48, Mount Ruapehu
Legal description:	Tongariro National Park
Valuation number:	06090/176/01
Map reference:	NZMS260 S19:296-201 NZTopo50 BH34:196-585

Details of Resource Consent

Granted:	11 January 2012
Expiry:	1 December 2014
Review:	July 2012 and 2013
Replacing consent number:	101961
Effluent / Contaminant:	treated wastewater
Maximum rate of discharge:	700 cubic metres per day (700 m^3/day)

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DECISION ON AN APPLICATION FOR A NON-NOTIFIED DISCHARGE PERMIT (TO LAND) UNDER THE RESOURCE MANAGEMENT ACT 1991

CONSENT HOLDER
Department of Conservation
Whakapapa Village
P O Box 71029
MOUNT RUAPEHU 3951

DECISION DATE 11 January 2012	**FILE REFERENCE** 7/5/DOC
CONSENT NUMBER 105684	**CONSENT TYPE** Discharge Permit (discharge to land)
ADDRESS FOR ACTIVITY Whakapapa Village, State Highway 48, Mount Ruapehu	**MAP REFERENCE** NZMS260 S19:296-201 NZTopo50 BH34:196-585
LEGAL DESCRIPTION Tongariro National Park	**VALUATION NUMBER** 06090/176/01
CONSENT PLANNER Leana Shirley	

1. BACKGROUND

Department of Conservation (DOC) were issued a consent in October 2002 to discharge tertiary treated wastewater to land (consent number 101961). The Whakapapa Wastewater Treatment Plant upgrade had not been completed at the time of granting the consent and so the applicant was also issued resource consent to discharge wastewater to water for a period of 3 years (consent number 101960). The wastewater treatment plant upgrade was carried out and completed in 2004.

On 10 September 2003, DOC applied for a variation to change consent conditions 6 and 7 of consent 101961 to account for changes to the system design (use of the oxidation pond for overflows), the additional volume of wastewater needing to be applied to land and the increased rate of discharge to land. Throughout the process, the applicant advised of other operation issues they had experienced and needed to address through the variation application. This application was never resolved as it was determined in 2010 that the application was outside the scope of original consented activity and therefore it was not appropriate to consider the application under section 127 of the Resource Management Act.

On 18 February 2011, DOC applied for a new consent to discharge treated wastewater to land. This application was amended via letter on 29 July 2011.

2. APPLICATION

On 18 February 2011, an application was received from, Department of Conservation; to discharge UV treated wastewater to land. The application details were as follows:

- Discharge up to 12,000 cubic metres per year of wastewater and stormwater from the emergency overflow pond (old oxidation pond) into land via a series of ground soakage trenches;
- Discharge contaminants into land through the base and sides of the unlined emergency overflow pond; and
- Discharge up to 700 cubic metres per day (700 m^3/day) of UV treated wastewater to land via drip irrigation at a rate of 3.5 litres per hour (3.5 L/hr) over a total land disposal area of 2.96 hectares.

On 29 July 2011, a letter amending the application was received requesting the applicant be issued a short term consent for three years to continue to discharge wastewater to land as follows:

- Discharge up to 700 cubic metres per day of treated wastewater to land during storm events and peak flow (winter);
- Discharge an annual average of 170 cubic metres per day of treated wastewater to land;
- Discharge to land via drip-line irrigation at a rate of 3.5 L/hr to a 2.96 hectare disposal field; and
- Discharge tertiary treated wastewater to the unlined emergency overflow pond and then to ground soakage via three existing ground soakage trenches.

The applicant amended the application after a meeting with Manawatu-Wanganui Regional Council staff highlighted potential issues relating to nutrient loading and the long term sustainability of the discharge activity. The applicant has proposed to undertake investigations into stormwater removal, nutrient loading, land disposal, plant performance and undertake intensive monitoring over the next 12 months. DOC then intends to use the information gathered to determine what level of treatment / additional infrastructure is required to ensure the effects of the discharge are minor.

The applicant has sought a term of 3 years for this resource consent.

This application was lodged to replace resource consent 101961 which expires on 18 September 2022.

3. THE SITE

The discharge occurs within Tongariro National Park which is administered by Department of Conservation. The Whakapapa Wastewater Treatment Plant site comprises of a total of 5.2 hectares. The discharge to land occurs through buried dripper lines situated on the old airstrip and tundra sites east of the Chateau golf course.

The site falls within the Cherry Grove (Whai_2) Water Management Zone and the Upper Whakapapa (Whai_2b) Water Management Sub-Zone.

4. PLANNING ASSESSMENT

The application has been assessed against the following statutory documents.

4.1 Land and Water Regional Plan (2003)

The discharge of treated wastewater to land from a wastewater treatment plant falls for consideration as a Discretionary Activity under DL Rule 13 of the Land and Water Regional Plan (2003).

4.2 Proposed One Plan (2010)

The discharge of treated wastewater into and on land is considered to be a Discretionary Activity under POP Rule 13-27 of the Proposed One Plan (2011) as it is unable to comply with the performance criteria of POP Rule 13-25. Specifically the discharge contains sewage and exceeds 50 cubic metres per day (50 m^3/day).

4.3 Overall Assessment Based on Regional Plans

The proposal has been assessed as a Discretionary Activity under the Land and Water Regional Plan and the Proposed One Plan (2010).

5. EVALUATION

5.1 Section 104

Section 104(1) of the Resource Management Act 1991 outlines the matters that the consent authority is to have regard to when considering applications for resource consent, subject to Part II of the Resource Management Act. I have assessed the application under these matters. Note that only the relevant sections, or parts of sections of statutory documents as applicable to this resource consent have been assessed in this report.

5.1.2 Environmental Effects

This application and subsequent amendments have been assessed with regard to the actual and potential adverse environmental effects by Harold Barnett, Manawatu-Wanganui Regional Council's Environmental Scientist.

Discussion
This proposal has the potential to result in adverse environmental effects on soil, groundwater and surface water quality. Below is an assessment of effects on these aspects.

Given the volume of wastewater initially proposed to be discharged and the land application area available, it was determined that the nutrient loading and hydraulic loading would potentially have more than minor effects. High hydraulic loadings are suspected to come from large stormwater inflows entering the wastewater reticulation following large storm events coinciding with the peak 'holiday' ski season. Nutrient loading, calculated from information provided in the initial application (dated February 2011) showed the loading on the land application area to be up to 667 kg N/ha/yr during peak flow. This loading rate is much higher than the limits specified in the Land and Water Regional Plan and Proposed One Plan and the effects of discharging at the above loading would potentially have more than minor effects on the soil quality, groundwater resource and adjoining surface water resource.

Given the sensitive nature of the receiving environment, a meeting was held between Horizons staff and the applicant to discuss Horizons' concerns regarding the application. Discussions at the meeting highlighted that there is limited information available on the treatment plant's performance and quality of wastewater being discharged. Following this meeting, the applicant formally amended the application to request a short term to allow for the necessary monitoring and investigations to be carried out and decisions to be made on appropriate upgrades and treatment measures to ensure the effects of the discharge in the long term are no more than minor.

The applicant has indicated that the focus of the investigation and remedial actions over the next 3 years will be to address hydraulic loads and concentration of nitrogen. This will involve improving plant performance (reduction in nitrogen, suspended solids and BoD_5) and also reducing the hydraulic loading through addressing key elements such as stormwater infiltration. Addressing these aspects will be critical elements behind ensuring the actual and potential effects of the discharge activity are no more than minor. The applicant provided a suite of suggested conditions as mitigation in combination with standard discharge conditions for the on going discharge to land under the current regime for three years.

Mitigation / conditions
In addition to the conditions proposed by the applicant, conditions addressing the following matters have been imposed to mitigate effects over the duration of this consent:

- Development and implementation of an Operation and Management Plan for the treatment plant and land application activities;
- Provision of an Annual Monitoring Report which covers all monitoring and an assessment of the results against consent conditions to be submitted by 1 March each year of the consent;
- Monitoring conditions, to monitor surface water quality to determine / provide more certainty on the level of effect the discharge is having on the nearby streams; and
- Soil monitoring conditions to determine / provide more certainty on the level of effect the discharge is having on soil quality.

Conclusion
The proposal put forward in the initial application was discovered to have adverse effects that may be more than minor due to plant performance, hydraulic loading and nutrient (nitrogen) loading. The applicant has proposed to operate as they currently do for a maximum of three years, while undertaking the necessary investigations and monitoring to determine how the plant should be operated and whether any upgrades or additional treatment are required. While the current discharge may have potential adverse effects over the duration of this consent, I am satisfied that the mitigation proposed by the applicant combined with the conditions imposed and the short term will mean that the overall adverse effects are sufficiently mitigated.

5.2 Objectives and Policies

The following identifies the relevant objectives and policies of both operative and proposed Regional Policy Statements and Regional Plans

5.2.1. Regional Policy Statement

Operative Regional Policy Statement

Objective 12 seeks to maintain the life supporting capacity of the streams and rivers.

Objective 13 seeks to maintain and improve the groundwater quality.

Policies 13.1 and 13.2 seek to prevent discharges to land where there will be a significant adverse effect on the quality of the groundwater and the potential users of the groundwater for domestic water supplies.

It is considered that the land discharge can be sufficiently managed to ensure the discharge of effluent to land will mitigate the potential effects on the surface and ground water. In addition, this application is for a short term consent (3 years) while monitoring and investigations into the operation of the plant and potential upgrades are undertaken. Therefore it is considered that this application is consistent with the objectives and policies of the Regional Policy Statement.

Proposed Regional Policy Statement (2010 version)
Objective 6-2 relates to water quality and seeks to maintain the existing groundwater quality or improve it where degraded.

Policy 6–2 relates to the maintenance of groundwater quality and requires management of land use activities to maintain the quality with the exception being when discharge to land being a better option, achieves the purpose of the RMA than discharge to water.

In this case, it is considered the application of wastewater can be managed to mitigate the potential effects on water quality. Given the sensitive receiving environment of the location of this activity, discharge to land is considered to be a better option than discharging to water in achieving the purpose of the RMA. As such it is considered that the application to discharge treated wastewater to land is consistent with the objectives and policies of the proposed Regional Policy Statement.

5.2.2 Land and Water Regional Plan (2003)

DL Objective 1 and 2 seeks to improve the groundwater quality and reduce nutrient leachate.

DL Policy 2 identified matters that need to be considered for resource consent applications.

DL Policy relates to restrictions around nitrogen loadings from wastewater discharges. The proposed discharge is for a short term (3 years) and a condition of consent will require the applicant to manage the discharge to mitigate the effects of nitrogen loading over the term of the consent.

The proposed discharge via dripper tubes consists of tertiary treated wastewater and the discharge from the old oxidation pond is secondary treated. The wastewater will be managed to ensure the discharge is evenly spread over the land to minimise any effect.

The application is therefore considered that the proposal is not contrary to the objectives and policies of the Land and Water Regional Plan.

5.2.3 Proposed One Plan as Amended by Decisions (2010)

Objective 13–1 relates to the discharges to land and water and requires any discharges that may enter water to have regard to the values associated with the water body and to avoid any adverse effects on that water body.

Policies 13-2 and 13-2B note the matters the Regional Council must have regard to when considering an application to discharge to land. The Regional Council must also consider alternative discharge options and the best practicable option available.

In this case, the discharge will need to be managed to ensure there is no surface runoff into both the Wairere Stream and its unnamed tributary. The consent is for a short term while the applicant monitors and investigates suitable treatment and plant management options. Therefore it is considered that the proposal is not inconsistent with the objectives and policies of the Proposed One Plan.

Overall Conclusion
After considering all of the relevant objectives and policies of both the operative and proposed Regional Plans, I consider that the proposed activity is consistent with the relevant Objectives and Policies.

5.3 Section 105

This consent is considered to be for a short term, while monitoring and investigations into proposed upgrades occur. However while the discharge is monitored and treatment is investigated, the current discharge will need to continue and as such it is considered that the discharge to land is the most practicable option while developing a longer term solution.

Having considered alternatives to this discharge and in particular alternative receiving environments, I was satisfied that the proposed discharge method was the most appropriate method of wastewater disposal for this site.

5.4 Section 107

Section 107 of the Resource Management Act specifies that a consent authority shall not grant a discharge permit to do something that would otherwise contravene section 15 if, after reasonable mixing the contaminant or water discharged, is likely to give rise to all or any of the following effects in the receiving waters:

(a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
(b) Any conspicuous change in the colour or visual clarity;
(c) Any emission of objectionable odour;
(d) The rendering of fresh water unsuitable for consumption by farm animals; and
(e) Any significant adverse effects on aquatic life.

This application is for a discharge of treated wastewater to land. There is potential for the discharge to reach water either via ground soakage or run-off. However, based on the level of treatment, the nature of the discharge (i.e. to land) and the management of the activity, I am comfortable that the discharge will not give rise to any of the above effects.

Having considered section 107, I am satisfied that the proposed discharge in its current form is consistent with the provisions of this section.

5.5 Part 2 of the Resource Management Act 1991

Part 2 of the Resource Management Act 1991 RMA includes the purpose and principles of the RMA, matters of national importance and other matters.

The proposal is considered to be consistent with the purpose and principles of the RMA as the wastewater treatment facility will provide for the development of community infrastructure to provide social, economic and cultural wellbeing whilst ensuring there adverse effects on the life supporting capacity of air, water, soil and ecosystems are sufficiently mitigated. The actual and potential effects are considered to be remedied by the short duration of consent, management of the facility and mitigated by appropriate conditions.

6. CONSENT DURATION

The Regional Policy Statement Objective 34 and Policy 34.2 allows for the duration of the consent to be considered on the merits of the application and has a number of factors that can be considered when determining the duration of a consent.

Policy 11A-5 of the POP (2010) states that consent expiry dates shall be set to the date sought by the applicant unless there are reasons that make this inappropriate. This policy also notes that consents shall be set to a common catchment expiry date identified within the POP.

The applicant has sought a term of 3 years for this consent. This term is considered appropriate and will therefore be included in the decision.

7. RECOMMENDATION

I recommend that the resource consent application by Department of Conservation for a Discretionary Activity to discharge treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu be granted for a term of 3 years expiring on 1 December 2014 pursuant to sections 104, 104B, 105, 107 and 108 of the Resource Management Act 1991 for the following reasons:

- the activity has been assessed by Manawatu-Wanganui Regional Council's Environmental Scientist. Based on this assessment I am satisfied the actual and potential effects of the proposal are sufficiently mitigated;
- the activity is not contrary to any relevant Objectives or Policies; and
- the activity is consistent with the purpose and principles of the Resource Management Act 1991.

And subject to the following conditions:

General

1. The consent holder shall undertake the activity in general accordance with the consent application and its associated plans and documents first lodged with Manawatu-Wanganui Regional Council on 18 February 2011, and further information received on:

   a. 29 July 2011 via letter, being an amendment to the requested consent term and proposed activity.

   Where there may be contradiction or inconsistencies between the application and further information provided by the applicant, the most recent information applies. In addition, where there may be inconsistencies between information provided by the applicant and conditions of the resource consent, the conditions of the resource consent apply.

   Advice Note: Any change from the location, design concepts and parameters, implementation and/or operation may require a new resource consent or a change of consent conditions pursuant to section 127 of the Resource Management Act 1991.

2. The activities authorised by this discharge permit shall be restricted to:

   a. discharge of treated wastewater via subsurface dripper tubes to an area of land no less than 2.96 hectares; and

b. the discharge of treated wastewater into land via a series of three infiltration trenches; and
c. the discharge of treated wastewater to land through the base and sides of the unlined emergency overflow pond

on land being legally described as Tongariro National Park at approximate map reference NZMS260 S19:296-201 / NZTopo50 BH34:196-585 as shown on the attached plan (Plan C105684A) attached to and forming part of this consent.

Land discharge restrictions

3. The maximum volume of treated wastewater (hereafter referred to as wastewater) authorised to be discharged into and onto land via subsurface dripper tubes and ground soakage (trenches) shall not exceed 700 cubic metres per day (700 m^3/day).

4. Subject to Condition 3, the average annual discharge of wastewater into and onto land shall not exceed 170 cubic metres per day (170 m^3/day).

5. The discharge of treated wastewater to land via subsurface irrigation shall not exceed a hydraulic loading rate of 1litre per hour per square metre of land (1 L/hr/m^2).

6. The consent holder shall ensure that only secondary or tertiary treated wastewater is discharged into the emergency overflow pond (old oxidation pond) when required during high flow (storm) events.

7. By **30 June 2014** the consent holder shall cease discharging treated wastewater from the emergency overflow pond (old oxidation pond) and all wastewater shall be discharged via the subsurface land application system.

8. The discharges into and onto land authorised by this consent shall comply with the following separation distances:

   a. 20 metres from bores, surface waterbodies and/or artificial watercourses; and
   b. 20 metres from any residential buildings, public places and amenity areas where people congregate, education facilities and public roads.

   Advice note: Condition 8 applies to both the discharges to land via subsurface irrigation and the discharge via infiltration trenches.

Odour

9. The activities authorised by this consent shall not cause any objectionable odour to the extent where it causes an adverse effect beyond the bounds of the wastewater treatment plant and land disposal area site.

   Advice note: Odour will only be considered objectionable, after a Manawatu-Wanganui Regional Council officer has considered the Frequency, Intensity, Duration, Offensiveness and Location of the odour (FIDOL factors).

Operation and Maintenance Plan

10. By **30 April 2012**, the consent holder shall update the existing Operation and Maintenance Plan (titled *Whakapapa Wastewater Treatment Plant Operations Manual,*

June 2006) and submit the updated Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager. The plan shall include but not be limited to:

a. A description of the entire treatment and disposal facilities including plans showing the buildings, treatment facilities, distribution lines for land disposal and infiltration trenches;
b. A description of the routine inspection and maintenance procedures to be undertaken at the treatment plant (i.e. the buffer pond, sedimentation basins, oxidation pond, filtration unit and UV sterilisation) and wastewater disposal area and procedures for the recording of all maintenance and repairs undertaken;
c. Procedure(s) for the managing, recording and reporting of daily wastewater applications (rates and volumes) to the disposal area;
d. An outline of the procedure for monitoring volumes and quality of wastewater inflow into the treatment plant and outflow to land disposal
e. A description of how the irrigation (sub-surface dripper tube and infiltration trench) systems will be operated and managed;
f. A description of the procedure(s) for the management of activated sludge and biosolids generated at the wastewater treatment plant including the dewatering and offsite disposal measures;
g. Details on the frequency that the irrigation lines are flushed to prevent/minimise blockages and ensure wastewater is irrigated evenly;
h. The management of odour from activities at the treatment plant;
i. A description of procedures for the management of unforeseen emergency situations such as failures of pumps and mechanical parts at the plant, blockages in the reticulation system, pipeline ruptures and power outages;
j. The maintenance of a daily weather register to record daily rainfall and wind direction;
k. a list of names of appropriate contact people in the event of system malfunction, including contact telephone numbers; and
l. the keeping of a complaints register to record any complaints received with regard to wastewater collection, reticulation, treatment and disposal (i.e. date, time, complainant, nature of complaint, what was done about it or what went wrong, who repaired it and how.

11. Should alterations to the Maintenance and Operations Plan be made as a result of changes to the treatment plant, land application area and/or wastewater scheme, the consent holder shall submit a revised copy of the Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager by **1 June** of each year.

12. The consent holder shall ensure that the wastewater treatment plant is operated in accordance with the Operation and Maintenance Plan at all times.

Recording

13. **By 1 March 2012,** the consent holder shall install and maintain, in a fully operational condition, flow meter(s) at the Wastewater Treatment Plant to accurately measure the volume of wastewater entering the plant and exiting the plant. The flow meters shall have a pulse counter output traceably calibrated to +/- 5 % or better.

14. The consent holder shall monitor the flow meters to keep an accurate record of the daily volumes entering the wastewater treatment plant and the volumes discharged to land via subsurface irrigation under this consent.

15. The consent holder shall keep an accurate daily record of the volume and treatment level of wastewater entering the emergency overflow pond and infiltration trenches. If no wastewater is discharged to the pond or trenches on any day, a 'nil' measurement shall be recorded.

Advice note: To achieve compliance with conditions 14 and 15 the consent may need to install an additional flow meter at the outlet of the irrigation field pressure pump.

16. A copy of the records required by Conditions 14 and 15 shall be forwarded to Manawatu-Wanganui Regional Councils Environmental Protection Manager by **31 May** each year in the Annual monitoring report required by Condition 30 or upon request.

Monitoring Programme

Wastewater and water quality sampling

17. Commencing **1 January 2012**, the consent holder shall collect a monthly sample of the tertiary treated wastewater in the 'wet well' (after wastewater has been through UV treatment) prior to the wastewater being discharged to land. Monthly wastewater sampling shall continue until **1 January 2014**.

18. Commencing **1 January 2012**, the consent holder shall collect a monthly instream sample both upstream and downstream of the wastewater treatment plant in the unnamed tributary of the Wairere Stream and in the Wairere Stream at the sites below as shown on Plan C105684B attached to and forming part of this consent. Monthly stream sampling shall continue until **1 January 2014**.

19. The wastewater and instream sampling required by conditions 17 and 18 shall be analysed for the following:

    a. pH;
    b. Dissolved Oxygen;
    c. Dissolved Carbonaceous BOD_5;
    d. Total Suspended Solids;
    e. Dissolved Reactive Phosphorus;
    f. Dissolved inorganic nitrogen (i.e. sum of nitrate, nitrite and ammoniacal nitrogen);
    g. Total ammoniacal nitrogen; and
    h. Ecoli.

20. All wastewater sample analysis required by conditions of this consent shall be undertaken by an independent laboratory accredited to IANZ.

Macro-invertebrate sampling (water quality sampling)

21. Commencing **August 2012,** the consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake macro-invertebrate sampling once between the months August to October (winter/spring) each year of this consent in both the unnamed tributary of the Wairere Stream and the Wairere Stream.

22. The macro-invertebrate sampling required by Condition 21 shall be undertaken following a period of at least three weeks without a significant flood event as an instantaneous river flow exceeding 9.063 m^3/second as recorded at the Whakapapa at Footbridge flow recording site operated by Genesis Energy). .

Advice note: Flow information at this site can be found visiting the Genesis Energy website http://www.genesisenergy.co.nz under the rivers, lakes and rainfall tab.

23. The macroinvertebrate sampling required by Condition 21 shall be undertaken at the following sites as shown on Plan C105684B:

    a. Unnamed Tributary of the Wairere Stream upstream of the Whakapapa Village Wastewater Treatment Plant (point 1 on Plan C105864B);
    b. Unnamed tributary of the Wairere Stream downstream of the Whakapapa Village Wastewater Treatment Plan (point 2 on Plan C105864B);
    c. Wairere Stream downstream of the unnamed tributary confluence (point 3 on Plan C105864B); and
    d. Wairere Stream upstream of the Whakapapa Village Wastewater Treatment Plant (point 4 on Plan C105684B).

24. The macro-invertebrate sampling required by Condition 21 shall follow Protocols C3 (hard bottomed quantitative), P3 (full count with subsampling option) and QC3 (Quality control for full count with subsampling option) from the Ministry for the Environment's *"Protocols for sampling macro-invertebrates in wadeable streams"* (Stark et al. 2001). Sampling shall involve:

    a. Collection of 5 replicate 0.1 m^2 Surber samples at random with a 20 m section of riffle habitat at each sampling site;
    b. Full count of the macro-invertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macro-invertebrate Community Index (MCI); and
    c. Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT individuals.

Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 21-24 can be implemented.

Periphyton and algae sampling (water quality sampling)

25. The consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake an assessment of the percentage cover, biomass, chlorophyll a, AFDW and community composition of periphyton, filamentous algae and cyanobacterial mats in riffle habitat as close as possible to the sites selected under condition 23.

26. The periphyton and algae assessment shall be undertaken seasonally, once during the months; February, May, August and October regardless of flow during the first two years of this consent (2012 and 2013). The periphyton and algae assessment shall include:

    a. A visual assessment of the percentage cover of both filamentous algae and algal mats (to the nearest 5%) at 5 points across each of four transects encompassing run habitat and extending across the width of the stream(s) at each sampling site. The visual monitoring methods shall follow the protocols outlined in Appendix 2 of "*A periphyton monitoring plan for the Manawatu-Wanganui Region*" (Kilroy et al. 2008). Reported estimates shall include:
        i. Percentage cover of visible stream bed by bacterial and/or fungal growths (sewage fungus) visible to the naked eye;
        ii. Percentage cover of visible stream bed by filamentous algae more than 2 cm long;

iii. Percentage cover of visible stream bed by diatoms or cyanobacteria mats more than 0.3 cm thick;
iv. Percentage cover of visible stream bed by diatoms less than 0.3 cm thick; and
v. Percentage cover of visible stream bed that is clean.

b. The collection of periphyton samples at the same established monitoring sites and transects as defined in Condition 26a The periphyton collection methods shall follow the protocols outlined in Appendix 3 of "*A periphyton monitoring plan for the Manawatu-Wanganui Region*" (Kilroy et al. 2008). Analysis of periphyton samples shall also follow the Biggs and Kilroy (2000) guidelines for chlorophyll a analysis.

Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 25-26 can be implemented.

Soil Sampling

27. In the month of **December 2012**, the consent holder shall undertake soil sampling at three separate areas. One sampling area shall be located in the Airport disposal area, one area shall be located in the Tundra disposal area and one are shall be located in an area not subject to wastewater irrigation (as a control area).

28. The consent holder shall take at least 9 cores from each area described in Condition 27 at varying depths as follows:

a. 3 cores at 0-10 cm depth;
b. 3 cores at 10-20 cm depth; and
c. 3 cores at 50-70 cm depth.

29. The soil samples required by Conditions 27 and 28 shall be analysed for the following:

a. pH;
b. phosphorus;
c. potassium;
d. magnesium; and
e. total nitrogen and base saturation.

