IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications by Waka Kotahi NZ Transport Agency to Manawatū Whanganui Regional Council for resource consents associated with the construction and operation of Te Ahu a Turanga: Manawatū Tararua Highway.

SECTION 87F REPORT OF KERRY STEWART PEARCE – EROSION AND SEDIMENT CONTROL

A. QUALIFICATIONS / EXPERIENCE

1 My full name is Kerry Stewart Pearce. I am a Director of Environmental Land Management Limited, which is subcontracted to Bryant Environmental Solutions Limited. I have been in that position since May 2005.

2 My role involves providing technical advice on earthworks and erosion and sediment control components of resource consent applications for Waikato Regional Council, Auckland Council, and Manawatū Whanganui Regional Council ("**Horizons**") along with monitoring the erosion and sediment control components of land use resource consents for Waikato Regional Council, Auckland Regional Council, and Horizons.

3 I have specific experience in both preparing technical assessments to support the Resource Management Act 1991 ("**RMA**") process, as well as on-site experience with a number of large projects including, Mighty River Power Puketoi Wind Farm, New Zealand Steel Managed Landfill, New Zealand Transport Agency ("**NZTA"**) Upper Harbour Corridor, Contact Energy Limited Te Mihi Power Station, NZTA Atiamuri Bridge Replacement, Mighty River Power Ngatamariki Power Station, Transpower Wairakei to Whakamaru "C" Transmission Line, and Mercury Turitea Wind Farm.

4 I hold a Bachelor of Applied Science (Agriculture) degree from Massey University. I am a member of the New Zealand Association of Resource Management.

5 I have been engaged by Horizons to provide expertise on the earthworks and erosion and sediment control aspects of the resource consent applications by Waka Kotahi NZ Transport Agency (the "**Transport Agency**") for resource consents associated with the construction of Te Ahu a Turanga: Manawatū Tararua Highway (the "**Project**").

6 I am familiar with the Project, having visited the site on 10 September 2019 and 20 November 2019. I have also reviewed the Application by the Transport Agency dated 9 March 2020, including the Technical Assessments and Drawings submitted with the Application. These include Section 3 of the Assessment of Effects (in Volume 1), the DCR (in Volume II) and the Drawing Set (in Volume III). I identify the technical assessments I have had particular regard to in paragraph [11] below.

7 I have also reviewed the