Annual reporting

30. Annual data records and a report summarising the results for each year ending 1 April shall be forwarded to the Manawatu-Wanganui Regional Council's Environmental Protection Manager by **31 May** of each year of this consent, commencing 31 May 2012 and shall include but not be limited to the following:

a. The results and analysis of wastewater and water quality sampling required by Conditions 17-19;
b. A copy of the Operations and Management Plan and any subsequent updates required by Conditions 10 and 11;
c. A copy of the inflow and outflow records required by Conditions 13 and 14;
d. The results and analysis of macro-invertebrate and periphyton sampling required by conditions 21-26;
e. The results and analysis of soil sampling required by Conditions 27-29;

f. An overall assessment of effects on land and water quality in the receiving environment from the discharges authorised by this resource consent;
g. Details of any upgrades or maintenance already implemented or planned for the following 12 months;
h. Details of investigations into plant performance including inflows, outflows, effluent disposal system and treatment system;
i. Details of any changes to the operation of the plant and/or proposed upgrades resulting from investigations into plant performance and monitoring results; and
j. The records of any complaints received and details of measures undertaken in response to the complaint.

Review

31. The Manawatu-Wanganui Regional Council may, under section 128 of the Act, initiate a review of all conditions of this consent in **July 2012 and 2013,** for the purpose of reviewing the effectiveness of these conditions in avoiding or mitigating any adverse effects on the environment. The review of conditions shall allow for:

a. deletion or amendments to any conditions of this resource consent to ensure adverse effects are appropriately mitigated; or
b. addition of new conditions as necessary, to avoid, remedy or mitigate any unforeseen adverse effects on the environment; or
c. if necessary and appropriate, the adoption of the best practicable options to avoid, remedy or mitigate any adverse effects on the environment.

Leana Shirley
CONSENTS PLANNER

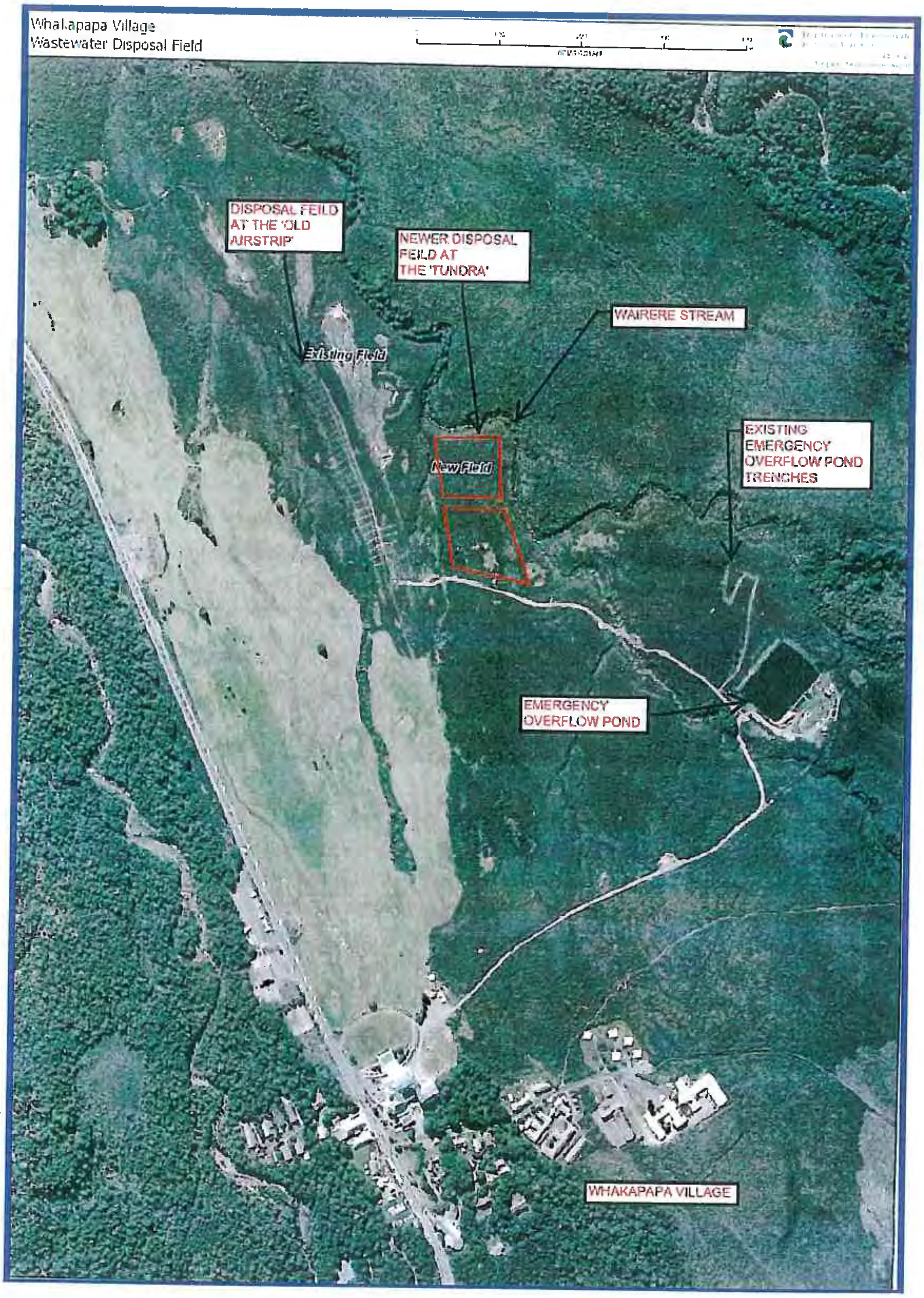
8. DECISION

For the reasons reported above, the Consents Manager of the Manawatu-Wanganui Regional Council (pursuant to delegated authority), grants resource consent by Department of Conservation under sections 104, 104B, 105, 107 and 108 of the Resource Management Act 1991 to discharge treated wastewater into and onto land at Whakapapa Village, State Highway 48, Mount Ruapehu for a term of 3 years expiring on **1 December 2014** and subject to conditions of consent in section 7 of this resource consent.

Phillip Hindrup
ACTING CONSENTS MANAGER

11 January 2012

Figure 7: Aerial plan showing the location of the "EOP', trenches and disposal fields



PLAN C105684A

Prepared by Horizons Regional Council, 2011. Contains Crown Copyright Information.

N

PLAN C105864B

0 20 40 60 80 100 120 140 160 180 200 Metres

Consent Conditions for Discharge Permit 105684
Department of Conservation

General

1. The consent holder shall undertake the activity in general accordance with the consent application and its associated plans and documents first lodged with Manawatu-Wanganui Regional Council on 18 February 2011, and further information received on:

   a. 29 July 2011 via letter, being an amendment to the requested consent term and proposed activity.

   Where there may be contradiction or inconsistencies between the application and further information provided by the applicant, the most recent information applies. In addition, where there may be inconsistencies between information provided by the applicant and conditions of the resource consent, the conditions of the resource consent apply.

   Advice Note: Any change from the location, design concepts and parameters, implementation and/or operation may require a new resource consent or a change of consent conditions pursuant to section 127 of the Resource Management Act 1991.

2. The activities authorised by this discharge permit shall be restricted to:

   a. discharge of treated wastewater via subsurface dripper tubes to an area of land no less than 2.96 hectares; and
   b. the discharge of treated wastewater into land via a series of three infiltration trenches; and
   c. the discharge of treated wastewater to land through the base and sides of the unlined emergency overflow pond

   on land being legally described as Tongariro National Park at approximate map reference NZMS260 S19:296-201 / NZTopo50 BH34:196-585 as shown on the attached plan (Plan C105684A) attached to and forming part of this consent.

Land discharge restrictions

3. The maximum volume of treated wastewater (hereafter referred to as wastewater) authorised to be discharged into and onto land via subsurface dripper tubes and ground soakage (trenches) shall not exceed 700 cubic metres per day (700 m^3/day).

4. Subject to Condition 3, the average annual discharge of wastewater into and onto land shall not exceed 170 cubic metres per day (170 m^3/day).

5. The discharge of treated wastewater to land via subsurface irrigation shall not exceed a hydraulic loading rate of 1litre per hour per square metre of land (1 L/hr/m^2).

6. The consent holder shall ensure that only secondary or tertiary treated wastewater is discharged into the emergency overflow pond (old oxidation pond) when required during high flow (storm) events.

7. By **30 June 2014** the consent holder shall cease discharging treated wastewater from the emergency overflow pond (old oxidation pond) and all wastewater shall be discharged via the subsurface land application system.

8. The discharges into and onto land authorised by this consent shall comply with the following separation distances:

   a. 20 metres from bores, surface waterbodies and/or artificial watercourses; and
   b. 20 metres from any residential buildings, public places and amenity areas where people congregate, education facilities and public roads.

Advice note: Condition 8 applies to both the discharges to land via subsurface irrigation and the discharge via infiltration trenches.

Odour

9. The activities authorised by this consent shall not cause any objectionable odour to the extent where it causes an adverse effect beyond the bounds of the wastewater treatment plant and land disposal area site.

   Advice note: Odour will only be considered objectionable, after a Manawatu-Wanganui Regional Council officer has considered the Frequency, Intensity, Duration, Offensiveness and Location of the odour (FIDOL factors).

Operation and Maintenance Plan

10. By **30 April 2012**, the consent holder shall update the existing Operation and Maintenance Plan (titled *Whakapapa Wastewater Treatment Plant Operations Manual, June 2006*) and submit the updated Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager. The plan shall include but not be limited to:

    a. A description of the entire treatment and disposal facilities including plans showing the buildings, treatment facilities, distribution lines for land disposal and infiltration trenches;
    b. A description of the routine inspection and maintenance procedures to be undertaken at the treatment plant (i.e. the buffer pond, sedimentation basins, oxidation pond, filtration unit and UV sterilisation) and wastewater disposal area and procedures for the recording of all maintenance and repairs undertaken;
    c. Procedure(s) for the managing, recording and reporting of daily wastewater applications (rates and volumes) to the disposal area;
    d. An outline of the procedure for monitoring volumes and quality of wastewater inflow into the treatment plant and outflow to land disposal
    e. A description of how the irrigation (sub-surface dripper tube and infiltration trench) systems will be operated and managed;
    f. A description of the procedure(s) for the management of activated sludge and biosolids generated at the wastewater treatment plant including the dewatering and offsite disposal measures;
    g. Details on the frequency that the irrigation lines are flushed to prevent/minimise blockages and ensure wastewater is irrigated evenly;
    h. The management of odour from activities at the treatment plant;
    i. A description of procedures for the management of unforeseen emergency situations such as failures of pumps and mechanical parts at the plant, blockages in the reticulation system, pipeline ruptures and power outages;
    j. The maintenance of a daily weather register to record daily rainfall and wind direction;
    k. a list of names of appropriate contact people in the event of system malfunction, including contact telephone numbers; and
    l. the keeping of a complaints register to record any complaints received with regard to wastewater collection, reticulation, treatment and disposal (i.e. date, time, complainant, nature of complaint, what was done about it or what went wrong, who repaired it and how.

11. Should alterations to the Maintenance and Operations Plan be made as a result of changes to the treatment plant, land application area and/or wastewater scheme, the consent holder shall submit a revised copy of the Plan to Manawatu-Wanganui Regional Council's Environmental Protection Manager by **1 June** of each year.

12. The consent holder shall ensure that the wastewater treatment plant is operated in accordance with the Operation and Maintenance Plan at all times.

Recording

13. **By 1 March 2012,** the consent holder shall install and maintain, in a fully operational condition, flow meter(s) at the Wastewater Treatment Plant to accurately measure the volume of wastewater entering the plant and exiting the plant. The flow meters shall have a pulse counter output traceably calibrated to +/- 5 % or better.

14. The consent holder shall monitor the flow meters to keep an accurate record of the daily volumes entering the wastewater treatment plant and the volumes discharged to land via subsurface irrigation under this consent.

15. The consent holder shall keep an accurate daily record of the volume and treatment level of wastewater entering the emergency overflow pond and infiltration trenches. If no wastewater is discharged to the pond or trenches on any day, a 'nil' measurement shall be recorded.

    Advice note: To achieve compliance with conditions 14 and 15 the consent may need to install an additional flow meter at the outlet of the irrigation field pressure pump.

16. A copy of the records required by Conditions 14 and 15 shall be forwarded to Manawatu-Wanganui Regional Councils Environmental Protection Manager by **31 May** each year in the Annual monitoring report required by Condition 30 or upon request.

Monitoring Programme

Wastewater and water quality sampling

17. Commencing **1 January 2012**, the consent holder shall collect a monthly sample of the tertiary treated wastewater in the 'wet well' (after wastewater has been through UV treatment) prior to the wastewater being discharged to land. Monthly wastewater sampling shall continue until **1 January 2014**.

18. Commencing **1 January 2012**, the consent holder shall collect a monthly instream sample both upstream and downstream of the wastewater treatment plant in the unnamed tributary of the Wairere Stream and in the Wairere Stream at the sites below as shown on Plan C105684B attached to and forming part of this consent. Monthly stream sampling shall continue until **1 January 2014**.

19. The wastewater and instream sampling required by conditions 17 and 18 shall be analysed for the following:

    a. pH;
    b. Dissolved Oxygen;
    c. Dissolved Carbonaceous BOD_5;
    d. Total Suspended Solids;
    e. Dissolved Reactive Phosphorus;
    f. Dissolved inorganic nitrogen (i.e. sum of nitrate, nitrite and ammoniacal nitrogen);
    g. Total ammoniacal nitrogen; and
    h. Ecoli.

20. All wastewater sample analysis required by conditions of this consent shall be undertaken by an independent laboratory accredited to IANZ.

Macro-invertebrate sampling (water quality sampling)

21. Commencing **August 2012,** the consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake macro-invertebrate sampling once between the months August to October (winter/spring) each year of this consent in both the unnamed tributary of the Wairere Stream and the Wairere Stream.

22. The macro-invertebrate sampling required by Condition 21 shall be undertaken following a period of at least three weeks without a significant flood event as an instantaneous river flow exceeding 9.063 m^3/second as recorded at the Whakapapa at Footbridge flow recording site operated by Genesis Energy). .

    Advice note: Flow information at this site can be found visiting the Genesis Energy website http://www.genesisenergy.co.nz under the rivers, lakes and rainfall tab.

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    c. Wairere Stream downstream of the unnamed tributary confluence (point 3 on Plan C105864B); and
    d. Wairere Stream upstream of the Whakapapa Village Wastewater Treatment Plant (point 4 on Plan C105684B).

24. The macro-invertebrate sampling required by Condition 21 shall follow Protocols C3 (hard bottomed quantitative), P3 (full count with subsampling option) and QC3 (Quality control for full count with subsampling option) from the Ministry for the Environment's *"Protocols for sampling macro-invertebrates in wadeable streams"* (Stark et al. 2001). Sampling shall involve:

    a. Collection of 5 replicate 0.1 m^2 Surber samples at random with a 20 m section of riffle habitat at each sampling site;
    b. Full count of the macro-invertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macro-invertebrate Community Index (MCI); and
    c. Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT individuals.

    Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 21-24 can be implemented.

<u>Periphyton and algae sampling (water quality sampling)</u>

25. The consent holder shall have an appropriately experienced and qualified freshwater ecologist undertake an assessment of the percentage cover, biomass, chlorophyll a, AFDW and community composition of periphyton, filamentous algae and cyanobacterial mats in riffle habitat as close as possible to the sites selected under condition 23.

26. The periphyton and algae assessment shall be undertaken seasonally, once during the months; February, May, August and October regardless of flow during the first two years of this consent (2012 and 2013). The periphyton and algae assessment shall include:

    a. A visual assessment of the percentage cover of both filamentous algae and algal mats (to the nearest 5%) at 5 points across each of four transects encompassing run habitat and extending across the width of the stream(s) at each sampling site. The visual monitoring methods shall follow the protocols outlined in Appendix 2 of "*A periphyton monitoring plan for the Manawatu-Wanganui Region*" (Kilroy et al. 2008). Reported estimates shall include:
        i. Percentage cover of visible stream bed by bacterial and/or fungal growths (sewage fungus) visible to the naked eye;
        ii. Percentage cover of visible stream bed by filamentous algae more than 2 cm long;
        iii. Percentage cover of visible stream bed by diatoms or cyanobacteria mats more than 0.3 cm thick;

    iv. Percentage cover of visible stream bed by diatoms less than 0.3 cm thick; and
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b. The collection of periphyton samples at the same established monitoring sites and transects as defined in Condition 26a The periphyton collection methods shall follow the protocols outlined in Appendix 3 of *"A periphyton monitoring plan for the Manawatu-Wanganui Region"* (Kilroy et al. 2008). Analysis of periphyton samples shall also follow the Biggs and Kilroy (2000) guidelines for chlorophyll a analysis.

Advice note: Please contact Manawatu-Wanganui Regional Council's Environmental Scientist – Water Quality on 0508 800 800 for guidance on how Conditions 25-26 can be implemented.

<u>Soil Sampling</u>

27. In the month of **December 2012**, the consent holder shall undertake soil sampling at three separate areas. One sampling area shall be located in the Airport disposal area, one area shall be located in the Tundra disposal area and one are shall be located in an area not subject to wastewater irrigation (as a control area).

28. The consent holder shall take at least 9 cores from each area described in Condition 27 at varying depths as follows:

    a. 3 cores at 0-10 cm depth;
    b. 3 cores at 10-20 cm depth; and
    c. 3 cores at 50-70 cm depth.

29. The soil samples required by Conditions 27 and 28 shall be analysed for the following:

    a. pH;
    b. phosphorus;
    c. potassium;
    d. magnesium; and
    e. total nitrogen and base saturation.

Annual reporting

30. Annual data records and a report summarising the results for each year ending 1 April shall be forwarded to the Manawatu-Wanganui Regional Council's Environmental Protection Manager by **31 May** of each year of this consent, commencing 31 May 2012 and shall include but not be limited to the following:

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    b. A copy of the Operations and Management Plan and any subsequent updates required by Conditions 10 and 11;
    c. A copy of the inflow and outflow records required by Conditions 13 and 14;
    d. The results and analysis of macro-invertebrate and periphyton sampling required by conditions 21-26;
    e. The results and analysis of soil sampling required by Conditions 27-29;
    f. An overall assessment of effects on land and water quality in the receiving environment from the discharges authorised by this resource consent;
    g. Details of any upgrades or maintenance already implemented or planned for the following 12 months;
    h. Details of investigations into plant performance including inflows, outflows, effluent disposal system and treatment system;
    i. Details of any changes to the operation of the plant and/or proposed upgrades resulting from investigations into plant performance and monitoring results; and
    j. The records of any complaints received and details of measures undertaken in response to the complaint.

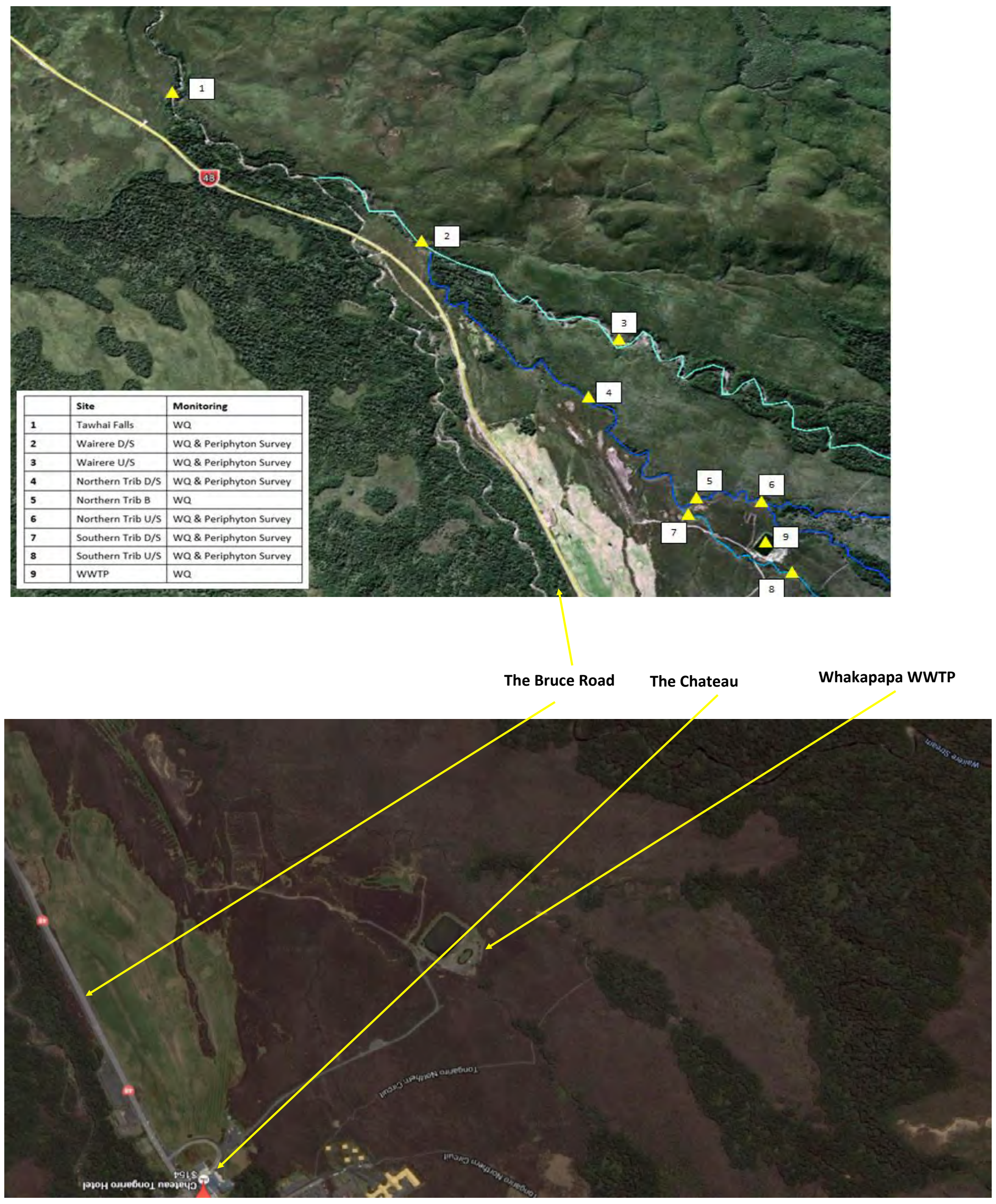
Review

31. The Manawatu-Wanganui Regional Council may, under section 128 of the Act, initiate a review of all conditions of this consent in **July 2012 and 2013,** for the purpose of reviewing the effectiveness of these conditions in avoiding or mitigating any adverse effects on the environment. The review of conditions shall allow for:

    a. deletion or amendments to any conditions of this resource consent to ensure adverse effects are appropriately mitigated; or
    b. addition of new conditions as necessary, to avoid, remedy or mitigate any unforeseen adverse effects on the environment; or
    c. if necessary and appropriate, the adoption of the best practicable options to avoid, remedy or mitigate any adverse effects on the environment.

APPENDIX D

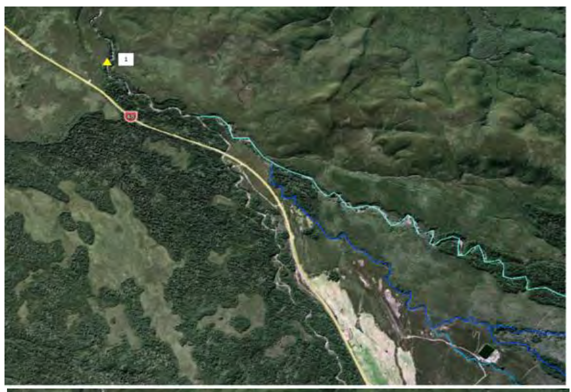
Wastewater Quality Sampling Schedule (2016)



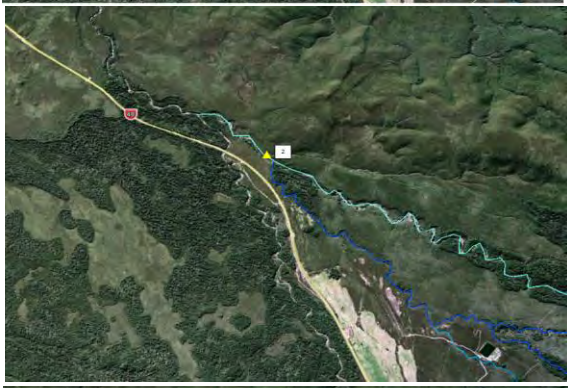
	Site	Monitoring
1	Tawhai Falls	WQ
2	Wairere D/S	WQ & Periphyton Survey
3	Wairere U/S	WQ & Periphyton Survey
4	Northern Trib D/S	WQ & Periphyton Survey
5	Northern Trib B	WQ
6	Northern Trib U/S	WQ & Periphyton Survey
7	Southern Trib D/S	WQ & Periphyton Survey
8	Southern Trib U/S	WQ & Periphyton Survey
9	WWTP	WQ

		Provided by Veolia			Analyzed by Watercare - Collected by Veolia									Aquanet/Veolia
Sampling Site No.	Site	Dissolved Oxygen	pH	Temperature	Nitrate (as N)	Nitrite (as N)	Ammoniacal Nitrogen (as N)	Dissolved Ammoniacal Nitrogen (as N)	Dissolved CBOD5 (1.2 µm Filtered)	Dissolved Inorganic Nitrogen (as N)	Dissolved Reactive Phosphorus (as P)	Total Suspended Solids	Escherichia coli	Periphyton Samples
1	Tawhai Falls	●	●	●	●	●	●	●	●	●	●	●	●	
2	Wairere D/S	●	●	●	●	●	●	●	●	●	●	●	●	●
3	Wairere U/S	●	●	●	●	●	●	●	●	●	●	●	●	●
4	Northern Trib D/S	●	●	●	●	●	●	●	●	●	●	●	●	●
5	Northern Trib B	●	●	●	●	●	●	●	●	●	●	●	●	
6	Northern Trib U/S	●	●	●	●	●	●	●	●	●	●	●	●	●
7	Southern Trib D/S	●	●	●	●	●	●	●	●	●	●	●	●	●
8	Southern Trib U/S	●	●	●	●	●	●	●	●	●	●	●	●	●
9	WWTP Post UV	●	●	●	●	●	●	●	●	●	●	●	●	
10	Emmergency Discharge Field Outlet (Prospective)	●	●	●	●	●	●	●	●	●	●	●	●	
11	Post Clarifiers (V-Notch Weir)	●	●	●	●	●	●	●	●	●	●	●	●	

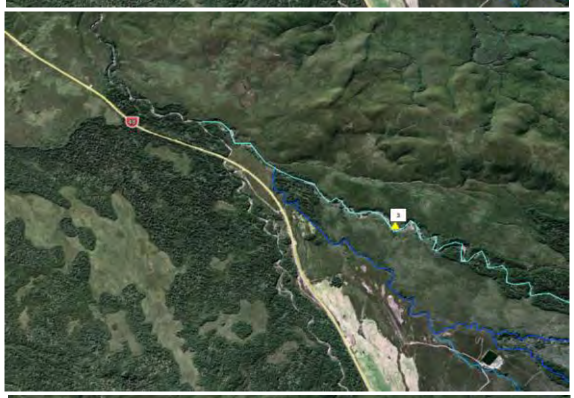
1 **Tawhai Falls**

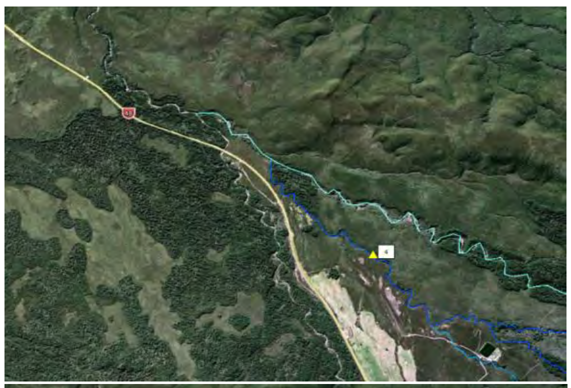
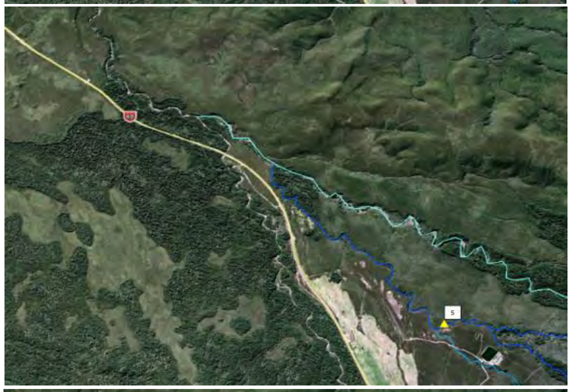
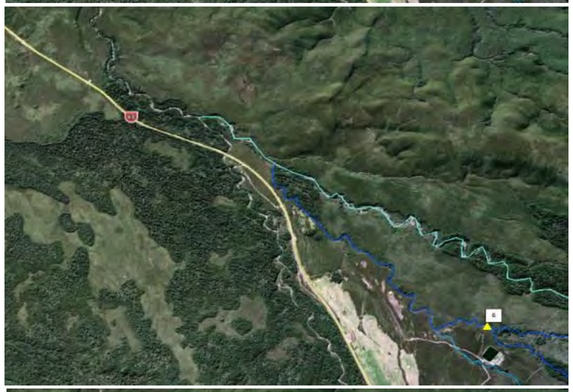
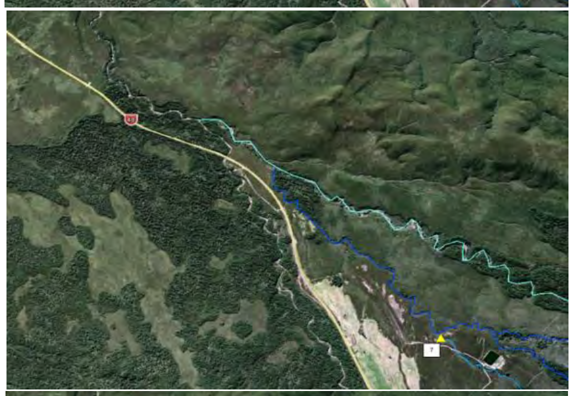
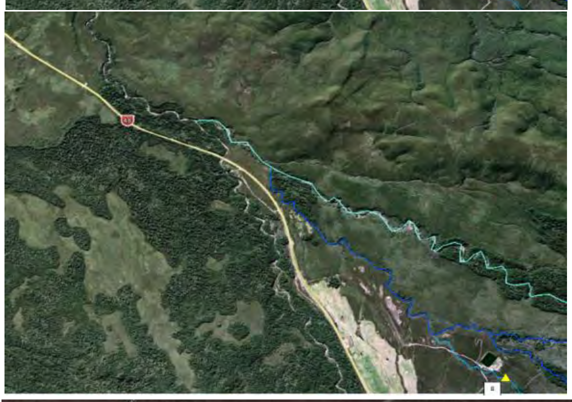
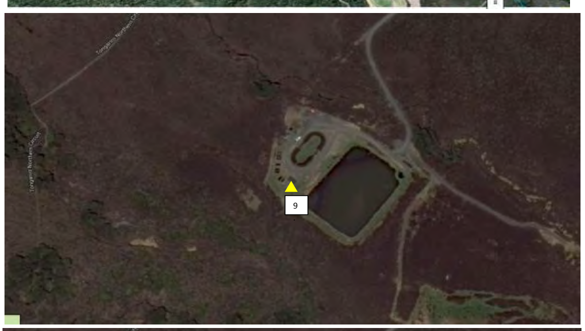
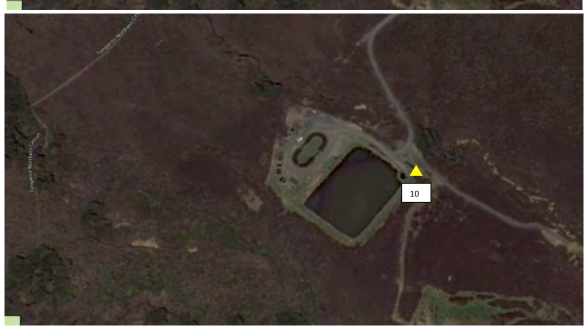


2 **Wairere D/S**



3 **Wairere U/S**



4	Northern Trib D/S	
5	Northern Trib B	
6	Northern Trib U/S	
7	Southern Trib D/S	
8	Southern Trib U/S	
9	WWTP Post UV	
10	Emmergency Discharge Field Outlet (Prospective)	
11	Post Clarifiers (V-Notch Weir)	

APPENDIX E

Whakapapa WWTP Health & Safety Risk Assessment

Hazard / Risk Register

Risk Assessment No.		
Hazard / Risk Register Site:	**Ruapehu**	
Hazard / Risk Assessment Scope:	**Bus Park WWPS, Iwikau**	**CATEGORIES:** C - Contractual, WTP - Water Treat, WWTP - W/water Treat, WN - Water Networks, WWN - W/water Networks, P - Pumpstations, SW - Stormwater, OH&S - (OH&S), E - Environmental, ERP - Emergency Response, RMA - Resource Management
Date Reviewed:		
Risk Assessment Team: (indicate team leader)		
Site Personnel Involved:		

Note* A Significant Hazard is one that can cause Serious Harm

Control Hierarchy	
1) Eliminate	Most Effective
2) Isolate	
3) Minimise	Least Effective

* **NB** - Risk rating cell colour will change automatically according to the rating scored

Number	Cat	Site	Process Component / Activity	Hazard / Event / Issue / Environmental Aspect	Business Section	Consequence Without Controls / Consequence / Environmental Impact	Significant Hazard Yes/No	Existing Controls	Control Hierarchy (1 - 3)	Ratings Cons.	Ratings Like.	Ratings Risk	Recommended actions to minimise risk	Responsible Person	Proposed Completion	Expected Final Risk (after actions) Cons.	Like.	Risk
2	OH&S	Ruap	Bus Park WWPS	Working around wet wells	Operations	Falling into the well	Yes	Height Safety Training for operators and anchor points. Two operators manditory. Safety rails proposed	3	4	3	12	Height Safety Training for operators and anchor points. Two operators manditory. Safety rails proposed	Contract Manager	On going	4	1	4
3	OH&S	Ruap	Bus Park WWPS	Traffic around WWPS. Pump station is in a carpark	Operations	Getting hit by traffic	Yes	Cones and barriers to be used while at WWPS. Park ute to obstruct any potential vehicles	3	4	3	12	Cones and barriers to be used while at WWPS. Park ute to obstruct any potential vehicles	Contract Manager	On going	4	1	4
2	OH&S	Ruap	Bus Park WWPS	Manual handling Any lifting or carrying activity, eg lifting lids, carrying materials including tools, waste, chemicals, etc	Operations	Back or associated soft tissue injuries	Yes	COP for Manual Handling (2001, OSH) Site inspections. M/H hazard assessments. Use safe lifting procedure. Use PPE/safety equipment where appropriate.	3	2	3	6	Use mechanical/other lifting devices where provided.	Contract manager	On going	2	2	4
3	OH&S	Ruap	Bus Park WWPS	Infectious waste, eg sewerage, trade waste- cleaning/water blasting, maintenance, lubrication of plant.	Operations	Infection from pathogens and other micro-organisms via open wounds or ingestion, splashes or immersion in waste water.	Yes	Training Policy. Pre-employment medicals. Immunisation Records. Safety checks. Site risk assessments. Immunisation Programme.	3	2	2	4	Training/induction on microbiological risks associated with sewerage & sludge.	Contract manager	On going	2	2	4
5	OH&S	Ruap	Bus Park WWPS	Sharp objects including broken glass, syringes, razor blades, etc Unblocking waste water pumps/ mains, handling screenings	Operations	Infected cuts.	Yes	Safety checks & site inspections. Immunisation policy for Hep A & B, Tetanus. Sharps disposal procedure. PPE/ Safety equipment. Hygiene procedures and first aid. Facilities for showering and washing.	3	2	3	6	Use skips to collect screening materials. Conduct regular checks to ensure compliance with procedures & work instructions	Contract manager	On going	2	2	4
6	OH&S	Ruap	Bus Park WWPS	Confined spaces Entry into man holes, pits, tanks, trenches or any other confined area where there may be limited access, atmospheric contaminants or restricted ventilation.	Operations	Asphyxiation from low oxygen or high carbon dioxide levels and poisoning from H2S, heat collapse and dehydration, burns from explosions (see below).	Yes	Confined space risk assessment & entry permit. AS/NZ 2865 2001 Safe Working in a Confined Space Site inspections and risk assessments. Gas monitoring. Confined space policy Annual health monitoring. Safe work procedures, including minimum of 2 people	3	4	3	12	Temporary barriers around excavations (sufficient to hold a person's weight-refer to excavations hazard), and secure covers over manholes or other permanent structures to prevent unauthorised entry. Mechanical or natural ventilation. Hotwork work instruc	Contract manager	On going	4	1	4
7	OH&S	Ruap	Bus Park WWPS	Explosive methane gas: Pits, sumps, man holes or trenches connected to sewers.	Operations	Serious burns, death.	Yes	Gas monitoring. No smoking policy. Hotwork work instruction/ permit system.	3	3	3	9	Signage indicating hazardous area.	Contract manager	On going	3	2	6
8	OH&S	Ruap	Bus Park WWPS	Slips, trips & falls. All work areas including access ways, stairways, ladders, slippery floor or ground conditions, etc.	Operations	Range of injuries from moderate to severe.	Yes	Regular maintenance programme, eg waterblasting, grading tracks, etc. Keep work sites tidy. PPE/ Safety Equipment, including suitable footwear.	3	2	3	6	Regular site safety audits to monitor and record conditions	Contract manager	On going	2	2	4
9	OH&S	Ruap	Bus Park WWPS	Electrical services/Pump stations, electrical panels/ switchboards.	Operations	Electrocutions/ burns due to faulty/ live wires or contact while wet and in contact with the ground.	Yes	OPS Procedures. Use isolation and lockout tags when doing repairs or maintenance. Electricity Act & Regs	3	3	3	9	Restrict access to power sources or switchboards. Electrical repairs or adjustments restricted to qualified electricians. Site safety Inspection. 6 monthly and annual checks	Contract manager	On going	3	2	6
10	OH&S	Ruap	Bus Park WWPS	Working alone: Wetwells & associated processes.	Operations	Various potential injuries.	Yes	Ongoing using injury data and toolbox meetings. Notification/reporting procedure to office/supervisor to monitor start/finish of jobs. Use of call centre 10pm-6am. Use of cell phones where coverage good. Safe work procedures.	3	3	3	9	Sensor/security lights for night access to plants. Ensure utilisation of After hours call centre to assist with monitoring	Contract manager	On going	3	2	6

11	OH&S	Ruap	Bus Park WWPS	UV exposure: Working outdoors. Ongoing particularly over summer months	Operations	Skin cancer, sunburn.	Yes	Wear work clothing provided to minimise direct exposure. Use sunscreen regularly at times of high exposure.	3	3	3	9	During each spring issue hot weather Safety Alert & Stock store with Suncream for issue to field staff.	Contract manager	On going	3	2	6
12	OH&S	Ruap	Bus Park WWPS	Inclement weather: Working outdoors in uncomfort-able conditions,	Operations	Various conditions including hypothermia, heat stress, dehydration, soft tissue injuries, etc.	Yes	Wear appropriate work clothing. Provide shelter & suitable washing facilities, including hot showers.	3	2	2	4	Where possible, plan work to avoid excessive exposure.	Contract manager	On going	2	2	4
13	OH&S	Ruap	Bus Park WWPS	Stress & fatigue (anytime), but particularly when doing regular overtime or on call.	Operations	Various potential injuries to self or others, including associated health conditions.	Yes	Stress and Fatigue Guidelines (OSH). Ongoing monitoring by supervisors, including fortnightly timesheet checks. Annual medicals. On call roster & escalation procedure.	3	2	3	6	Supervision & review of work performance (both informal & through PDR).	Contract manager	On going	2	2	4
14	OH&S	Ruap	Bus Park WWPS	There is no warning signage on WWPS electrical cabinet	Operations		Yes		3	2	2	4	Warning signage must be displayed at the entrance onto the WWPS site and security fence installed around the perimeter of the plant, warning unauthorised people to stay out of the plant at all times.	Contract manager	On going	2	1	2
15	WWTP	Ruap	Bus Park WWPS	Vandalism/ unauthorised entry to sites	Operations	May result in injury or significant property damage	No	Regular monitoring. Signage – no unauthorised entry.	3	2	2	4	All locks secure while sites unmanned. Operator regular monitoring.	Contract manager	On going	2	2	4
16	E	Ruap	Bus Park WWPS	Odours	Operations	Odours present on site	No		3	2	2	4	Monitor by operator	Contract manager	On going	2	2	4
17	E	Ruap	Bus Park WWPS	Operator / public contact with pathogens - signage covered in graffitti	Operations	Injury/disease to VW personnel or community personnel	No	H&S system, Induction program, fencing, remote site, training, handwash stations	3	3	2	6	innoculations & on going monitoring, replace signage	Contract manager	On going	3	2	6
18	E	Ruap	Bus Park WWPS	Power Failure	Operations	Environmental harm to stream Decreased service quality - (Resource consent failures) due to inability to treat sewage	No		3	3	2	6	ERP contigency plans	Contract manager	On going	3	2	6

APPENDIX F

Material Safety Data Sheets (MSDS)

Material Safety Data Sheet (MSDS) Index

Safety Data Sheet

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: **AE 1115 POLYMER SOLUTION**

Recommended use of the chemical and restrictions on use: A flocculant for water clarification.

Supplier: Ixom Operations Pty Ltd
ABN: 51 600 546 512
Street Address: Level 8, 1 Nicholson Street
Melbourne 3000
Australia

Telephone Number: +61 3 9665 7111
Facsimile: +61 3 9665 7937
Emergency Telephone: **1 800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Aspiration hazard - Category 1

SIGNAL WORD: DANGER

Hazard Statement(s):
H304 May be fatal if swallowed and enters airways.

Response:
P301+P310 IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P331 Do NOT induce vomiting.

Storage:
P405 Store locked up.

Disposal:
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Poisons Schedule (SUSMP): None allocated.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Hazard Codes
Distillates, petroleum, hydrotreated light	64742-47-8	10-30%	H304

Non hazardous component(s)	-	to 100%	-

4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Seek medical advice if effects persist.

Skin Contact:
If skin contact occurs, remove contaminated clothing and wash skin with running water. If irritation occurs seek medical advice.

Eye Contact:
If in eyes, wash out immediately with water. In all cases of eye contamination it is a sensible precaution to seek medical advice.

Ingestion:
Rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek medical advice.

Indication of immediate medical attention and special treatment needed:
Treat symptomatically. Delayed pulmonary oedema may result.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media:
Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

Specific hazards arising from the substance or mixture:
Not combustible, however following evaporation of the water component of the material, the residual material can burn if ignited. On burning will emit toxic fumes.

Special protective equipment and precautions for fire-fighters:
Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to vapour or products of combustion. Keep containers cool with water spray.

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures/Environmental precautions:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up:
Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal. Wash area down with detergent and excess water. Recover the cleaning water for subsequent disposal.

7. HANDLING AND STORAGE

Precautions for safe handling:
Avoid skin and eye contact and breathing in vapour, mists and aerosols.

Conditions for safe storage, including any incompatibilities:
Store in a cool, dry, well ventilated place. Protect from freezing. Do not store in steel containers. Do not store in aluminium containers. Do not store in copper or copper alloy containers. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for leaks.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters: No value assigned for this specific material by Safe Work Australia.

Appropriate engineering controls:
Use in well ventilated areas. Keep containers closed when not in use.

Individual protection measures, such as Personal Protective Equipment (PPE):
The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, SAFETY GLASSES, GLOVES.

Wear overalls, safety glasses and impervious gloves. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.
If determined by a risk assessment an inhalation risk exists, wear a suitable mist respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Liquid
Colour:	White to Off-white
Odour:	Slight Hydrocarbon
Specific Gravity:	1.019 @21°C
Relative Vapour Density (air=1):	<1
Vapour Pressure (20 °C):	ca. 18.0 mmHg
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not applicable
Autoignition Temperature (°C):	Not available
Solubility in water (g/L):	Not available
Boiling Point/Range (°C):	Not available
pH:	ca. 7.0
Viscosity:	640 cPs @21°C
Freezing Point/Range (°C):	< -5

10. STABILITY AND REACTIVITY

Reactivity: Reacts with metals.

Chemical stability: Stable under normal conditions.

Possibility of hazardous reactions:	Hazardous polymerisation will not occur.
Conditions to avoid:	Avoid freezing temperatures.
Incompatible materials:	Incompatible with strong oxidising agents.
Hazardous decomposition products:	Oxides of carbon.

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion:	Swallowing can result in nausea, vomiting, diarrhoea, and gastrointestinal irritation. Breathing in vomit may lead to aspiration pneumonia (inflammation of the lung). Collapse and possible death may occur.
Eye contact:	May be an eye irritant.
Skin contact:	Contact with skin may result in irritation. Repeated or prolonged skin contact may lead to irritant contact dermatitis.
Inhalation:	Breathing in mists or aerosols may produce respiratory irritation.

Acute toxicity:
Oral LD50 (rat): 10,080 mg/kg
Dermal LD50 (rabbit): 10,100 mg/kg
Inhalation LC50 (rat): 15,000 ppm/4hr

Chronic effects: No information available for the product.

12. ECOLOGICAL INFORMATION

Ecotoxicity	Avoid contaminating waterways.

13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to Waste Management Authority. Dispose of contents/container in accordance with local/regional/national/international regulations.

14. TRANSPORT INFORMATION

Road and Rail Transport
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

Marine Transport
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

Air Transport
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

15. REGULATORY INFORMATION

Classification:
This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Aspiration hazard - Category 1

Hazard Statement(s):
H304 May be fatal if swallowed and enters airways.

Poisons Schedule (SUSMP): None allocated.

16. OTHER INFORMATION

Supplier Safety Data Sheet; 12/ 2008.

This safety data sheet has been prepared by Ixom Operations Pty Ltd Toxicology & SDS Services.

Reason(s) for Issue:
Revised Primary SDS
Change in Formulation
Change in Hazardous Substance Classification

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Ixom Operations Pty Ltd cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Ixom representative or Ixom Operations Pty Ltd at the contact details on page 1.

Ixom Operations Pty Ltd's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

Safety Data Sheet

IXOM

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: **CAUSTIC SODA - LIQUID (46%-50%)**

Other name(s): Sodium hydroxide - liquid (46%-50%), Soda lye solution (46%-50%), Caustic soda solution (46%-50%), Sodium hydroxide solution (46%-50%), Liquid caustic soda (46%-50%), LCS 46%, Rezolv 46, Algane C46, Rezolv 50.

Recommended use of the chemical and restrictions on use: Chemical manufacture; neutralising agent; pulp and paper, aluminium, detergent, and textile processing; vegetable oil refining; reclaiming rubber; etching and electroplating; food additive.

Supplier: Ixom Operations Pty Ltd
ABN: 51 600 546 512
Street Address: Level 8, 1 Nicholson Street
Melbourne 3000
Australia

Telephone Number: +61 3 9665 7111
Facsimile: +61 3 9665 7937
Emergency Telephone: **1 800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Corrosive to Metals - Category 1
Skin Corrosion - Sub-category 1A
Eye Damage - Category 1

SIGNAL WORD: DANGER

Hazard Statement(s):
H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.

Precautionary Statement(s):

Prevention:
P234 Keep only in original container.
P260 Do not breathe dust / fume / gas / mist / vapours / spray.
P264 Wash hands thoroughly after handling.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

Response:
P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P363 Wash contaminated clothing before re-use.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P310 Immediately call a POISON CENTER or doctor/physician.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P390 Absorb spillage to prevent material damage.

Storage:
P405 Store locked up.
P406 Store in corrosive resistant container with a resistant inner liner.

Disposal:
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Poisons Schedule (SUSMP): S6 Poison.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Hazard Codes
Sodium hydroxide	1310-73-2	46-50%	H290 H314 H318
Water	7732-18-5	50-54%	-

4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. For all but the most minor symptoms arrange for patient to be seen by a doctor as soon as possible, either on site or at the nearest hospital.

Skin Contact:
If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor.

Eye Contact:
If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre or a doctor, or for at least 15 minutes.

Ingestion:
Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

Indication of immediate medical attention and special treatment needed:
Treat symptomatically. Can cause corneal burns.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media:
Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

Hazchem or Emergency Action Code: 2R

Specific hazards arising from the substance or mixture:
Non-combustible material.

Special protective equipment and precautions for fire-fighters:
Not combustible, however following evaporation of aqueous component residual material can decompose if involved in a fire, emitting toxic fumes. Contact with metals may liberate hydrogen gas which is extremely flammable. Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures/Environmental precautions:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up:
Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Work up wind or increase ventilation. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal. Caution - heat may be evolved on contact with water.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S6 and must be stored, maintained and used in accordance with the relevant regulations.

Precautions for safe handling:
Avoid skin and eye contact and breathing in vapour, mists and aerosols.

Conditions for safe storage, including any incompatibilities:
Store in cool place and out of direct sunlight. Store away from incompatible materials described in Section 10. Store away from foodstuffs. Do not store in aluminium or galvanised containers nor use die-cast zinc or aluminium bungs; plastic bungs should be used. At temperatures greater than 40°C, tanks must be stress relieved. Keep containers closed when not in use - check regularly for leaks.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters: No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for constituent(s):

Sodium hydroxide: Peak Limitation = 2 mg/m^3

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

Peak Limitation - a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

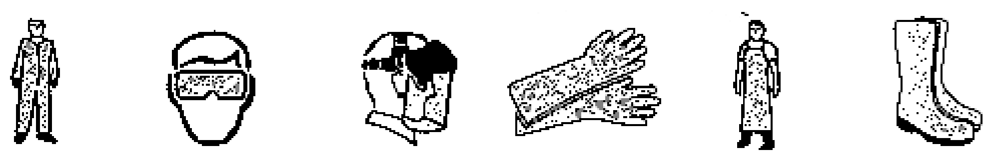
These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls:
Ensure ventilation is adequate to maintain air concentrations below Workplace Exposure Standards. Keep containers closed when not in use.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as Personal Protective Equipment (PPE):
The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, CHEMICAL GOGGLES, FACE SHIELD, GLOVES (Long), APRON, RUBBER BOOTS.



Wear overalls, chemical goggles, face shield, elbow-length impervious gloves, splash apron or equivalent chemical impervious outer garment, and rubber boots. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.
If determined by a risk assessment an inhalation risk exists, wear a suitable mist respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Liquid
Colour:	Colourless to Slightly Coloured
Solubility:	Miscible with water.
Specific Gravity:	1.48-1.52 @20°C
Relative Vapour Density (air=1):	Not available
Vapour Pressure (20 °C):	1.34 mm Hg (calculated)
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not applicable
Autoignition Temperature (°C):	Not applicable
Boiling Point/Range (°C):	ca. 145 (literature)
pH:	14 (literature)
Freezing Point/Range (°C):	ca. 12 (calculated)

10. STABILITY AND REACTIVITY

Reactivity: Reacts violently with acids. Reacts exothermically on dilution with water.

Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Absorbs carbon dioxide from the air.

Possibility of hazardous reactions: Reacts with ammonium salts, evolving ammonia gas. Reacts readily with various reducing sugars (i.e. fructose, galactose, maltose, dry whey solids) to produce carbon monoxide. Take precautions including monitoring the tank atmosphere for carbon monoxide to ensure safety of personnel before vessel entry.

Conditions to avoid: Avoid exposure to moisture.

Incompatible materials: Incompatible with ammonium salts , aluminium , tin , and zinc .

Hazardous decomposition products: None known.

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation.

Acute toxicity: No LD50 data available for the product. For the constituent Sodium hydroxide :

Skin corrosion/irritation: Severe irritant (rabbit).
Chronic effects: No information available for the product.

12. ECOLOGICAL INFORMATION

Ecotoxicity Avoid contaminating waterways.

13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to Waste Management Authority. Dispose of contents/container in accordance with local/regional/national/international regulations.

14. TRANSPORT INFORMATION

Road and Rail Transport
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

UN No:	1824
Transport Hazard Class:	8 Corrosive
Packing Group:	II
Proper Shipping Name or Technical Name:	SODIUM HYDROXIDE SOLUTION
Hazchem or Emergency Action Code:	2R

Marine Transport
Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN No:	1824
Transport Hazard Class:	8 Corrosive
Packing Group:	II
Proper Shipping Name or Technical Name:	SODIUM HYDROXIDE SOLUTION

IMDG EMS Fire:	F-A
IMDG EMS Spill:	S-B

Air Transport
Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

UN No:	1824
Transport Hazard Class:	8 Corrosive
Packing Group:	II
Proper Shipping Name or Technical Name:	SODIUM HYDROXIDE SOLUTION

15. REGULATORY INFORMATION

Classification:
This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Corrosive to Metals - Category 1
Skin Corrosion - Sub-category 1A
Eye Damage - Category 1

Hazard Statement(s):
H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.

Poisons Schedule (SUSMP): S6   Poison.

All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

`Registry of Toxic Effects of Chemical Substances'. Ed. D. Sweet, US Dept. of Health & Human Services: Cincinatti, 2014.

This safety data sheet has been prepared by Ixom Operations Pty Ltd Toxicology & SDS Services.

Reason(s) for Issue:
Change in company details

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Ixom Operations Pty Ltd cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Ixom representative or Ixom Operations Pty Ltd at the contact details on page 1.

Ixom Operations Pty Ltd's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

Safety Data Sheet

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name:	**SODIUM HYPOCHLORITE SOLUTION (10-15% AVAILABLE CHLORINE)**
Recommended use of the chemical and restrictions on use:	Dairy, food and beverage industries: Sanitising processing equipment. Textile industry: Bleaching agent. Water treatment: Sanitising agent. Available chlorine = 10 - 15%.
Supplier:	Ixom Operations Pty Ltd
ABN:	51 600 546 512
Street Address:	Level 8, 1 Nicholson Street Melbourne 3000 Australia
Telephone Number:	+61 3 9665 7111
Facsimile:	+61 3 9665 7937
Emergency Telephone:	**1 800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Skin Corrosion - Sub-category 1C
Eye Damage - Category 1
Acute Aquatic Toxicity - Category 1

SIGNAL WORD: DANGER

Hazard Statement(s):
H314 Causes severe skin burns and eye damage.
H400 Very toxic to aquatic life.

Precautionary Statement(s):

Prevention:
P260 Do not breathe dust / fume / gas / mist / vapours / spray.
P264 Wash hands thoroughly after handling.
P273 Avoid release to the environment.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

Response:
P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P363 Wash contaminated clothing before re-use.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P310 Immediately call a POISON CENTER or doctor/physician.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P391 Collect spillage.

Storage:
P405 Store locked up.

Disposal:
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Other Hazards:
AUH031 Contact with acids liberates toxic gas.

Poisons Schedule (SUSMP): S5 Caution.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Hazard Codes
Water	7732-18-5	>60%	-
Sodium hypochlorite	7681-52-9	10-<30%	H314 H400
Sodium hydroxide	1310-73-2	<1%	H290 H314 H318

4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing. Seek immediate medical advice.

Skin Contact:
If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor.

Eye Contact:
Immediately wash in and around the eye area with large amounts of water for at least 15 minutes. Eyelids to be held apart. Remove clothing if contaminated and wash skin. Urgently seek medical assistance. Transport promptly to hospital or medical centre. Continue to wash with large amounts of water until medical help is available.

Ingestion:
Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

Indication of immediate medical attention and special treatment needed:
Treat symptomatically. Can cause corneal burns. Delayed pulmonary oedema may result.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media:
Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

Hazchem or Emergency Action Code: 2X

Specific hazards arising from the substance or mixture:
Non-combustible material.

Special protective equipment and precautions for fire-fighters:
Decomposes on heating emitting toxic fumes, including those of chlorine . Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures/Environmental precautions:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up:
Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Work up wind or increase ventilation. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S5 and must be stored, maintained and used in accordance with the relevant regulations.

Precautions for safe handling:
Avoid skin and eye contact and breathing in vapour, mists and aerosols. Keep out of reach of children.

Conditions for safe storage, including any incompatibilities:
Store in cool place and out of direct sunlight. Store away from foodstuffs. Store away from acids. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for leaks.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters: No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for constituent(s):

Chlorine: Peak Limitation = 3 mg/m^3 (1 ppm)
Sodium hydroxide: Peak Limitation = 2 mg/m^3

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

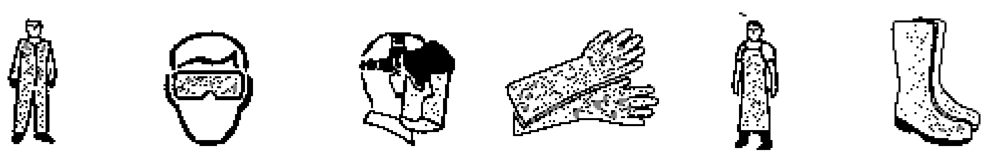
Peak Limitation - a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls:
Ensure ventilation is adequate and that air concentrations of components are controlled below quoted Workplace Exposure Standards. If inhalation risk exists: Use with local exhaust ventilation or while wearing air supplied mask. Keep containers closed when not in use.

Individual protection measures, such as Personal Protective Equipment (PPE):
The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, CHEMICAL GOGGLES, FACE SHIELD, GLOVES (Long), APRON, RUBBER BOOTS.



Wear overalls, chemical goggles, face shield, elbow-length impervious gloves, splash apron or equivalent chemical impervious outer garment, and rubber boots. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.
If determined by a risk assessment an inhalation risk exists, wear an air supplied respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Liquid
Colour:	Pale Yellow - Green
Odour:	Chlorine
Solubility:	Miscible in water.
Specific Gravity:	1.2 @20°C
Relative Vapour Density (air=1):	Not available
Vapour Pressure (20 °C):	Not available
Flash Point (°C):	Not applicable
Flammability Limits (%):	Not applicable
Autoignition Temperature (°C):	Not available
Boiling Point/Range (°C):	Not available
pH:	12.5 (1% w/w)

10. STABILITY AND REACTIVITY

Reactivity:	Contact with acids liberates toxic gas.

Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. The amount of available chlorine diminishes over time.

Possibility of hazardous reactions: Hazardous polymerisation will not occur. Reacts exothermically with acids . Reacts with ammonia, amines and ammonium salts to product chloramines. Decomposes on heating to produce chlorine gas.

Conditions to avoid: Avoid contact with foodstuffs. Avoid exposure to heat, sources of ignition, and open flame. Avoid exposure to light. Avoid contact with other chemicals. Avoid contact with acids .

Incompatible materials: Incompatible with acids , metals , metal salts , peroxides , reducing agents , and ethylene diamine tetraacetic acid . Incompatible with ammonia and ammonium coumpounds such as amines and ammonium salts.

Hazardous decomposition products: Chlorine.

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation. Delayed (up to 48 hours) fluid build up in the lungs may occur.

Acute toxicity: No LD50 data available for the product. For the constituent
SODIUM HYPOCHLORITE:
Oral LD50 (mice): 5800 mg/kg

Serious eye damage/irritation: Moderate irritant (rabbit). Standard Draize test
Chronic effects: No information available for the product.

12. ECOLOGICAL INFORMATION

Ecotoxicity Avoid contaminating waterways.
For SODIUM HYPOCHLORITE:

Persistence/degradability: This material is biodegradable.

Aquatic toxicity: Very toxic to aquatic organisms.

48hr LC50 (fish): 0.07 - 5.9 mg/L.

13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to Waste Management Authority. Dispose of material through a licensed waste contractor. Decontamination and destruction of containers should be considered.

14. TRANSPORT INFORMATION

Road and Rail Transport
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

UN No:	1791
Transport Hazard Class:	8 Corrosive
Packing Group:	III
Proper Shipping Name or Technical Name:	HYPOCHLORITE SOLUTION
Hazchem or Emergency Action Code:	2X

Marine Transport
Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN No:	1791
Transport Hazard Class:	8 Corrosive
Packing Group:	III
Proper Shipping Name or Technical Name:	HYPOCHLORITE SOLUTION
IMDG EMS Fire:	F-A
IMDG EMS Spill:	S-B

Air Transport
Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

UN No:	1791
Transport Hazard Class:	8 Corrosive
Packing Group:	III
Proper Shipping Name or Technical Name:	HYPOCHLORITE SOLUTION

15. REGULATORY INFORMATION

Classification:
This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Skin Corrosion - Sub-category 1C
Eye Damage - Category 1
Acute Aquatic Toxicity - Category 1

Hazard Statement(s):
H314 Causes severe skin burns and eye damage.
H400 Very toxic to aquatic life.

Poisons Schedule (SUSMP): S5 Caution.

All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

`Registry of Toxic Effects of Chemical Substances'. Ed. D. Sweet, US Dept. of Health & Human Services: Cincinatti, 2012.

This safety data sheet has been prepared by Ixom Operations Pty Ltd Toxicology & SDS Services.

Reason(s) for Issue:
Revised Primary SDS
Alignment to GHS requirements

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Ixom Operations Pty Ltd cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Ixom representative or Ixom Operations Pty Ltd at the contact details on page 1.

Ixom Operations Pty Ltd's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

APPENDIX G

Data Record Sheet for Plant Performance Monitoring

Whakapapa Wastewater Treatment Plant

Day	Time	Operator Initials	Weather	Flow L/S	Total m3 Inlet	Total m3 Irrigation	UV Intensity	RDO G/M3	DO Clarifier 1	DO Clarifier 2	DO Emer Pond	Temp Deg C	Temp Clarifier 1	Temp Clarifier 2	Temp Emer Pond	pH	pH Clarifier 1	pH Clarifier 2	pH Emer Pond	MLSS G/M3	SVI	WAS m3	Comments / Faults
1																							
2																							
3																							
4																							
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APPENDIX H

Current Process Shortcomings and Improvement Recommendations

Current Process Shortcomings:

- High flows to the plant cannot be buffered;
- Inflow and Infiltration makes the high flows totally unmanageable;
- The clarifiers are on the very edge of their capacity. Peak flows, even excluding I&I, are hard to process or will create upsets resulting in wash-out of solids which impact on the tertiary filters;
- The tertiary filters need an escape route from a fouled position;
- The tertiary filters need an overhaul from hazard and operability point of view;
- The tertiary filters might need augmentation;
- The nitrification step must be separated from the BOD removal and denitrification. The total reactor volume is too small and the DO profile cannot be varied sufficiently to carry out both processes in the same volume;
- Insufficient alkalinity is present in the wastewater and must be dosed for nitrification to significantly progress towards completion;
- The capacity of the aerators is insufficient for either BOD removal or nitrification, but when BOD removal and denitrification are combined in the current Pasveer ditch the paddle aerators can have a future, be it on an intermittent basis;
- For full denitrification on the current design basis an external carbon source is required. In order to deploy this chemical efficiently a post-denitrification reactor is required;
- For a substantial removal of phosphorous a chemical dosing will be needed in combination with a good tertiary filtration step;
- The re-aeration tank should re-assume its aeration duty on intermittent basis so that sludge is conditioned well before either return to the Pasveer ditch or for dewatering. That obviously prompts the need for another waste sludge solution; and
- Too little information is available about the actual plant loadings and flow profiles during peak and shoulder periods to make accurate design decisions pertaining to nutrient removal.

Improvement Recommendations

A 2-stages upgrade is recommended. The first stage is aimed at improving plant operability, collection of data, compulsory upgrades and improvements on nitrogen removal whereas the second stage is more around fine-tuning of the plant performance and operability

Stage 1 comprises:

- Combatting inflow and infiltration plus generating more buffer capacity in the network;
- Installation of automated data collection and communication between various sites plus additional measured for improved collection of data on flows and loads;
- Construction of a new switchboard and control centre at the WWTP in order to accommodate the future motors and instruments;
- The tertiary filters will be overhauled as part of stage 1 as well as the internal sludge management and disposal system;
- Installation of a semi-natural wetland system. This is a commitment made by the Department of Conservation. The system will be installed mainly for social-cultural reasons, but is understood to be designed for denitrification duties.
- The wetlands being aimed at denitrification raises the need for improved nitrification at the WWTP site. If the initial stage 1 improvements do not generate the desired nitrification level, a dedicated fixed film nitrification process will be installed at the WWTP. This will then also entail influent screening and a grit trap at the plants' inlet.

During and after stage 1 the combination of the nitrification capacity of the WWTP and the denitrification capacity of the wetlands will be assessed in practice. After this stage the upgrade approach will be partially adaptive.

Stage 2

After upgrade stage 1 it will become clear whether additional denitrification capacity and/or alkalinity supply is required for meeting effluent standards. This may then lead to denitrification capacity installed at the plant at stage 2, as well as some chemical storage and dosing facilities. If chemical phosphorous removal is considered required, this will be installed as part of stage 2. Lastly at this point the composition and quantity of waste sludge is finally certain for which a sludge dewatering facility can be built.

APPENDIX I

Table of Significant Assets

Table of Significant Assets

List of Significant Assets (to be read in conjunction with P&ID see Section 3.4 in the O&M Manual)

Label	Description	Make / Model	Comment	Manual ref[1]
Valve				
V-101	Gate Valve	150mm Valve, Cast Iron	Valve between Pasveer Channel and Flow Splitter	N/A
V-102-1	Penstock Valve	Custom made	Valve on Exit of Flow Splitter to control flow to Settler 1	N/A
V-102-2	Penstock Valve	Custom made	Valve on Exit of Flow Splitter to control flow to Settler 2	N/A
V-201	Gate Valve	Buried	Valve after Pump P05 (Pump Station 1), controls Flow to Filters	N/A
V-202	Gate Valve	Buried	Valve to send water from Pump Station 1 to Pond	N/A
V-203-1	Ball Valve	Conti Ball Valve, CW617N, DN50, PN25	Isolation valve between Settler 1 and RAS Pump (P-01)	B13
V-203-2	Ball Valve	Conti Ball Valve, CW617N, DN50, PN25	Isolation valve between Settler 2 and RAS Pump (P-02)	B13
V-204	Ball Valve	Transmark Fcx Ball Valve, 50mm	Isolation valve between Settler 2 and RAS Pump (P-01)	N/A
V-205	Ball Valve	Conti Ball Valve, CW617N, DN50, PN25	Isolation valve between Settler 1 and RAS Pump (P-02)	B13
V-206-1	Ball Valve	Conti Ball Valve, CW617N, DN50, PN25	Isolation valve on RAS Pump P-01 discharge	B13
V-206-2	Ball Valve	Conti Ball Valve, CW617N, DN50, PN25	Isolation valve on RAS Pump P-02 discharge	B13
V-207	Gate Valve	Brass Valve, DN 80	RAS Valve after Polymer Dosing Point	N/A
V-208	Ball Valve	Steel Valve, DN 80	RAS Valve before Inlet (Screening Chamber)	N/A
V-301-A	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Inlet Valve on Filter A	B1
V-301-B	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Inlet Valve on Filter B	B1

[1] Refers to manufacturers manual in Appendix B

Label	Description	Make / Model	Comment	Manual ref[1]
V-301-C	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Inlet Valve on Filter C	B1
V-302-A	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Filter to waste valve on Filter A	B1
V-302-B	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Filter to waste valve on Filter B	B1
V-302-C	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Filter to waste valve on Filter C	B1
V-303-A	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Backwash Valve on Filter A	B1
V-303-B	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Backwash Valve on Filter B	B1
V-303-C	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN50, F79U Double Acting	Backwash Valve on Filter C	B1
V-304-A	Ball Valve	GF Piping Systems Ball Valve Type 546, DN25	Drain Valve on Filter A	B2
V-304-B	Ball Valve	GF Piping Systems Ball Valve Type 546, DN25	Drain Valve on Filter B	B2
V-304-C	Ball Valve	GF Piping Systems Ball Valve Type 546, DN25	Drain Valve on Filter C	B2
V-305	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN40, F79U Double Acting	Air Blower isolation valve for air scouring Filter	B1
V-306	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN40, F79U Double Acting	No-load start valve	B1
V-307	Butterfly Valve	KEYSTONE, DN80	Filter Bypass Valve. Allows sending water back to Pasveer Channel	N/A
V-308	Actuated Butterfly Valve	KEYSTONE Butterfly Valve, DN80, F79U Double Acting	Filter Outlet Valve for all three Filters. Closes on backwash	B1
V-309	Butterfly Valve	KEYSTONE, DN80	UV isolation Valve. Allows using low flow Bypass	N/A
V-310	Ball Valve	GF Piping Systems Ball Valve Type 546, DN40	Restricted flow Valve on Line to UV	B2
V-311	Butterfly Valve	KEYSTONE, DN80	Filter isolation Valve. Allows bypassing filters	N/A
V-312	Butterfly Valve	KEYSTONE, DN80	Filter isolation Valve. Allows bypassing filters	N/A

Label	Description	Make / Model	Comment	Manual ref[1]
V-401	Gate Valve	Buried	Valve prior to Screen Chamber (downstream Chamber 1)	N/A
V-402	Gate Valve	Buried	Valve downstream Chamber 1 to unknown, purpose unknown	N/A
V-403	Gate Valve	Buried	Valve between Chamber 1 and Tertiary Treatment Pond, purpose unknown	N/A
V-404	Ball Valve		Valve in Tertiary Treatment Pond outlet to control flow to Overflow Trenches	N/A
V-405	Gate Valve	Buried	Valve between Screen Chamber and Pump station 2	N/A
V-406	Gate Valve	Buried	Valve after Screen chamber to control flow to unknown location	N/A
V-407-A	Non-Return Valve	AVK Non-Return Valve, 100 mm	After Pump station 2 to prevent backflow to pump P-06	N/A
V-407-B	Non-Return Valve	AVK Non-Return Valve, 100 mm	After Pump station 2 to prevent backflow to pump P-07	N/A
V-408-A	Gate Valve	AVK Gate Valve, 100 mm	Valve on outlet line of P-07	N/A
V-408-B	Gate Valve	AVK Gate Valve, 100 mm	Valve on outlet line of P-06	N/A
V-501	Ball Valve	Steel Valve, DN15	Valve prior to Service water tank to control water supply/tank level	N/A
V-502	Ball Valve	Steel Valve, DN50	pump P-03 suction Isolation valve	N/A
V-503	Gate Valve	Brass Valve, DN15	Valve allows Service Water network to be pressurised from town supply	N/A
V-504	Needle Valve	Brass Valve, DN15	Service Water tap to turn hose supply on and off	N/A
V-505	Ball Valve	Steel Valve, DN50	Pump P-03 discharge isolation valve	N/A
V-506	Gate Valve	Liquetec N.Z., Model-LV-G3, BS5154-1989, DN50	Valve for service water flush of RAS pumps	B13
V-507	Ball Valve	Hansen, Compact Ball Valve, CC100, UPVC, DN50	Valve for service water flush of RAS pumps	N/A
V-508	Ball Valve	DN20	Service water for Polymer make-up	N/A
V-601	Ball Valve	GF Piping Systems Ball Valve Type 546, 25 mm	Polymer pump (P-04) suction isolation valve	B2

Label	Description	Make / Model	Comment	Manual ref[1]
V-602	Ball Valve	GF Piping Systems, PVC, DN15	Polymer pump (P-04) discharge isolation valve	N/A
V-701	Gate Valve	DN80	Valve prior to Re-aeration tank	N/A
V-702	Ball Valve	Vstd Plastic Valve, DN 80	Valve after pump P-08 back to RAS line/Geo bag	N/A
V-703	Ball Valve	GF Piping Systems, DN80	Valve after P-08 to isolate hose	N/A
V-704-A	Ball Valve	Vstd plastic valve, DN80	Valve in Geo bag bund	N/A
V-704-B	Ball Valve	Vstd plastic valve, DN80	Valve in Geo bag bund	N/A
Others				
	Screening Basket	Garry Kidd Engineering	Screen 15 mm openings	N/A
Pasveer Channel	Pasveer Channel	Constructor unknown	Pasveer Channel with two Aerators	N/A
	Large Aerator	3.0 kW Paddle Aerator Whitehead & Poole	Alleged SOTE of 1.8 kg O_2/kW	N/A
	Small aerator	1.5 kW Paddle Aerator	Alleged SOTE of 1.8 kg O_2/kW	N/A
AIT-001	Dissolved Oxygen Instrument	Hach sc 100 Controller	Measures DO in Pasveer Channel, Controller in same room as Sand Filters	B8
	Flow Splitter	600mm x 700mm	Ensures equal distribution between Settlers	N/A
S-01	Settler 1	Dortmond tank, 18 m^2	Separates activated sludge from effluent	N/A
S-02	Settler 2	Dortmond tank, 18 m^2	Separates activated sludge from effluent	N/A
FI 001	Flow Meter	Endress + Hauser, FMU90	Measures effluent flow from both settlers before entering pump station 1	B7
	Pump station 1	3400mm x 3400mm x 3500mm	Pumps effluent from both settlers to Filters	N/A
P-05	Filter Feed Pump	Grundfos SV044DHS50B2003, 34 l/s, 50 Hz	Feeds the sand filters with clarified water	N/A
P-01	RAS pump 1	Davey Mukmova pump, Model 25303-4	Pumps RAS from Settler 1 back to Inlet (Screening Chamber)	B10
P-02	RAS pump 2	Davey Mukmova pump, Model 25303-4	Pumps RAS from Settler 2 back to Inlet (Screening Chamber)	B10
Filter A	Sand Filter A	FILTEC Sand Filter, 900m diameter	Three filters after Pump Station 1 and prior to UV	B11 & B12

Label	Description	Make / Model	Comment	Manual ref[1]
Filter B	Sand Filter B	FILTEC Sand Filter, 900m diameter	Three filters after Pump Station 1 and prior to UV	B11 & B12
Filter C	Sand Filter C	FILTEC Sand Filter, 900m diameter	Three filters after Pump Station 1 and prior to UV	B11 & B12
K-01	Blower	FPZ SCL 30 DH, 50 Hz, Year 2004	For Sand Filter air scour	B3
U-01	UV reactor	Trojan System UV3000 PTP 6 lamps	UV after Filters before Screen Chamber	B4
	Screen Chamber	Ø 1200mm concrete manhole	After UV – reactor, prior to Pump station 2	N/A
	Pump Station 2	Ø 2400mm concrete manhole		N/A
P-06	Pump in pump station 2	Flygt 3068.170, M13-10-2BB	Pump effluent to Dripper fields	B16
P-07	Pump in pump station 2	Flygt 3068.170, M13-10-2BB	Pump effluent to Dripper fields	B16
	Valve Chamber	Ø 1050mm concrete Manhole	After Pump station 2, prior to dripper fields	N/A
FI 002	Flow Meter	Flow totaliser equipped with pulse counter	Controls Flow to Irrigation Fields	N/A
	Service Water Tank	Rx Plastics DE, 2000litres	Feeds water to Polymer make-up, RAS pumps and hose	N/A
P-03	Service Water Pump	Davey Pump, HM90-13-0	Service Water Pump	B9
	Polymer make-up tank	Skellerup Rotomould tank, 1000l	Tank in the same room as filters	N/A
MX-1	Mixer on Polymer tank	SEW-EURODRIVE, R1 27 DH71, No 22 19142 2004 01	Mixer on the Polymer tank	N/A
P-04	Dosing pump	Wallace & Tiernan Liquid Feed Systems Encore 100 Diaphragm Metering Pump	Dosing Pump for Polymer make-up for RAS	B6
K-05	Compressor	ABAC POLE POSITION OL 231 V240 ASH, Lot 209765	Supplies instrument air for pneumatic valve operation	N/A
	Re-aeration tank	37.5m^3 concrete tank, 9 diffused bubble aerators with combined 25m^3/h air capacity	In use as sludge thickener	N/A
P-08	Pump	Brand and model unknown	Not in use at the moment	N/A
P-09	Pump	Brand and model unknown	Used for decanting water off thickened sludge	N/A
	Geo bag bund	Currently not in use	Not in use at the moment	N/A

- Where available, As-builts and electrical diagrams are included within Appendix A.
- Manufacturer Manuals, as indicated above, are provided within Appendix B.

APPENDIX 12

CONSULTATION AND AFFECTED PARTIES WRITTEN APPROVAL

TIMELESS SINCE 1929

CHATEAU

TONGARIRO HOTEL

FILE No.	ERM 04 RMA.			
DATE	13 MAY 2016			
INITIALS	INFO	ACTION	COPY TO	SIGNED
Nic				✓
Greg				
			02537	

Dr. Nic Peet
Group Manager Strategy and Regulation
Horizon's Regional Council
Private Bag 11025
Manawatu Mail Centre
PALMERSTON North 4442

10 May 2016

Letter of Support for the Department of Conservation (DOC) – Whakapapa WWTP Resource Consent Application 2016

Dear Nic,

As a stakeholder within the Whakapapa/Iwikau Village we Chateau Tongariro support the process of the DOC Whakapapa Wastewater Treatment Plan resource consent application to be officially lodged with the Horizon's Regional Council in June 2016.

In accordance with the Resource Management Act 1991 and as a directly affected party, Chateau Tongariro supports the proposal to consent the Whakapapa WWTP and give our written approval to the resource consent application submitted by DOC for the Whakapapa Wastewater Treatment Plant.

We are supportive of the staged and adaptive approach proposed by DOC as part of any resource consent approval given by Horizon's Regional Council as all upgrades and improvements need to be compliant and affordable over time.

Yours sincerely

Kathy Guy
General Manager
Chateau Tongariro Hotel
Private Bag MT RUAPEHU

State Highway 48, Private Bag 71901, Tongariro National Park
Tel (+64 7) 892 3809 **Fax** (+64 7) 892 3704
Email stay@chateau.co.nz **www.chateau.co.nz**

12 May 2016

Dr. Nic Peet
Group Manager Strategy and Regulation
Horizon's Regional Council
Private Bag 11025
Manawatu Mail Centre
Palmerston North 4442

Letter of Support for the Department of Conservation (DOC) – Whakapapa WWTP Resource Consent Application 2016

Dear Nic,

As a stakeholder within the Whakapapa/Iwikau Village we, Ruapehu Ski Club Inc. support the process of the DOC Whakapapa Wastewater Treatment Plan resource consent application to be officially lodged with the Horizon's Regional Council in June 2016.

In accordance with the Resource Management Act 1991 and as a directly affected party, Ruapehu Ski Club Inc. supports the proposal to consent the Whakapapa WWTP and give our written approval to the resource consent application submitted by DOC for the Whakapapa Wastewater Treatment Plant.

We are supportive of the staged and adaptive approach proposed by DOC as part of any resource consent approval given by Horizon's Regional Council as all upgrades and improvements need to be compliant and affordable over time.

Yours sincerely

Adrian

Adrian Adriaansen President

Ruapehu Ski Club Inc.
PO Box 8064 Symonds Street
Auckland 1150

TE RŪNANGANUI O NGĀTI HIKAIRO KI TONGARIRO
PO Box 338, Turangi 3353 | E: hinemoa@hekainga.co.nz

4 March 2016

Dr. Nic Peet
Group Manager Strategy and Regulation
Horizon's Regional Council
Private Bag 11025
Manawatu Mail Centre
PALMERSTON NORTH 4442

Na te hau matao o Tongariro, ka wiri ai te tangata, na te wiri o te tangata, ka whakapiri ai nei e tātou, tihei mauri ora

Tēnā koe te rangatira e Nic

RE: NGATI HIKAIRO AND THE DEPARTMENT OF CONSERVATION – WHAKAPAPA WWTP RESOURCE CONSENT APPLICATION

At a hui of Te Rūnanganui o Ngāti Hikairo ki Tongariro (TRoNH) held on 25 September 2015 the trustees agreed to support the engagement directly with the Department of Conservation (DOC) who are seeking a resource consent to continue activities, including discharges associated with the operation of the Whakapapa Wastewater Treatment Plant within the amenity area of the Tongariro National Park.

Since this meeting Ngāti Hikairo and DOC have worked collaboratively with the Project Advisory Group in support of the resource consent process including the proposed lodgement of the updated resource consent application on 14 March 2016. The trustees are supportive of the collaborative approach in seeking resource consent approval, including options analysis, improvements and upgrades to the Whakapapa Wastewater Treatment Plant to meet the statutory requirements required to continue to operate the plant.

The primary motivation for Ngāti Hikairo is to ensure that the best possible long-term solution is sought in the best interest of the maunga and ngā awa. Therefore Ngāti Hikairo are directed to be more "solution-focussed" rather than "process driven" to achieve an outcome that befits the "mana o ngā maunga".

Te Rūnanganui o Ngāti Hikairo ki Tongariro have confidence with the project team that has been brought together and are reliant on their technical advice and planning in their given fields to achieve the best possible outcome.

In accordance with the Resource Management Act 1991, the trustees support the proposal and give our written approval to the resource consent application submitted by DOC for the Whakapapa Wastewater Treatment Plant. We are supportive of an adaptive approach proposed by DOC as part of resource consent approval given by Horizon's Regional Council going forward.

If you require any further information or would like further clarification please do not hesitate to email or ring the Ngati Hikairo representatives for the Whakapapa WWTP as noted

- Taina Tahi: **M:** 021 2288 317, **E:** tainatahi@hotmail.co.nz
- Bubs Smith **M:** 021 931 984, **E:** bubs@tuwharetoa.co.nz

Nāku nā

Hinemoa Wanikau
Board Secretariat

ON BEHALF OF TE RŪNANGANUI O NGĀTI HIKAIRO KI TONGARIRO

Te Ngaehe Wanikau
Chair – Otukou Marae

Kevin Kakahi
Chair – Papakai Marae

Brenton Searancke
Chair – Hikairo Marae

RUAPEHU DISTRICT COUNCIL

Private Bag 1001, Taumarunui 3946, New Zealand
Telephone +64 7 895 8188 • Fax +64 7 895 3256
Email info@ruapehudc.govt.nz
Website www.ruapehudc.govt.nz

Our Ref: 623505
File: W30-0027

8 March 2016

Jasmine Mitchell
Consents Processing Officer
Horizons Regional Council
Private Bag 11025
Manawatu Mail Centre
PALMERSTON NORTH 4442

Dear Jasmine

DEPARTMENT OF CONSERVATION (DOC) APPLICATION FOR RESOURCE CONSENT - WHAKAPAPA WATER SUPPLY

Ruapehu District Council (RDC) has been kept informed of the resource consent renewal process for Whakapapa Wastewater Treatment Plant:

- Discharge consent 105684 (granted by Horizons 11 January 2012 and which expired 1 December 2014)

This includes current scientific data, proposed upgrades and acknowledgement of the Tangata Whenua, Fish and Game and other stakeholder consultation that is under way to provide a better understanding of the operational requirements and environmental effects of the activities.

RDC has been advised that the application for the renewal of the Whakapapa wastewater resource consent is required to be lodged with Horizons Regional Council by 14 March, 2016.

Tongariro National Park is a cornerstone of tourism in the Ruapehu District, attracting almost one million visitors annually. Tourists visit some of its biggest attractions including two major ski fields, Whakapapa and Turoa located on the slopes of Mount Ruapehu, and one of New Zealand's Great Walks, the Tongariro Alpine Crossing. Whakapapa Village provides support to this tourism industry and RDC is committed to working with DOC to ensure a safe, reliable wastewater collection network and treatment system that is sustainable and effective for the Ruapehu District. Effective and efficient wastewater collection and disposal is essential to protect the environment and to maintain public health.

On that basis, RDC wish to provide the following statement to be included with the application lodged by DOC for the Whakapapa wastewater resource consent:

1 Ruapehu District Council (RDC) has been involved in discussion surrounding the application for the renewal of the Whakapapa wastewater resource consent application since July 2015.

There is ongoing collaborative effort between RDC and the Department of Conservation (DOC) to avoid, remedy or mitigate cultural and environmental effects associated with the renewal of the resource consent noted above and operation of the plant.

2 We have not had the opportunity to review the final application documentation at the present time however we have been presented with the key elements of the application.

3 We acknowledge that a term of consent of 30 years is being sought.

4 We have been advised that we will be provided with a full copy of the final application when it is lodged to enable us to complete a full review.

5 On the basis of the above points, we wish to advise Horizons Regional Council that we support, in principle, the renewal of the Whakapapa wastewater resource consent by the DOC, subject to viewing the final consent application documentation.

Yours sincerely

Clive Manley
CHIEF EXECUTIVE

JF

Mt RUAPEHU
WHAKAPAPA & TUROA
Ruapehu Alpine Lifts Limited
Whakapapa Ski Area
Private Bag 71902
Mt Ruapehu 3951
New Zealand
Ph: 07 892-4000
Fax: 07 892-3732
Email: info@mtruapehu.com
www.MtRuapehu.com

9 March 2016

Dr Nic Peet
Group Manager Strategy and Regulation
Horizon's Regional Council
Private Bag 11025
Manawatu Mail Centre
Palmerston North 4442

Ruapehu Alpine Lifts (RAL) and the Department of Conservation (DOC) – Whakapapa WWTP Resource Consent Application

Dear Nic,

RAL supports the reconsenting of the (DOC) Whakapapa Wastewater Treatment Plant resource consent, with an application being lodged with Horizon's Regional Council on Monday 14th March 2016. This application will seek consent for:

- Discharge Permit for the discharge of human effluent onto land.
- Discharge Permit for the discharge of contaminants overland to stream or river identified as a natural state.

As a stakeholder and a community service provider within the Iwikau and Whakapapa Village, DOC has regularly held workshops and meetings in support of the resource consent process, including the proposed lodgement of this updated resource consent application. In addition, at the request of the stakeholders, DOC has had the original consent process peer reviewed through Ruapehu District Council's Engineering Consultant, Veolia, who have recommended additional improvements to Plant Treatment and process which have been incorporated in this updated consent application. RAL support this review, the recommendations made and the re-lodging of the resource consent application.

In accordance with the requirements of the Resource Management Act 1991, and as a directly affected party, RAL supports the proposal to re-consent the Whakapapa WWTP. As a stakeholder we are supportive of the adaptive approach proposed by DOC as part of any resource consent approval given by Horizon's Regional Council, and note all upgrades and improvements must be compliant and affordable.

If you have any questions regarding this letter of support please contact me.

Yours sincerely

Dave Mazey

Dave Mazey
CHIEF EXECUTIVE OFFICER

LOVE WINTER
LOVE RUAPEHU
www.mtruapehu.com

Mt RUAPEHU
WHAKAPAPA & TUROA

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9 March 2016

Dr Nic Peet
Group Manager Strategy and Regulation
Horizon's Regional Council
Private Bag 11025
Manawatu Mail Centre
Palmerston North 4442

Ruapehu Alpine Lifts (RAL) and the Department of Conservation (DOC) – Whakapapa WWTP Resource Consent Application

Dear Nic,

RAL supports the reconsenting of the (DOC) Whakapapa Wastewater Treatment Plant resource consent, with an application being lodged with Horizon's Regional Council on Monday 14th March 2016. This application will seek consent for:

- Discharge Permit for the discharge of human effluent onto land.
- Discharge Permit for the discharge of contaminants overland to stream or river identified as a natural state.

As a stakeholder and a community service provider within the Iwikau and Whakapapa Village, DOC has regularly held workshops and meetings in support of the resource consent process, including the proposed lodgement of this updated resource consent application. In addition, at the request of the stakeholders, DOC has had the original consent process peer reviewed through Ruapehu District Council's Engineering Consultant, Veolia, who have recommended additional improvements to Plant Treatment and process which have been incorporated in this updated consent application. RAL support this review, the recommendations made and the re-lodging of the resource consent application.

In accordance with the requirements of the Resource Management Act 1991, and as a directly affected party, RAL supports the proposal to re-consent the Whakapapa WWTP. As a stakeholder we are supportive of the adaptive approach proposed by DOC as part of any resource consent approval given by Horizon's Regional Council, and note all upgrades and improvements must be compliant and affordable.

If you have any questions regarding this letter of support please contact me.

Yours sincerely

Dave Mazey

Dave Mazey
CHIEF EXECUTIVE OFFICER

15th July 2016-07-14

Dr Nic Peet
Group Manager Strategy and Regulation
Horizons Regional Council
Private Bag11025
Manawatu Mail Centre
Palmerston North 4442

Letter of Support for the Department of Conservation Whakapapa WWTP Wastewater Consent Application 2016-07-14

Dear Dr Peet,
As representative of stakeholders within the Whakapapa/Iwikau Villages, after much consideration we the Ruapehu Mountain Clubs Association has decided to support the process of the DOC Whakapapa Wastewater Treatment Plan Resource Consent application which we understand has been lodged with Horizons Regional Council in June 2016-07-14.
In accordance with the Resource Management Act 1991 and as representing directly affected parties which are the Ski and Tramping Clubs in those villages, we support the proposal to consent to the Whakapapa WWTP and give our written approval to the Resource Consent Application submitted by DOC for the WWTP.
We are supportive of the staged and adaptive approach proposed by DOC as part of any Resource Consent approval given by Horizons Regional Council as all upgrades and improvements need to be compliant and affordable over time.

Yours sincerely

A-M Josephine Bouchier
President Ruapehu Mountain Clubs Association
President@rmca.org.nz
P.O. Box 26354
Epsom
Auckland 1344

Skotel Alpine Resort Ltd

Ngauruhoe Place, Whakapapa Village
P O Box 71 030, Mt Ruapehu 3951
Ph 07 8923719

9th May 2016

Dr. Nic Peet
Group Manager Strategy and Regulation
Horizon's Regional Council
Private Bag 11025
Manawatu Mail Centre 4442

Statement in Support of the Department of Conservation (DOC) – Whakapapa WWTP Resource Consent Application 2016

Dear Dr Peet,

As a stakeholder within the Whakapapa/Iwikau Village we, the Skotel Alpine Resort Ltd support the process of the DOC Whakapapa Wastewater Treatment Plan resource consent application to be officially lodged with the Horizon's Regional Council in June 2016.

In accordance with the Resource Management Act 1991 and as a directly affected party, the Skotel Alpine Resort supports the proposal to consent the Whakapapa WWTP and we give our written approval to the resource consent application submitted by DOC for the Whakapapa Wastewater Treatment Plant.

The climatic conditions that are present on the site of the proposals provide some difficulties in ensuring that designed processes work satisfactorily. We believe that it is essential to adopt the staged and adaptive approach proposed by DOC as part of any resource consent approval given by Horizon's Regional Council. The proposed upgrades and improvements need to be both compliant over time and affordable for those responsible for the capital and running cost.

Yours sincerely,

John Strevens

John Strevens
Director
Skotel Alpine Resort Ltd

We do not wish to be heard at any hearing for this application
Address for service:- Skotel Alpine Resort, P O Box 71030, Mt Ruapehu 3951

APPENDIX 13

WHIO SURVEY

Whakapapa Wastewater Treatment Plant Whio Survey

Bubs Smith

Geoff Marshall

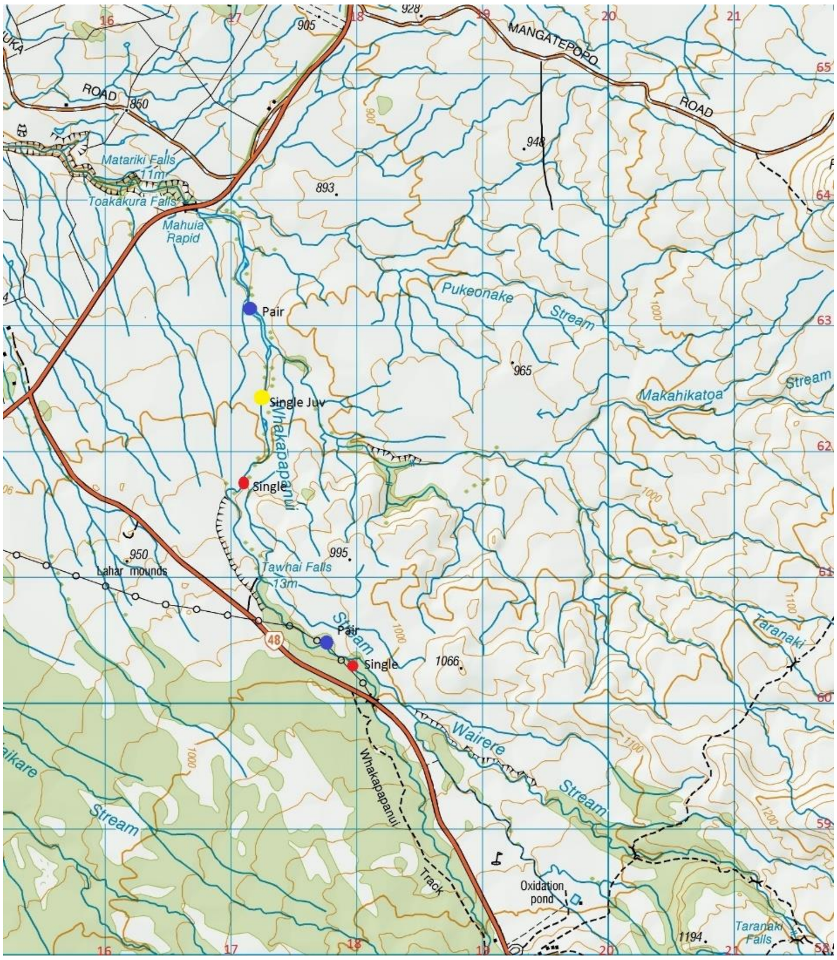
27th Feb 2016

Whio Survey
Saturday 27th Feb 2016

Site
Tributary adjacent to Whakapapa Oxidation pond, downstream to Wairere Stream and then the Whakapapanui stream downstream SH47 at Mahuia rapids. Total distance of 9.24 km.

	sex		easting	northing
single	unknown	Bird flew up stream	1817948	5660324
pair	Unbanded pair	Pair stayed	1817770	5660469
single	Female adult	Bird flew downstream	1817080	5661745
single juvenile	Unknown CV Juv	Bird stayed	1817255	5662424
pair	Unbanded pair	Pair flew down to territory and back up	1817126	5663176

Total
2 pairs
2 single
1 Juvenile



Wairere Stream Trib. (2.6km) - 0.05 m^3/s

This stream can be broken into 2 distinct sections

Top section (0.8km)

Although there is ample riparian vegetation along the stream, the stream holds very little invertebrates even if birds are wanting to "hide away" during moult.
After 2-300 mts from the Oxidation pond, there is a noticeable increase of nutrients in the stream which can be attributed to the seepage from the "field where the pipes are lain"

Photo looking upstream of the trib beside oxidation pond

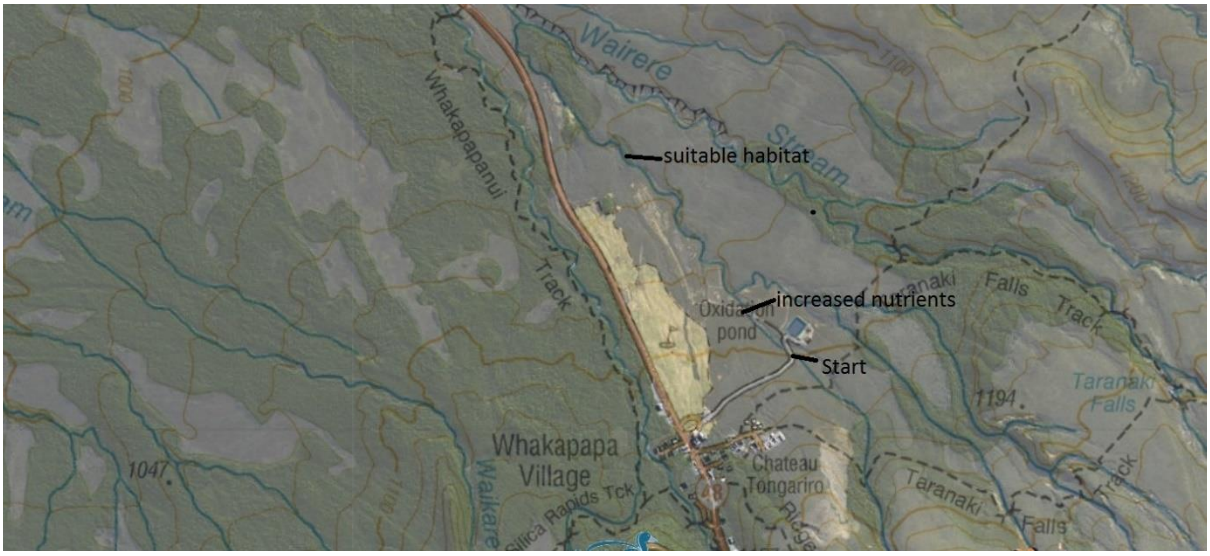
Lower Section (1.8km)

This section has really good forest growth for 2km until it meets the Wairere stream. Ideal for whio to "hide" when in wing moult, but although there are more invertebrates than upper section, still a bit of green slime on most of the rocks until the Wairere stream. About half of the substrate for this section of the stream is not ideal for invertebrates as the rocks seem to be fused to the bed. (kind of like concrete). Believe there would be a lot of pressure from predators due to proximity to golf course and the high number of rabbits

Photo looking downstream amongst forested lower section

	distance	vegetation	invertebrates	water
Upper section of Trib	300 mts	Tussock, toitoi, heather	poor	Good, although not many inverts

Lower section of Trib	2.0 kms	Beech trees	A few	Few more inverts but 1 km of hard substrate



Wairere Stream (600mts) - 0.5 m^3/s

Noticeable difference in regards to the stream substrate. Really ideal habitat although we never saw any whio downstream to the Whakapapanui confluence, there was a bit of sign on the rocks of birds presence. (duck shit)

Looking downstream on Wairere at confluence of tributary from oxidation pond.

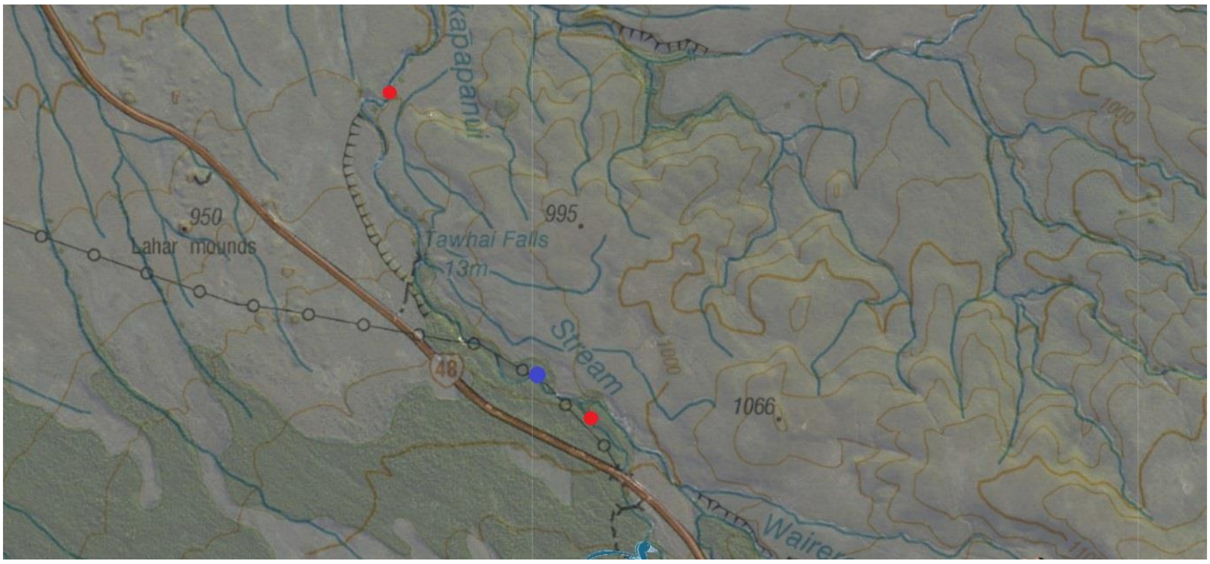
	distance	vegetation	invertebrates	water
Wairere	600 mts	Tussock, toitoi, heather, bush	Very good	Noticeably better water quality.

Whakapapanui Stream 6.04km – 2.0 m^3/s

First sighting of single bird was at confluence of Wairere and Whakapapanui streams. Bird flew upstream and was unable to identify the sex. Quite a bit of duck shit around confluence with an additional 1.5m^3/s of water.

2nd sighting was of a pair on the Whakapapanui below Wairere confluence. Very territorial pair with vocal male. This pairs territory is above the Tawhai falls.

Geoff marking pairs location on GPS

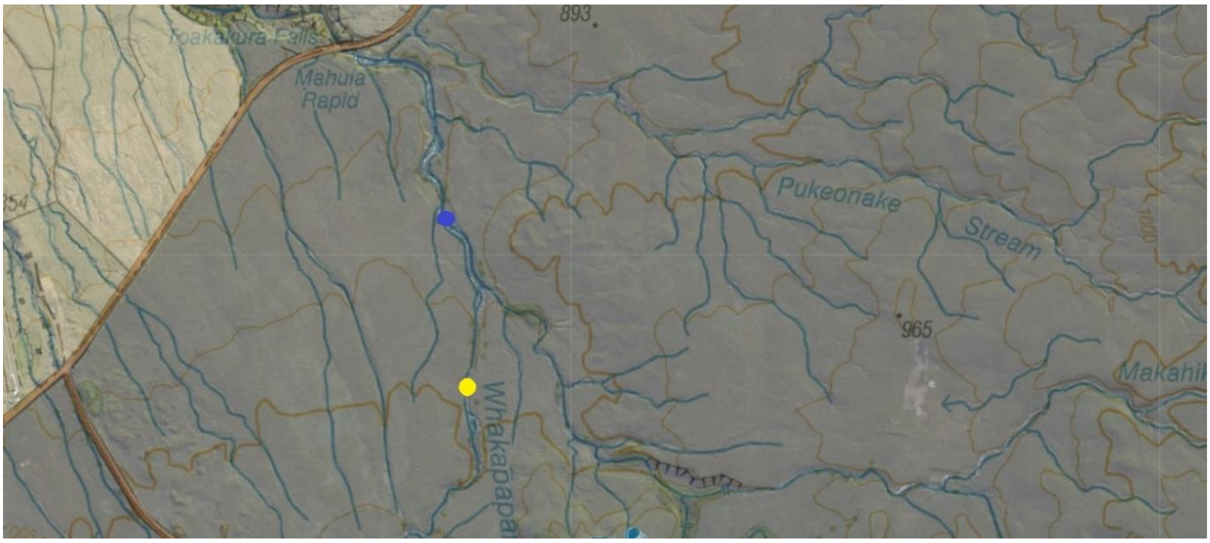


3rd sighting was of an adult female below the Tawhai falls. This female was well hidden under rocks and would not have noticed without the presence of the dog. This female flew downstream and saw once more 600 mts downstream. Never saw male mate but suspect he was probably hidden away in wing moult.

Fourth sighting was a CV juvenile whom was happily sitting on a rock in the middle of the river.

Fifth sighting was a pair whom were quite vocal which eventually flew downstream to the end of their territory and then back upstream. This pair was below the Makahikatoa stream which adds another 2.5m^3/s to the flow.

5th pair photo.

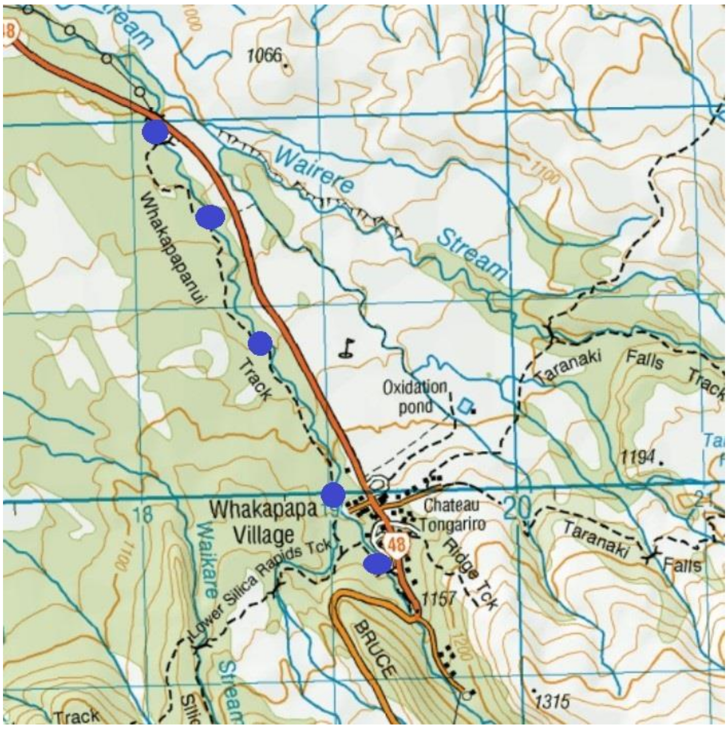


Quite sure there was another pair just at Mahuia rapids which probably swam down into gorge but we were a bit too slow to get to rapids before they went into gorge.

Comment

The tributary that was surveyed adjacent to the Oxidation pond is not an ideal habitat for whio because of the meagre abundance of invertebrates for most of the streams length, the abundance of predators due to closeness of golf course and the fact that the Tributary runs parallel between both the Wairere and Whakapapanui which is highly desirable habitat. This is highlighted in the map below which was surveyed a week later which shows there being 5 pairs on the Whakapapanui river between the Bruce Road bridge and Wairere stream confluence. (per comms Dean Flavell)

Within the tributary we observed what we believe to be brook trout. No known rainbow or brown in these upper reaches as the Matariki Falls (11mts) and the Tawhai Falls (13mts) restrict access.



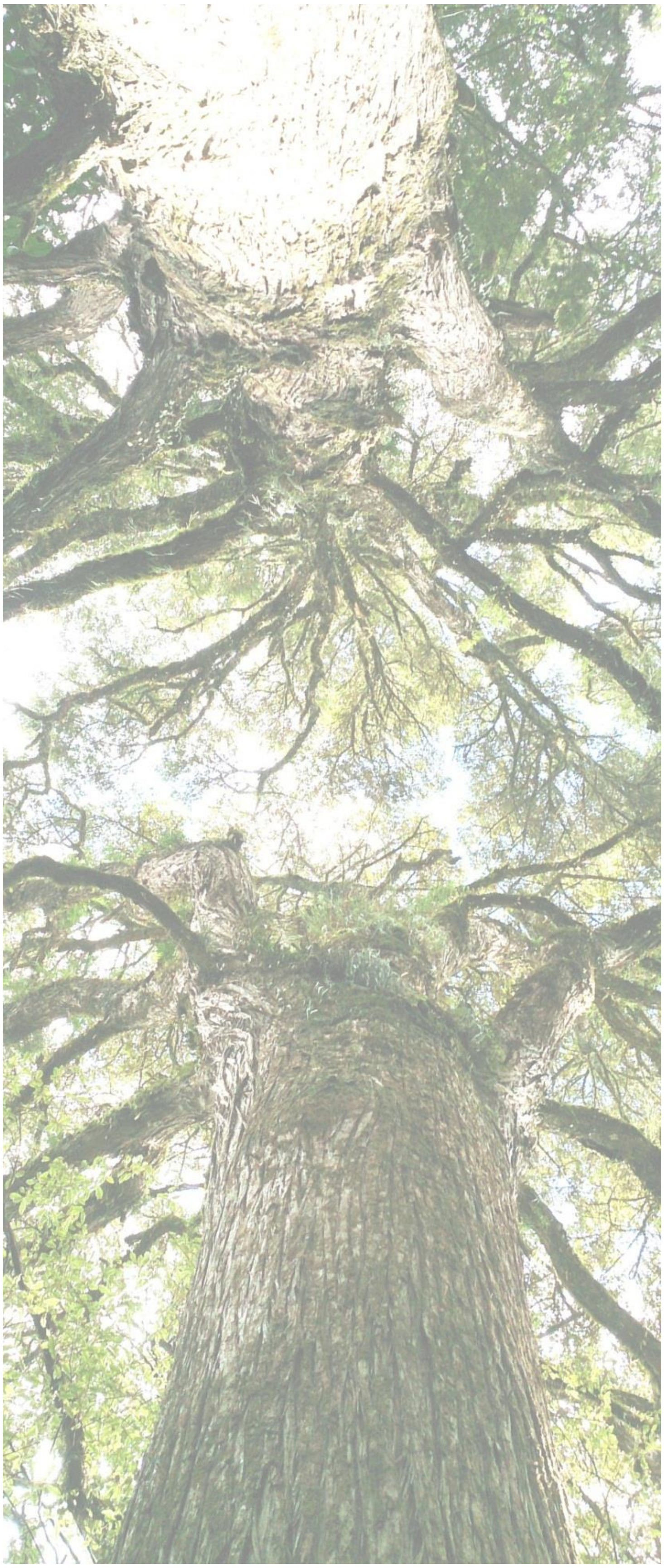
5 Pairs from Bruce road bridge down to confluence of Wairere stream

Total survey distance	9.24km
Start time	8.00am
Finish time	3.30pm
speed	1.34km/h
Start point	Oxidation Pond (E1819689, N5658401) 1100asl
End point	Mahuia Rapids (E1816741, N5663900) 840asl
Descent	260 mts = 28 mts/km
Catchment area at end	79.2 km^2
Flow at end point	6.3m^3/s
Weather	Overcast day

Pairs	2
Singles	2
Juveniles	1

APPENDIX 14

LANDSCAPE PLAN



Whakapapa Wastewater Treatment Plant — Landscape Plan

Prepared for:
Department of Conservation, Ruapehu District Office

Compiled by Nicholas Singers Ecological Solutions Limited.

NSES Ltd report 7: 2016/17

Author(s): Nicholas Singers and Christine Bayler for Nicholas Singers Ecological Solutions Limited
Date: June 2016

DISCLAIMER

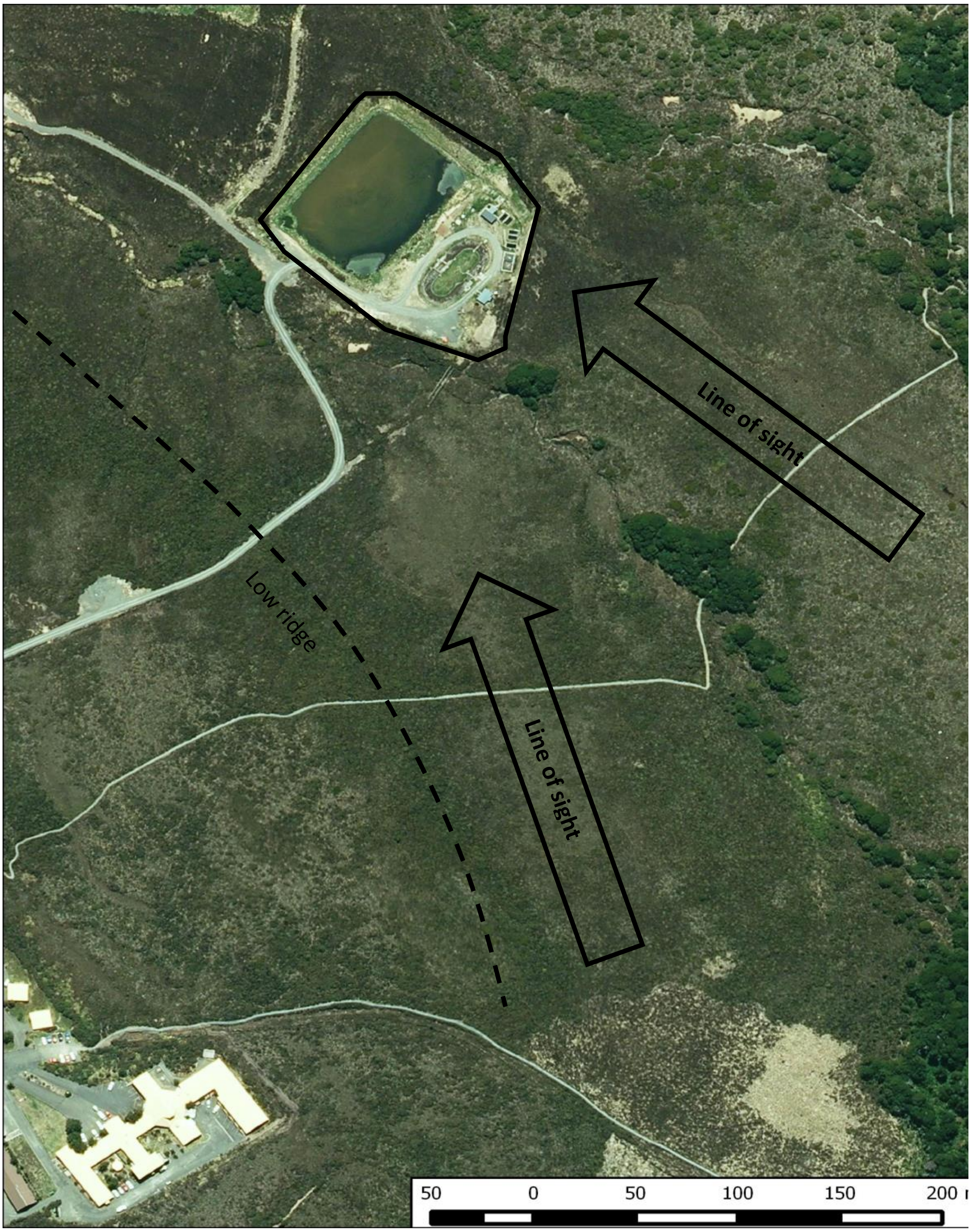
This report has been prepared by Nicholas Singers Ecological Solutions Ltd (NSES Ltd.) exclusively for and under contract to Department of Conservation. Unless otherwise agreed in writing by NSES Ltd., NSES Ltd. accepts no responsibility for any use of, or reliance on any contents of this report by any person other than Department of Conservation and shall not be liable to any person other than Department of Conservation, on any ground, for any loss, damage or expense arising from such use or reliance.

Contents

Introduction

The Whakapapa wastewater treatment plant is located in Tongariro National Park in a subalpine environment. The visual impact of the treatment plant is of concern in the setting of the Park and can be clearly seen from the Taranaki Falls Track and the Tongariro Northern Circuit Track, though is hidden from most of the Whakapapa Village by a low ridge. It is most obvious from Taranaki Falls Track which comes within 200-250 m of the treatment plant (Figure 1).

Figure 1: Overview of the Whakapapa wastewater treatment plant showing the Taranaki Falls Track.



The vegetation surrounding the plant is low statured shrubland dominated by heather (*Calluna vulgaris*), manuka (*Leptospermum scoparium*) and inaka (*Dracophyllum longifolium*) and is in the process of vegetation succession — eventually to forest of mountain toatoa (*Phyllocladus alpinus*) and mountain beech (*Fuscospora cliffortioides*). The colour and texture of this vegetation ranges from the dark green of mountain beech trees through the variable khaki colours of manuka, red–purple of heather and orange-brown of inaka, to the bluish–green of scattered mountain toatoa. Of these heather and manuka are the most abundant and are similar in colour except when flowering. While present within mountain beech forest, there is a lack of large leaved deep green vegetation, such as Colenso's kohuhu (*Pittosporum colensoi*), mountain five-finger (*Pseudopanax colensoi*), three-finger (*Raukawa simplex*), broadleaf (*Griselinia littoralis*) and large-leaved coprosma shrubs. For the treatment plant to blend better into the surrounding environment, use of vegetation that is similar in colour, texture will be required to screen buildings and infrastructure and to replace exotic grassland vegetation.

At present the immediate area of the treatment plant is dominated by introduced grasses, which until recently were mown. The vivid green of the grass is a stark contrast to the vegetation of the surrounding landscape. This contributes to making the treatment plant visually polluting, as does the use of white and orange barriers and the clutter around the structures (Figure 2).

Figure 2: View of Whakapapa wastewater treatment plant from Taranaki Falls Track. Note: the colour and texture of the hinter vegetation dominated by heather, manuka and mountain toatoa grading into the dark foliage of mountain beech. This will be replicated around the plant.

Landscape screening of the treatment will require densely planting scrub and trees capable of growing to 7–8m to create a physical screen. This however will take several decades and consequently more rapid landscape change is required to visually soften appearance. Key to this will be to change the vegetation around the settling pond to be more natural and assist to modify the structures square boundary.

As all planting material must be locally sourced in order to comply with the Tongariro National Park Management Plan simply purchasing suitable plants from a local nursery is very limited. Consequently suitable plants will need to be sourced locally from seed, cuttings, or wild sourced seedlings. This will mean that the goal of reducing the visual impact of the treatment plant will not be immediately possible due to these circumstances.

Landscape Plan

Suitable plants need to be resilient, have low palatability to mammalian browsers such as hares, deer and rabbits, and be in-keeping with the surrounding environment. Plant spacing has a huge influence on the speed of vegetation change — the closer the planting distance the shorter the period of vegetation change will be. Planting at 1 x 1 m spacing's should result in close to 100% cover within 4–5 years, while at 2 x 2 m this could take three times as long. Manuka is the best choice for most of the planting areas, because it is easy and cheap to grow, can be ready to plant in 12 months and is not palatable to most browsers. Importantly, manuka is also a very common plant in the immediate area. To avoid a monoculture look, manuka would need to be interspersed with slower growing species to match the diversity of form and texture of the surrounding environment as shown in the hinter of Figure 2. Manuka also provides an ideal nurse crop for vegetation succession so it is expected that eventually wild seedlings of other species will colonise beneath it.

While toetoe (*Austroderia fulvida*) would also be a suitable choice with regards to its availability, rapid growth, resilience and low palatability, its form and colour, especially when planted *en masse* would be visually discordant with the surrounding environment. For this same reason the bright green palatable shrubs such as broadleaf, Colenso's kohuhu, mountain five finger and three finger are also unsuitable, as their form and colour are not present in the immediate area.

The areas proposed for landscaping are shown in Figure 3.

- Area 1 (approximately 2,330 m^2). It is recommended that this area be planted at 1 x 1 m spacing to quickly transform the area to hide the settling pond and buildings. The eastern margin will effectively be planted as a hedge of manuka. This will also help to reduce the potential visual impact of the planned waste-water treatment wetland below the pond from the two tracks. Manuka should mostly be used for this area (95%), interspersed with mountain beech and mountain toatoa (5. Around the margin of the settling pond pukio (*Carex secta*) and giant spiked sedge (*Eleocharis sphaceolata*) should be planted at 0.5 x 0.5 m spacing. This will soften the margin of the pond making it appear more natural. There are already several pukio growing in this area. Both of these plants should grow extremely rapidly utilising the available nitrogen and may also assist with a small amount of nitrogen removal. This area would require approximately 530 pukio/giant spiked sedge, 1995 manuka, 55 mountain beech and 50 mountain toatoa.

- Area 2: is approximately 1,450 m^2. Here it is recommended that trees are supplementary planted at 2m x 2 m spacing amongst the existing vegetation to creat a tall growing visual barrier. To do this a mixture of mountain beech and mountain toatoa should be used for this area (Figure 4). This in effect will increase the size of the small beech forest remnant on the south eastern corner. This area would require approximately 180 mountain beech and 180 mountain toatoa.
- Area 3: is approximately 180 m^2 around the outside of the race plus 228 m^2 in the centre. This area should be planted with snow totara (*Podocarpus nivalis*), which is low growing enough to not impede access, but robust enough to withstand trampling, durable and long-lived. Snow totara is not immediately present but is abundant above the mountain beech bush line. Snow totara has a colour and form which is in-keeping with the surrounding area. Snow totara would be planted at 1 x 1 m spacing – excluding path areas, requiring approximately 408 plants which would create a large carpet around and in the centre of the race.

Figure 3: Landscape plan for Whakapapa wastewater treatment plant.

Figure 4: Whakapapa wastewater treatment plant from the Northern Circuit Track showing how a line of beech and mountain toatoa trees could screen the facility from view. Some saplings of these species are already present

Sourcing plants

The ability to source suitable planting material from a commercial nursery is a limiting factor in the development of this landscape plan. Manuka and pukio are both very fast growing native species and can be grown to planting grade size within 12 months. Seed of both is freely available locally — suitable seed of pukio has already been collected for the wastewater treatment wetland.

Slower growing species such as mountain beech and mountain toatoa will take 2-3 years to reach a suitable planting size from seed. Both however are very free seeding plants in the wild and locally hundreds of seedlings of these species can be found easily in suitable sites. The main advantage of collecting wild seedlings is that the time which plants are ready to plant out can be reduced and it also ensures that plants are ecologically suitable. As such it is recommended that wild seedlings of mountain beech and mountain toatoa (<15cm high) are collected and then grown on to planting size within a nursery. It is likely that a range of other ecological suitable species will also be able to be sourced from collecting wild seedlings, such as inaka and thin barked totara. Any additional species could be accommodated with the three planting areas and would help to increase the complexity of the plantings to better match adjoining vegetation. Snow totara is easily grown from cuttings which are readily available from the park, for example off Bruce Road above the Silica Springs track.

Land preparation, planting and post-planting protection

All areas intended to be planted will require some pre-planting preparation especially control of exotic grass and heather, to reduce competition while plants are small sized. In areas 1 and 3 exotic grass will need to be sprayed with a higher than normal (2%) mixture of glyphosate as chewing's fescue is present which is difficult to kill.

In area 2, heather will need to be sprayed with Metsulfuron-methyl (35gms/100L) making sure to avoid killing saplings of natives such as manuka, inaka, mountain toatoa. As heather takes a long time to break down it should be sprayed soon so the planting area is more suitable when the plants are ready. It is likely that a small amount of vegetation trimming will be required in area 2 where manuka is already dense to create light wells for trees.

Mountain beech seedlings will also require protection from hares and rabbits. Suitable tree protectors with stakes would be required. All plants should also be fertilised with a long life fertiliser tablet placed into the bottom of the planting hole below the roots.

Plants should also be mulched with wool mats which prevent grass and other weeds from growing around them. While initially expensive, wool mats prevent the need for spray releasing 2–3 times and can result in up to 5-10% morality of planted trees. Old wool carpet is another option which is used by Project Tongariro at the Te Matapuna Wetland planting sites and is cut into squares by the Tongariro Prison, though using this is dependent on the availability of wool carpet locally. Both wool mats and old carpet break down within 12-15 months.

Alternative Landscaping Methods

To decrease costs, other methods could also be considered. Areas where large quantities of manuka are required, instead of planting, laying of manuka slash could be used instead. Manuka slash could be obtained from the edges of vehicle tracks such as along the treatment plant road or Kapoors Road. Grass and other vegetation would first need to be sprayed out and then manuka slash densely placed over the area. If this practice was carried out in early November a good strike of seedlings should result.

Heather is particularly abundant in the immediate area surrounding the treatment plant. As heather is quite competitive with native vegetation and retards growth, it is stalling vegetation succession. In area 2 it is recommended that heather control be undertaken as soon as possible, however outside of this area a release of the heather beetle biocontrol agent to control heather may be a simple way to control heather and encourage faster native regeneration in the surrounding environment. This would assist to increase the speed of native regeneration around the treatment plant.

APPENDIX 15

PHOTO MONTAGE OF WETLAND

1 WHAKAPAPA WASTEWATER WETLAND CONCEPT PLAN
1:750

client / project name: DoC/ WHAKAPAPA WASTEWATER WETLAND
drawing name: **LANDSCAPE CONCEPT PLAN**
designed by: Stuart Farrant
drawn by: Hannah Dow
original issue date: 28 FEBRUARY 2017
scales: As shown

revision no:	amendment	approved	date

dcm URBAN

DCM URBAN DESIGN LIMITED
28 NORMANS ROAD
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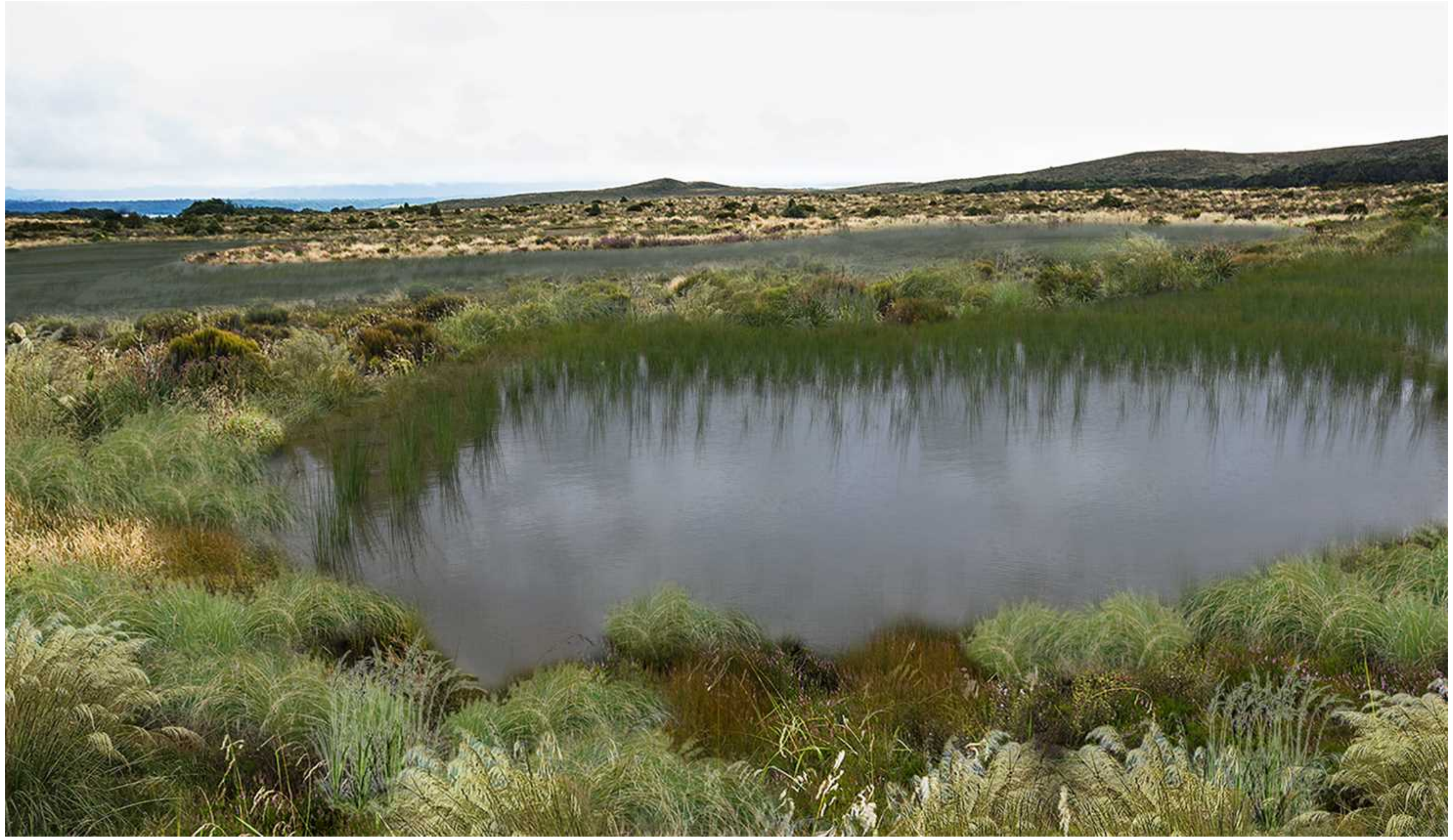
021 114 0377 WWW.DCMURBAN.COM

MORPHUM ENVIRONMENTAL LTD

project no / drawing no.: **2017_003 / 001**

revision: **0**

1 WHAKAPAPA WASTEWATER WETLAND PERSPECTIVE - EXISTING VIEW
NTS



2 WHAKAPAPA WASTEWATER WETLAND PERSPECTIVE - PROPOSED VIEW
NTS

client / project name:	DoC/ WHAKAPAPA WASTEWATER WETLAND	**revision no:**	**amendment**	**approved**	**date**
drawing name:	**LANDSCAPE CONCEPT PERSPECTIVE**				
designed by:	Stuart Farrant				
drawn by:	Hannah Dow				
original issue date:	28 FEBRUARY 2017				
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dcm URBAN

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project no / drawing no.: **2017_003 / 002** revision: **0**

APPENDIX 16

OPTIONS ANALYSIS - MWH

Attachment B: Options Assessment

A colour code is used to illustrate a ranking of each factor for each option, as follows.

G	Factor indicates option is favourable in respect of the factor
R	Factor indicates option is unfavourable in respect of the factor
A	Uncertain: more information needed, or midway been a favourable or unfavourable situation

Option	Drip irrigation	Trenches	Overland Flow	Wetlands	Discharge outside Park
Factor					
Technical					
Land area	Large area required; technically available in Amenities Area but significant topographical modification	Large area required; technically available in Amenities Area but significant topographical modification	Modest area; land available in Amenities Area	Modest area; land available in Amenities Area	Constraint of being with Amenities Area does not exist
Area location	Most of Amenities Area possibly including golf course	Existing area and old paddock	Old paddock	Old paddock	Unknown
Cold climate	Nutrient uptake reduced but uncertain if a performance issue will result	Nutrient uptake reduced but uncertain if a performance issue will result	Nutrient uptake reduced but uncertain if a performance issue will result	Nutrient uptake reduced but uncertain if a performance issue will result	Nutrient uptake reduced but uncertain if a performance issue will result
High rainfall, snow and snow melt	Uncertain if these would compromise option	Uncertain if these would compromise option	Uncertain if these would compromise option	Uncertain if these would compromise option but probably no.	Uncertain if these would compromise option
Water table	Uncertain about water table rise and compromising option	Uncertain about water table rise and compromising option	Not an issue	Not an issue	Unknown; probably same as for Amenities Area options
Soils	Uncertain about suitability of soils	Uncertain about suitability of soils	Soils not an issue	Soils not an issue	Unknown; probably same as for Amenities Area options
Gravity feed or pumped	Uncertain; likely pumping will be needed	Uncertain; likely pumping will be needed	Gravity	Gravity	May function by gravity
Longevity	Finite life indicatively 20 years	Finite life indicatively 20 years	Indefinite	Indefinite	As for Amenities Area options
Maintenance requirements	High	High	Low	Low	Unknown; probably same as for Amenities Area options

Option	Drip irrigation	Trenches	Overland Flow	Wetlands	Discharge outside Park
Factor					
Risks	High relating to high groundwater & surface water flow; SIN exceedance; premature soil / dripper clogging; failure to obtain sufficient suitable land	High relating to high groundwater & surface water flow; SIN exceedance; premature soil clogging; failure to obtain sufficient suitable land	High relating to high groundwater & surface water flow (can be mitigated); SIN exceedance and increase DRP in surface water; insufficient storage if snow cover or frozen ground	Low but risk of SIN exceedance and increase DRP in surface water. Possible problems with freezing.	Probably same as for Amenities Area options
Effects					
Cultural					
Landscape effects	Large area of land engineered	Moderate area of land engineered	Moderate/ small area of land engineered; contrasting / non-native plant cover	Small area of land engineered;	Low
Aquatic effects	Unknown	Unknown	Unknown	Unknown	Unknown
Terrestrial ecology effects	Uncertain; possible effects because of soil moisture regime, nutrients, rabbit / predator issues	Uncertain; possible effects because of soil moisture regime, nutrients, rabbit / predator issues	High modification: contrasting / non-native plant cover; may facilitate rabbit / predator issues	Low modification; use native plants	Low modification
Need to exclude the public	No	No	Yes	No (but yes from wetland water)	Yes (private land)
Public perception	Favourable	Favourable	Unfavourable	Favourable	Favourable
Regulatory					
RMA and TNPMP	Favourable	Favourable	Uncertain	Favourable	Favourable
Compliance with Horizons in-stream guidelines	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain

APPENDIX 17

HYDROGEOLOGICAL ASSESSMENT FOR WETLAND AREA - LATTEY

HYDROGEOLOGICAL INVESTIGATION
AREA G

WHAKAPAPA VILLAGE
WASTE WATER TREATMENT PLANT
STATE HIGHWAY 48
MOUNT RUAPEHU

PROJECT NO. J16125-REP-02

PREPARED FOR
DEPARTMENT OF CONSERVATION

PREPARED BY
ALASDAIR PARK

January 2017

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Report Prepared by:

Alasdair Park
Geologist

Report reviewed by:

Susan Rabbitte
Principal Geologist/Hydrogeologist

EXECUTIVE SUMMARY

Development of a surface flow wetlands system is proposed at Whakapapa WWTP. An initial 5Ha wetland is planned for construction on Area G. Surface flow wetlands require an impermeable or low permeability base layer to prevent uncontrolled escape of water from the system. The nature of the underlying geology will have a bearing on water flow out of the wetlands. Hydrogeological investigations have taken place at several locations across the disposal fields. These indicate that while variable, there is a general near surface geological profile of Soil, Ash, Pumice and Conglomerate. The current design plan involves using a layer of clay rich Ash to line the wetland cells. Investigation directly on Area G, is however, limited. Lattey Group (Lattey) was engaged by the Department of Conservation (DOC) to confirm the near surface geological profile of Area G, assess the suitability of the ash layer for use as a low to impermeable cell liner and assess the hydrogeological risks to the development of the wetland.

The objectives of this investigation are therefore to confirm the nature of the near surface geology underlying Area G. Identify the type and thickness of the underlying geological units. Establish the suitability of clay-rich Ash layers for use as a low permeability to impermeable liner for the wetlands. Assess the risk of uncontrolled escape of effluent from the wetland system though the ground prior to treatment by plants.

Investigation included the geological logging of disturbed soil hand auger samples from six sites across Area G and permeability testing of two representative samples from an accessible outcrop just outside the southern boundary of Area G.

The predicated pattern of soil, sandy pumice and clay rich ash was observed across Area G in the six hand auger samples. Soils were damp and the sandy pumice layer was wet indicating it is a water bearing unit and is permeable. Nearby outcrops show the clay rich ash layer to be underlain by conglomerate. 'Outcrop 6', 35m South West of the area, shows 80cm red conglomerate with filled vertical fractures on top of a dark grey, boulder rich conglomerate. Previous investigation shows ash on top of a hard, light brown conglomerate at the junction of the northern and southern tributaries.

An ideal permeability value of 10^{-9}, which represents 'practically impervious' drainage was identified for the ash liner by design engineers. Permeability testing results indicate that the clay rich ash layer is on the boundary between 'low' drainage and 'practically impervious' with results values close to 10^{-8}. Based on these findings this would be suitable for use as a low permeability liner for the wetland cells.

Clay rich ash was present in the base of all six hand auger holes, however the base of this layer was not reached. A thickness of approximately 1m has been estimated for the ash layer based on extrapolating the log from 'Outcrop 6'. Water was observed in the overlying pumice layer and it is assessed that the current thickness of clay is suitable for creating a low permeability layer, the estimated thickness is in the order of 1m.

While the predicated geological layers were confirmed, investigation of nearby outcrops showed considerable disturbance to geological boundaries and some changes to bed thickness. Based on the variation observed in nearby outcrops, there is expected to be some variation of bed thicknesses and geological boundaries across the area. Areas where there is no clay rich ash should be identified during earth works and ash should be moved from non-cell areas to cover any exposed conglomerates. Ash layers may contain occasional areas with pebbles or boulders, these may affect the ability of the cell to retain water and should be removed and replaced with, or covered with ash from a non-cell area. It is recommended that an inspection of the cells be made by the design engineer or other suitably qualified person prior to filling with water to confirm adequate ash coverage and identify any unusual areas.

TABLE OF CONTENTS

1.0 INTRODUCITON

1.1 BRIEF

Development of a surface flow wetlands system is proposed at Whakapapa WWTP. An initial 5Ha wetland is planned to be constructed on Area G. Surface flow wetlands require an impermeable or low permeability base layer to prevent uncontrolled escape of water from the system. The nature of the underlying geology will have a bearing on water flow out of the wetlands. Hydrogeological investigations have taken place at several locations across the disposal fields. These indicate that while variable, there is a general near surface geological profile of Soil, Ash, Pumice and Conglomerate. The current design plan involves using a layer of clay rich ash to line the wetland cells. Investigation directly on Area G, is however, limited. Lattey Group (Lattey) was engaged by the Department of Conservation (DOC) to confirm the near surface geological profile of Area G, assess the suitability of the ash layer for use as a low to impermeable cell liner and assess the hydrogeological risks to the development of the wetland.

1.2.1 OBJECTIVES

The objectives of this investigation are therefore to confirm the nature of the near surface geology underlying Area G. Identify the type and thickness of the underlying geological units. Establish the suitability of clay rich ash layers for use as a low permeability to impermeable liner for the wetlands. Assess the risk of uncontrolled escape of effluent from the wetland system though the ground prior to treatment by plants.

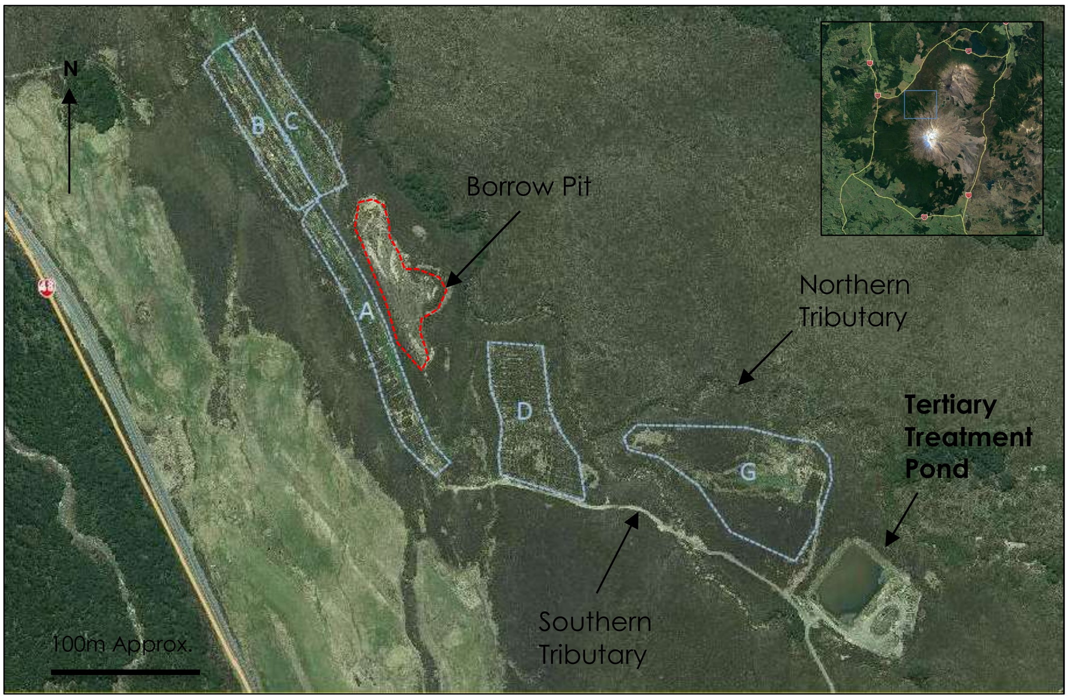
Investigation included the geological logging of disturbed soil hand auger samples from six sites across Area G and permeability testing of two representative samples from an accessible outcrop just outside the southern boundary of Area G.

2.0 SITE DESCRIPTION AND LOCATION

2.1 SITE DESCRIPTION

The site is located north of the village of Whakapapa, in the Tongariro National Park, Figure 1, with the address Whakapapa Village, State Highway 48, Mount Ruapehu. The legal description of the property is Tongariro National Park Lot 7 DP69559. Map References include NZMS260 519:296-201; NZ Topo50 BH34:196-585.

FIGURE 1: SITE LOCATION AND WASTE DISPOSAL FIELDS



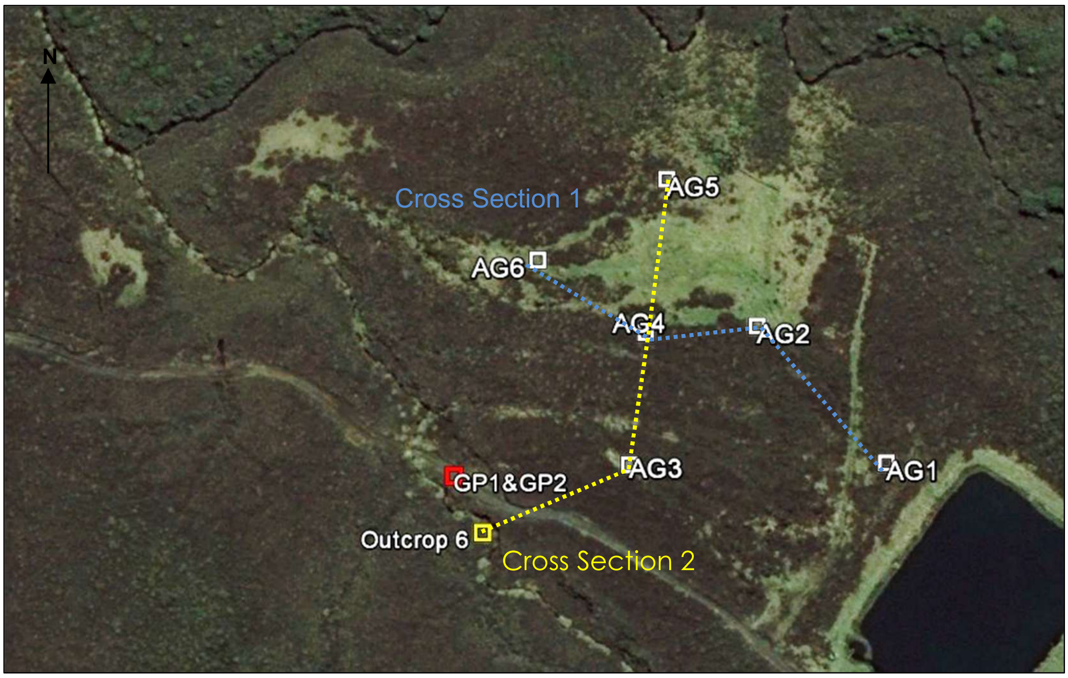
2.2 PROPOSED DEVELOPMENT

Development of a surface flow wetlands is proposed at the Whakapapa WWTP effluent disposal fields. An initial wetland is planned in the area to the North West of the tertiary treatment pond labelled Area G in Figure 1. Surface flow wetlands require a low to impermeable base layer or lining to ensure effluent is retained at the surface in treatment cells for treatment by plants. Initial engineering design plans include the use of clay rich volcanic ash layers to line the cells. The design also includes plans to re-locate sections of a permeable sandy pumice layer. This investigation will include the logging of six hand auger samples to confirm the expected presence of the pumice and ash layers as well as conduct permeability testing on two representative samples of the ash to assess its suitability for use as a low to impermeable liner for the wetland system.

3.0 INVESTIGATION

Disturbed soil samples were collected using an AMS mini soil auger on the 1st and 2nd December 2016. The samples were collected at six sites across Area G labelled AG1 to AG6 in Figure 2. They were laid out in 18cm piles and logged to *New Zealand Geotechnical Society (2005) Field Description of Rocks and Soils*. Lithological logs of the samples are available in Appendix 1 and photographs are available in Appendix 2.

FIGURE 2: SAMPLE LOCATIONS



After the hand augering confirmed the presence of clay rich ash layers throughout Area G two representative permeability samples were collected from an accessible roadside outcrop just outside the southern boundary of Area G. Samples were named GP1 and GP2, their location is show on Figure 2. GP1 was taken from a layer of orangey-brown silty ash. GP2 was taken from a grey-black clay layer. An outcrop in the nearby southern tributary gives a good example of the lithological pattern expected in Area G. The outcrop, labelled 'Outcrop 6' displays the general near surface lithological pattern of Area G. The tape measure is set as 1m in the Figure 3 photograph. Sample GP1 is representative of the layer described as *Red Brown Clay* and GP2 is representative of the *Grey Black Clay*. Figure 4 shows a filled vertical fracture observed in the red conglomerate underlying the clay rich ash layers in Outcrop 6.

FIGURE 3: OUTCROP 6 PHOTOGRAPH

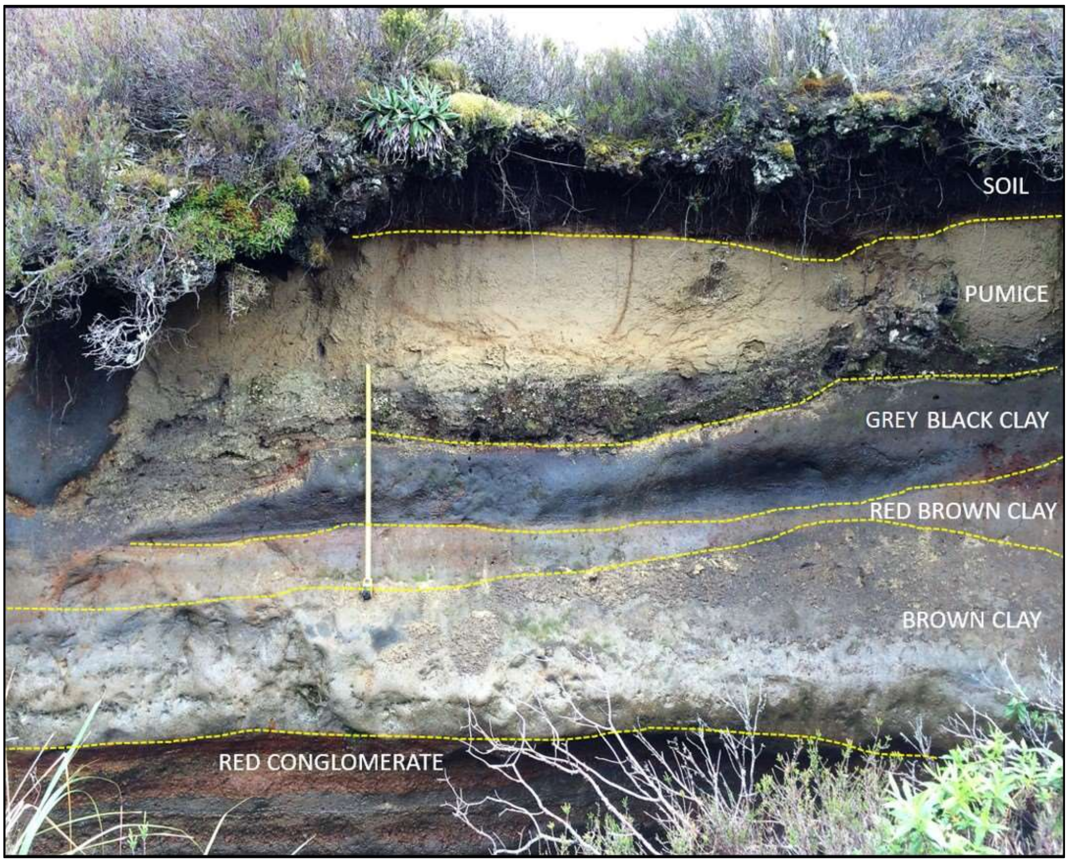


FIGURE 4: RED CONGLOMERATE 'OUTCROP 6'

4.0 RESULTS

4.1 HAND AUGER SAMPLES

The expected pattern of Soil, Pumice and Clay-rich Ash was observed in all six hand auger samples.

Cross Section 1, Figure 5, shows a representation of lithology from a North-West to South-East section in Area G. Cross Section 2, Figure 6, runs in a North-South direction, with 'Outcrop 6' added to the South West and beds extrapolated to give a visual indication of the depth to the base of the ash. Lighter shaded layers in Cross Section 2 are estimated and were not logged. Due to the distances between logs, up to 157.8m, and the expected variability of the landscape, these cross sections should be used as a rough guide only.

Soil depths varied from 10cm to 50cm, generally around 30cm thick. The soil was rich dark brown to black, clayey SILT with occasional rootlets and was occasionally sandy in some locations. Soils were damp when brought to surface but not wet.

Pumice, similar in colour and texture to that seen in 'Outcrop 6' was observed at all the hand auger sites. The pumice layer mainly consisted of light brown sand. This was observed as either a loose fine to very fine grained sand, resembling beach sand, or coarser grained sand with occasional unbroken pumice fragments. The fine to very fine sands were observed in the top and middle of the unit. The medium and coarser grained sands were observed in two colours, either light brown in colour, observed in the top or middle of the unit, or a dark orange red colour, observed at the base of the unit. Pumice samples were wet when brought to surface, except for AG4 which was saturated halfway down the unit and AG5 which was all damp. Visual inspection of the pumice at outcrops indicate this is a permeable unit and the presence of water in the pumice layer supports this observation.

Clay-rich ash was recorded at each location and observed thicknesses varied between 54 to 72cm thick. The base of the ash was not intersected at any of the hand auger sites. The ash layers were wet when logged, however the auger holes filled with water after cutting though the wet pumice layer. In situ-saturation of the ash could therefore not be assessed from the hand auger sample observations. Based on the extrapolated log it is estimated that there is an average of 1m thickness of clay rich ash across the area, this estimate includes the brown clay rich ash logged in outcrop 6.

Two units underlying the ash layer were observed and logged at 'Outcrop 6' 35m South East of the Area G boundary, the out crop is shown in Figure 3. An 80cm, thickly banded, dark red conglomerate was observed below the Ash layers. This unit contained a range of angular pebbles and rocks <2cm in size. Boulders were observed at the boundary with an underlying dark grey conglomerate. Large, >30cm, boulders were observed in the dark grey conglomerate. A filled fracture was also observed running vertically though the red conglomerate, Figure 4. Permeability of the conglomerates was not tested. The presence of fractures in the red conglomerate indicates there will be a risk of vertical water flow through this unit.

Outcrop 6 displays a high level of variation of bed thicknesses and disturbance of geological boundaries over a relatively small area. The pumice layer varies between 60cm and 1m thick, the black ash between 40 and 60cm and the red brown clay between 10 and 30cm. The brown clay layer, logged underneath the red brown clay, varies between 50 and 70cm thick. An area of disturbance between boundaries includes a ripped-up section of dark grey ash to the left of the photo that has been lifted and infilled with pumice. It is expected that there will be considerable variation of both bed thickness and contact boundaries across Area G.

Close to the area of samples GP1 and GP2, an outcrop of light grey ash was observed which contained several large pebbles.

FIGURE 5: CROSS SECTION 1

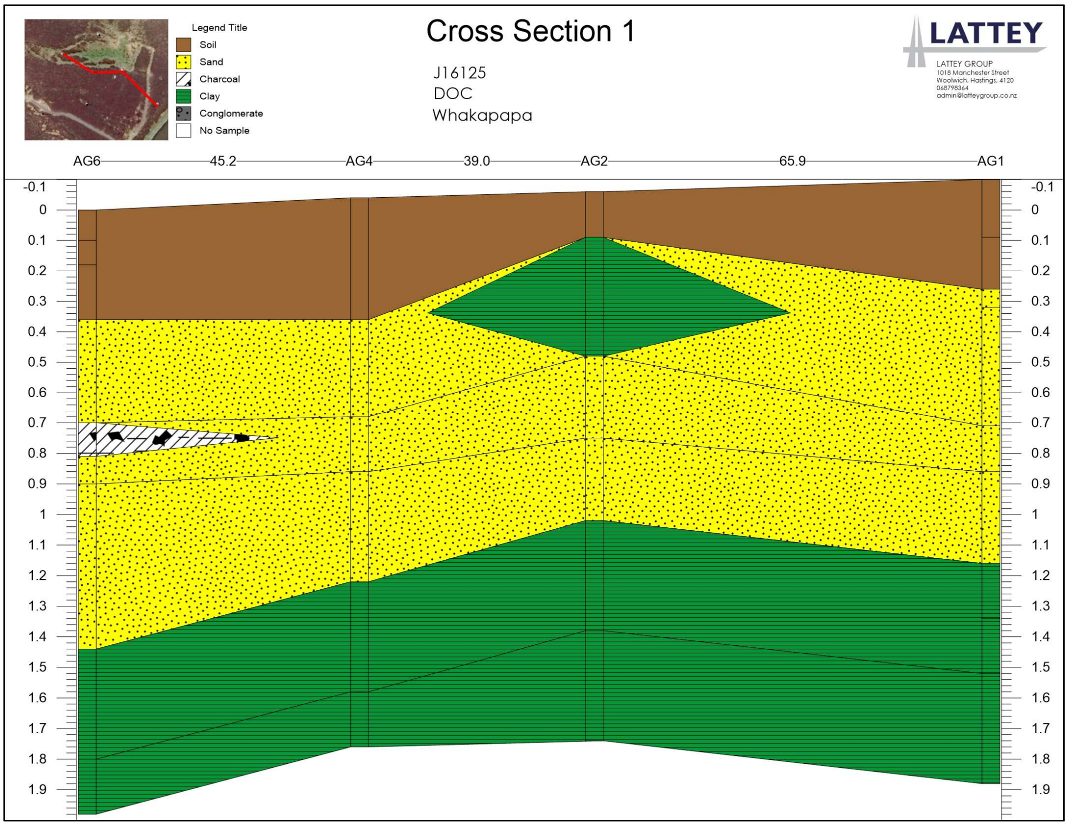
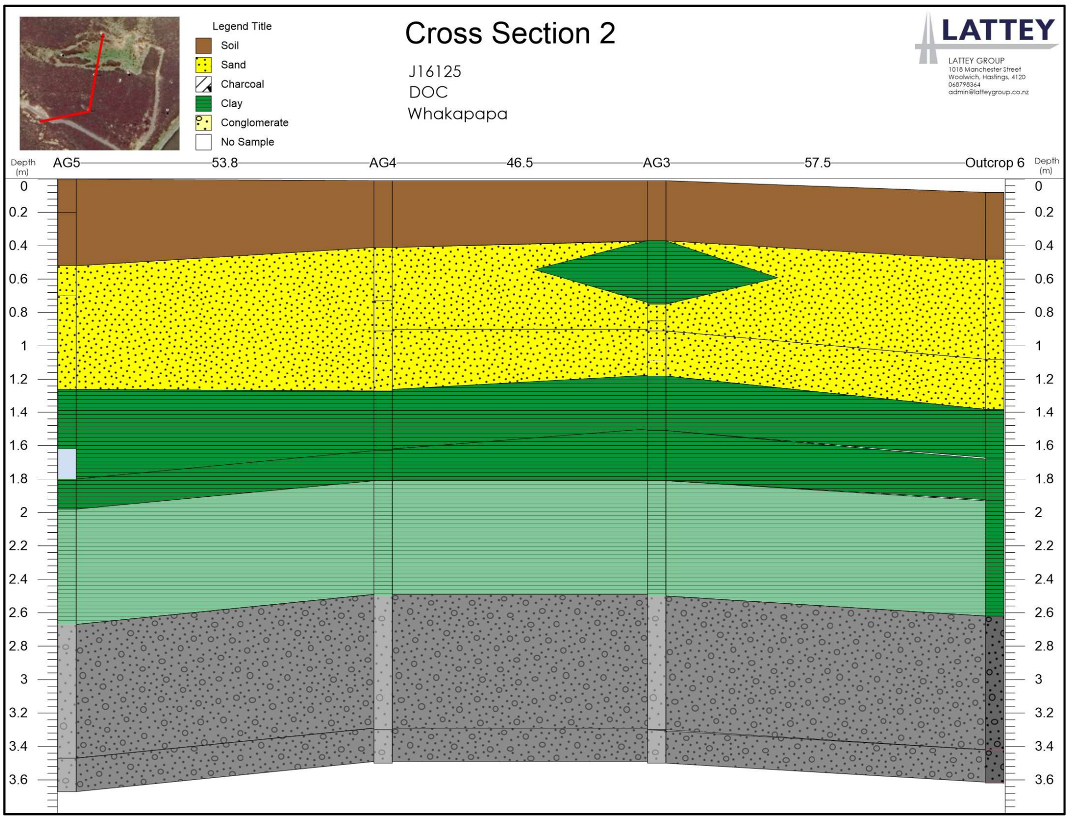


FIGURE 6: CROSS SECTION 2



4.2 PERMEABILITY ANALYSIS

For use as an impermeable liner an ideal permeability value for the clay rich ash layer of 10^{-9} was identified by the design engineers. This value is described as 'practically impervious' in Figure 7, *Das 1996 Geotechnical Engineering Handbook*. Permeability sample analysis results are detailed in Table 1 The results show that permeability of both ash layers tested have values of 10^{-08} m/s. The results when compared with typical permeability values, shown in Figure 7, indicate that the drainage of the clay rich ash layers is on the boundary between poor drainage and practically impervious. On the basis of these results the clay layers tested are considered suitable for use as a low permeability liner to the wetland cells.

FIGURE 7:TYPICAL PERMEABILITY VALUES (DAS 1996)

<table>
<tr><th></th><th colspan="12">Permeability (m/s)</th></tr>
<tr><th></th><th>10^{0}</th><th>10^{-1}</th><th>10^{-2}</th><th>10^{-3}</th><th>10^{-4}</th><th>10^{-5}</th><th>10^{-6}</th><th>10^{-7}</th><th>10^{-8}</th><th>10^{-9}</th><th>10^{-10}</th><th>10^{-11}</th></tr>
<tr><td>Drainage</td><td colspan="6">Good</td><td colspan="2">Poor</td><td colspan="4">Practically impervious</td></tr>
<tr><td rowspan="2">Soil Types</td><td rowspan="2" colspan="2">Clean gravel</td><td colspan="3">Clean sands, clean sand & gravel mixtures</td><td colspan="4">Very fine sands, organic & inorganic silts, mixtures of sand, silt & clay, glacial till, stratified clay</td><td rowspan="2" colspan="2">Impervious soils, e.g., homogeneous clays below zone of weathering</td></tr>
<tr><td colspan="2"></td><td colspan="5">"Impervious" soils modified by effects of vegetation & weathering</td></tr>
</table>

FIGURE 1.10 Typical permeability values (after Terzaghi et al. 1996; reprinted with permission of John Wiley & Sons, Inc.).

TABLE 1: PERMEABILITY ANALYSIS RESULTS

SAMPLE ID	PRESSURE HEAD (kPa)	PERMEABILITY (m/s)
GP1	20	8.74×10^{-08}
	40	8.11×10^{-08}
	60	7.89×10^{-08}
GP2	20	5.05×10^{-08}
	40	4.82×10^{-08}
	60	4.52×10^{-08}

4.3 RISKS AND RECCOMENDATIONS

A clay rich Ash has been confirmed in all six hand augers indicating that it will be present across the area. Permeability samples taken from two representative samples indicate that the clay will be suitable for use as a low permeability liner for the wetland cells. As seen in the outcrop photograph in Figure 3, bed thicknesses and geological boundaries are expected to vary across the area and some areas may have reduced thicknesses or a lack of clay rich Ash. This may result in the exposure underlying conglomerates, which have not been permeability tested and, based on inspection of nearby outcrops, may contain vertical fractures. The current engineering plan includes moving some clay rich ash from non-cell areas to line cells in areas where it is lacking. Based on the saturation of the pumice layer and the permeability results from the grey black and red brown ash layers, the current thickness of clay rich ash is assessed to be suitable for water retention in the cells. The ash layer is estimated to be, on average, 1m thick across Area G. Inspection and testing of the lining of the cells by the design engineer or other suitably qualified person to confirm ash coverage and identify any irregular areas is also recommended prior to planting and filling.

5.0 CONCLUSION

- Predicated pattern of soil, sandy pumice and clay rich ash was observed across Area G in hand six auger samples.
- Soils were damp and sandy pumice layer was wet indicating it is a water bearing unit and is permeable.
- Nearby outcrops show the clay rich ash layer to be underlain by conglomerate. 'Outcrop 6', 35m South West of the area, shows 80cm red conglomerate with filled vertical fractures on top of a dark grey boulder rich conglomerate. Previous investigation shows ash on top of a hard, light brown conglomerate the junction of the northern and southern tributaries.
- An ideal permeability value of 10^{-9}, which represents 'practically impervious' drainage was identified by the design engineers for the ash liner. Permeability testing results of indicates that the clay rich ash layer is on the boundary between 'low' drainage and 'practically impervious' with results values of 10^{-8}. This would be suitable for use as a low permeability liner for the wetland cells.
- While the predicated geological layers were confirmed, investigation of nearby outcrops show considerable disturbance to geological boundaries and some changes to bed thickness. There is expected to be some variation of bed thicknesses and geological boundaries across the area based on. Areas where there is no clay rich ash should be identified during earth works and clay rich ash should be moved from non-cell areas to cover any exposed conglomerates.
- Ash layers may contain occasional areas with pebbles or boulders, these may affect the ability of the cell to retain water should be removed and replaced with, or covered with ash from a non-cell area.
- Clay rich ash was present in the base of all six hand auger holes, however the base of this layer was not reached. Water has been observed in the overlying pumice layer and it is assessed that the current average thickness of clay rich ash is suitable for creating a low permeability layer. A thickness in the order of 1m has been estimated for the ash layer by extrapolating the log from 'Outcrop 6'.
- It is recommended that inspection and testing of the cells be made by the design engineer or other suitably qualified person prior to filling with water to confirm adequate ash coverage and identify any unusual areas.

7.0 REFERENCES

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New Zealand Geotechnical Society 2005: Field Description of Rocks and Soils

APPENDIX 1

LITHOLOGICAL LOGS

HAND AUGER LOG

Well: AG1
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729775
Northing: 6220172
Elevation (m): 1091
Datum: NZMG

Depth (m)	Lithology	Lithology Description	Visual Sample Saturation
0–0.19	Soil	dark brown, clayey SAND, soft, non-semi cohesive, low plasicity, [SOIL, damp]	Damp SWL
0.19–0.36	Soil	medium brown, clayey SAND, soft, non-semi cohesive, low plasicity, [SOIL, damp]	Damp
0.36–0.42	Sand	medium to light orange brown, coarse to fine SAND, weak, unconsolidated [PUMICE, wet]	Wet
0.42–0.81	Sand	light brown, very fine to fine SAND, weak, unconsolidated, [PUMICE, wet]	Wet
0.81–0.96	Sand	dark orange brown, coarse to fine SAND, weak, unconsolidated, [PUMICE, wet, common pumice fragments, common charcoal fragments]	Wet
0.96–1.26	Sand	dark orange brown, coarse to fine SAND, weak, unconsolidated, [PUMICE, wet, common pumice fragments]	Wet
1.26–1.44	Clay	dark brown, sandy CLAY, soft, high plascticity [ASH, wet]	Wet
1.44–1.62	Clay	dark brown black, sandy CLAY, soft, high plascticity [ASH, wet]	Wet
1.62–1.98	Clay	dark brown black, sandy CLAY, soft, high plascticity [ASH, wet]	Wet

TD (m): 1.98

SWL (cmBLS): 11

Comments: Survey and Elevation by Hand Held GPS

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HAND AUGER LOG

Well: AG2
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729731
Northing: 6220221
Elevation (m): 1087
Datum: NZMG

Depth (m)	Lithology	Lithology Description	Visual Sample Saturation
0 – 0.15	Soil	dark brown black, silty CLAY, soft, medium to high plasticity [SOIL, damp with rootlets]	Damp
0.15 – 0.54	Clay	light brown, slity CLAY, soft, high plascticity [damp]	SWL Damp
0.54 – 0.81	Sand	light brown, very fine to fine SAND, weak, unconsolidated, [PUMICE, wet]	Wet
0.81 – 1.08	Sand	dark orange brown, coarse to fine SAND, weak, unconsolidated, [PUMICE, wet, occasional charcoal fragments]	Wet
1.08 – 1.44	Clay	dark brown, sandy CLAY, soft, high plascticity [ASH, wet]	Wet
1.44 – 1.8	Clay	medium to light brown, silty CLAY, soft, high plasticity [ASH, wet]	Wet

TD (m): 1.8

SWL (cmBLS): 16

Comments: Survey and Elevation by Hand Held GPS

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HAND AUGER LOG

Well: AG3
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729685
Northing: 6220174
Elevation (m): 1085
Datum: NZMG

Depth (m)	Graphic Lithology	Lithology	Lithology Description	Visual Sample Saturation	Depth (m)
0 – 0.36		Soil	dark brown black, clayey SILT, soft, semi cohesive, low plasticity [SOIL, damp with rootlets]	Damp SWL	0 – 0.36
0.36 – 0.74		Clay	dark brown, sandy CLAY, soft, high plascticity [damp]	Damp	0.36 – 0.74
0.74 – 0.84		Sand	medium to light brown, coarse to fine SAND, weak, unconsolidated [PUMICE, wet]	Wet	0.74 – 0.84
0.84 – 0.9		Sand	medium to light brown, coarse to fine SAND, weak, unconsolidated [PUMICE, wet with occasional charcoal fragments]	Wet	0.84 – 0.9
0.9 – 1.08		Sand	medium to light brown, coarse to fine SAND, weak, unconsolidated [PUMICE, wet]	Wet	0.9 – 1.08
1.08 – 1.17		Sand	dark orange brown, coarse to fine SAND, weak, unconsolidated, [PUMICE, wet,]	Wet	1.08 – 1.17
1.17 – 1.5		Clay	dark brown, sandy CLAY, soft, high plascticity [ASH, wet]	Wet	1.17 – 1.5
1.5 – 1.8		Clay	medium to light brown, silty CLAY, soft, high plasticity [ASH, wet]	Wet	1.5 – 1.8

TD (m): 1.8

SWL (cmBLS): 30

Comments: Survey and Elevation by Hand Held GPS

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HAND AUGER LOG

Well: AG4
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729692
Northing: 6220220
Elevation (m): 1085
Datum: NZMG

Depth (m)	Lithology	Lithology Description	Visual Sample Saturation
0–0.4	Soil	dark brown, clayey SILT, soft, semi cohesive, low plasticity [SOIL, damp with rootlets]	SWL Damp
0.4–0.72	Sand	light brown, fine to medium SAND, weak, unconsolidated, [Pumice, damp]	Damp
0.72–0.9	Sand	light brown, medium to fine SAND, weak, unconsolidated, [PUMICE, wet]	Wet
0.9–1.26	Sand	dark orange brown, coarse to fine SAND, weak, unconsolidated, [PUMICE, wet]	Wet
1.26–1.62	Clay	dark brown, sandy CLAY, soft, high plascticity [ASH, wet]	Wet
1.62–1.8	Clay	medium to light brown, silty CLAY, soft, high plasticity [ASH, wet]	Wet

TD (m): 1.8
SWL (cmBLS): 11
Comments: Survey and Elevation by Hand Held GPS

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HAND AUGER LOG

Well: AG5
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729701
Northing: 6220273
Elevation (m): 1086
Datum: NZMG

Depth (m)	Graphic Lithology	Lithology	Lithology Description	Visual Sample Saturation	Depth (m)
0 – 0.2		Soil	dark brown black, clayey SILT, soft, semi cohesive, low plasticity [SOIL, damp]	Damp	0 – 0.2
0.2 – 0.52		Soil	dark brown, clayey SILT, soft, semi cohesive, low plasticity [SOIL, damp]	Damp	0.2 – 0.52
0.52 – 0.7		Sand	light brown, fine to medium SAND, weak, unconsolidated, [Pumice, damp]	SWL Damp	0.52 – 0.7
0.7 – 1.26		Sand	light brown, fine to very fine SAND, weak, unconsolidated, [Pumice, damp]	Damp	0.7 – 1.26
1.26 – 1.62		Clay	dark brown, sandy CLAY, soft, high plasticity [ASH, damp]	Damp	1.26 – 1.62
1.62 – 1.8		No Sample	No Recovery		1.62 – 1.8
1.8 – 1.98		Clay	light orange brown, sandy CLAY, soft, high plasticity [ASH, damp]	Damp	1.8 – 1.98

TD (m): 1.98

SWL (cmBLS): 51

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HAND AUGER LOG

Well: AG6
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729655
Northing: 6220246
Elevation (m): 1081
Datum: NZMG

Depth (m): 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9

Graphic Lithology	Lithology	Lithology Description	Visual Sample Saturation
	Soil	dark brown black, silty CLAY, soft, medium to high plasticity [SOIL, damp with rootlets]	Damp
	Soil	dark brown, clayey SILT, soft, medium to low plascicity, [SOIL, damp with rootlets]	SWL Damp
	Soil	dark orange brown, clayey SILT, soft, medium to low plascicity, [SOIL, damp with rootlets]	Damp
	Sand	light brown, coarse to fine SAND, weak, unconsolidated [PUMICE, wet with occational <2cm pumice fragments]	Wet
	Charcoal	dark black, CHARCOAL, unconsolidated	Wet
	Sand	light brown, very fine to fine SAND, weak, unconsolidated [PUMICE, wet]	Wet
	Sand	dark orange brown, coarse to fine SAND, weak, unconsolidated, [Pumice, wet]	Wet
	Clay	dark brown, silty CLAY, soft, high plasticicty, [ASH, wet]	Wet
	Clay	medium to light brown, silty CLAY, soft, high plasticity [ASH, wet]	Wet

TD (m): 1.98
SWL (cmBLS): 11
Comments: Survey and Elevation by Hand Held GPS

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HAND AUGER LOG

Well: Outcrop 6
Client: DOC
Project: J16125
Geologist: Alasdair Park

Started: 2/12/2016
Finished: 2/12/2016

Loaction: Whakapapa
Easting: 2729629
Northing: 6220161
Elevation (m): 1078
Datum: NZMG

Lithology	Lithology Description	Visual Sample Saturation
Soil	dark brown, SOIL	
Sand	medium to coarse, light brown SAND [PUMICE]	
Sand	coarse, dark SAND [PUMICE]	
Clay	dark, black brown CLAY [ASH]	
Clay	dark, reddish brown CLAY [ASH]	
Clay	Light brown CLAY	
Conglo merate	dark red, sandy CONGLOMERATE, moderatley hard with rare boulders at base	
Conglo merate	dark grey, CONGLOMERATE, moderatley hard occational boulders	

Depth (m): 0, 0.2, 0.4, 0.6, 0.8, 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.4, 2.6, 2.8, 3, 3.2, 3.4

TD (m): 3.54
SWL (cmBLS):
Comments: Survey and Elevation by Hand Held GPS

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APPENDIX 2

HAND AUGER SAMPLE PHOTOGRAPHS

AG1

AG2

AG3

AG4

AG5

AG6

APPENDIX 3

PERMEABILITY ANALYSIS RESULTS

DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

OPUS

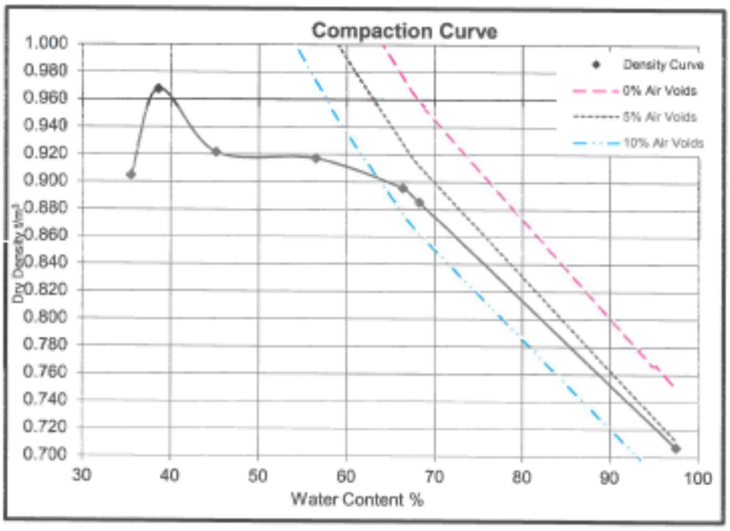
Project :	Whakapapa WWTP
Location :	Whakapapa WWTP
Client :	DOC c/o Lattey Group
Contractor :	Lattey Group
Sampled by :	Alasdair Park
Date sampled :	02/12/16
Sampling method :	*Digging
Sample description :	Orangey Brown; CLAY
Sample condition :	As Received
Solid density :	2.78 t/m³ (Assumed)
Source:	GP1

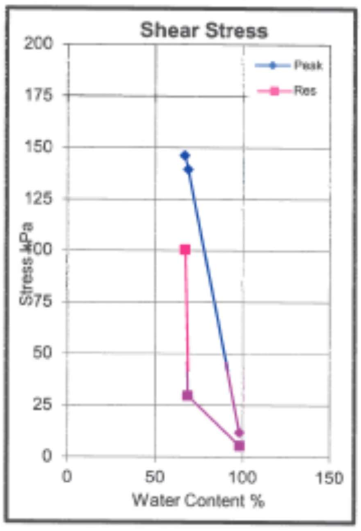
Project No :	1-LA243.16
Lab Ref No :	AL817/1
Client Ref No :	J16125

Test Results

Maximum dry density	0.92	t/m³	Natural water content	97.5	%
Optimum water content	56.5	%	Fraction tested	Passing 19mm test sieve	

Sample ID		B	D	C	A	F	E	Nat
Bulk density	t/m³	1.226	1.341	1.338	1.435	1.490	1.489	1.396
Water content	%	35.5	38.6	45.2	56.5	66.4	68.2	97.5
Dry density	t/m³	0.905	0.967	0.922	0.917	0.896	0.885	0.707
Sample condition		Hard Dry	Hard Dry	Hard Dry	Firm Dry	Firm Moist	Firm Moist	Very Soft Wet
Peak stress	kPa	UTP	UTP	UTP	140+	146	139	11
Remoulded stress	kPa	UTP	UTP	UTP	140+	101	29	5





Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	
Shear Strength using a Hand Held Shear Vane, NZ Geotechnical Soc Inc 8/2001		

Date tested : 09-15/12/16
Date reported : 21/12/16

***Sampling is not covered by IANZ Accreditation. Results apply only to sample tested. This report may only be reproduced in full**

IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 21/12/16

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PF-LAB-025 (30/05/2013)

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

OPUS

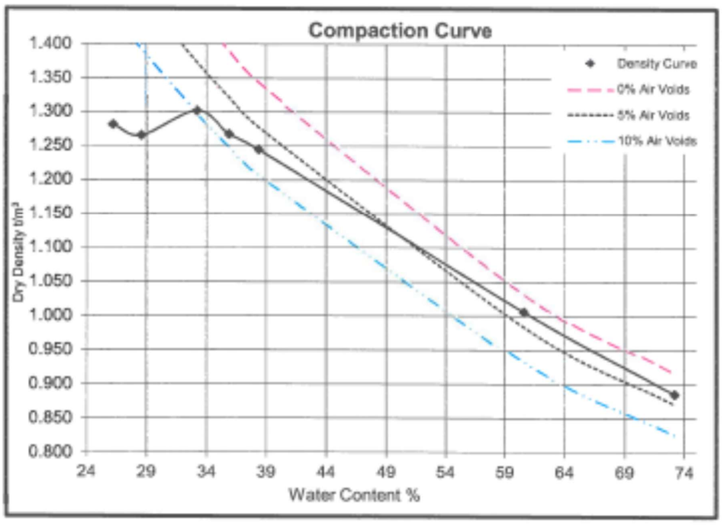
Project :	Whakapapa WWTP
Location :	Whakapapa WWTP
Client :	DOC c/o Lattey Group
Contractor :	Lattey Group
Sampled by :	Alasdair Park
Date sampled :	02/12/16
Sampling method :	*Digging
Sample description :	Dark Grey; ASH/CLAY
Sample condition :	As Received
Solid density :	2.78 t/m³ (Assumed)
Source:	GP2

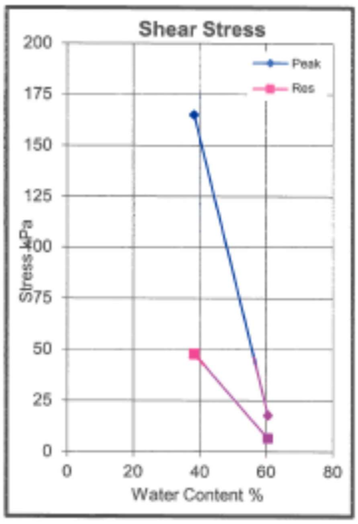
Project No :	1-LA243.16
Lab Ref No :	AL817/2
Client Ref No :	J16125

Test Results

Maximum dry density	1.30 t/m³		Natural water content	73.2 %
Optimum water content	33.2 %		Fraction tested	Passing 19mm test sieve

Sample ID		B	C	F	E	D	A	Nat
Bulk density	t/m³	1.617	1.628	1.735	1.723	1.723	1.615	1.533
Water content	%	26.2	28.6	33.2	35.9	38.4	60.6	73.2
Dry density	t/m³	1.282	1.266	1.302	1.268	1.245	1.006	0.885
Sample condition		Hard Moist-Dry	Firm-Hard Moist-Dry	Hard Dry	Firm Moist-Dry	Firm Moist	Very Soft Moist	Very Soft Saturated
Peak stress	kPa	UTP	UTP	UTP	140+	165	18	-
Remoulded stress	kPa	UTP	UTP	UTP	140+	48	7	-





Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	
Shear Strength using a Hand Held Shear Vane, NZ Geotechnical Soc Inc 8/2001		

Date tested : 07-22/12/16
Date reported : 11/01/17

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Date : 11/01/17

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CONSTANT HEAD PERMEABILITY TEST REPORT

OPUS

Project :	Whakapapa WWTP
Location :	Whakapapa WWTP
Client :	DOC c/o Lattey Group
Contractor :	Lattey Group
Sampled by :	Alasdair Park
Date sampled :	02/12/16
Sampling Method:	* Digging
Sample Description:	Orangey Brown; CLAY
Sample Condition:	See Note Below
Solid Density:	2.78 t/m³ (Assumed)
Sample Ref:	GP1

Project No :	1-LA243.16
Lab No :	AL817/3
Order No:	J16125

SOIL PROPERTIES		
Sample Reference		GP1
Depth(m)		Not Stated
Specimen length	(mm)	113.6
Specimen diameter	(mm)	98.1
Specimen mass	(g)	1174.4
Pre test water content	(%)	57.4
Wet density	(t/m^3)	1.37
Dry density	(t/m^3)	0.87
Post test water content	(%)	70.1

PERMEABILITY TEST RESULT

See Notes below

Cell Pressure	650
Saturation Backpressure	550
Effective confining pressure	100

Head (kPa)	Permeability (m/s)
20	8.74×10^{-08}
40	8.11×10^{-08}
80	7.89×10^{-08}

The sample was banged up at close to Optimum Moisture Content and MDD, at standard compaction in a split proctor mould.

Test Method

Permeability Test Based on :] BS 1377 1990 Part 6

Water Content : NZS 4402 : 1986 Test 2.1

Notes

-Sample was tested using the triaxial test apparatus to enable back pressure saturation of the test specimens.

-OMC = 56.5% and 95% of MDD 0.92t/m³ was taken from Report with Lab No AL817/1, Project No. 1-LA243.16

Date tested : 21/12/16 - 09/01/17

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Date reported : 12/01/17

IANZ Approved Signatory :

Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 12/01/2017

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CONSTANT HEAD PERMEABILITY TEST REPORT

OPUS

Project :	Whakapapa WWTP
Location :	Whakapapa WWTP
Client :	DOC c/o Lattey Group
Contractor :	Lattey Group
Sampled by :	Alasdair Park
Date sampled :	02/12/16
Sampling Method:	* Digging
Sample Description:	Dark Grey; ASH/CLAY
Sample Condition:	See Note Below
Solid Density:	2.78 t/m^3 (Assumed)
Sample Ref:	GP2

Project No :	1-LA243.16
Lab No :	AL817/4
Order No:	J16125

SOIL PROPERTIES

Sample Reference		GP2
Depth(m)		Not Stated
Specimen length	(mm)	113.6
Specimen diameter	(mm)	98.1
Specimen mass	(g)	1412.5
Pre test water content	(%)	33.0
Wet density	(t/m^3)	1.65
Dry density	(t/m^3)	1.24
Post test water content	(%)	41.0

PERMEABILITY TEST RESULT

See Notes below

Cell Pressure	600
Saturation Backpressure	500
Effective confining pressure	100

Head (kPa)	Permeability (m/s)
20	5.05×10^{-08}
40	4.82×10^{-08}
80	4.52×10^{-08}

The sample was banged up at close to Optimum Moisture Content and MDD, at standard compaction in a split proctor mould.

Test Method

Permeability Test Based on : BS 1377 1990 Part 6

Water Content : NZS 4402 : 1986 Test 2.1

Notes

-Sample was tested using the triaxial test apparatus to enable back pressure saturation of the test specimens.

-OMC = 33.2% and 95% of MDD 1.30t/m³ was taken from Report with Lab No AL817/2, Project No. 1-LA243.16

Date tested : 22/12/16 - 09/01/17

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This report may only be reproduced in full

Date reported : 12/01/17

IANZ Approved Signatory :

Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 12/01/2017

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APPENDIX 4

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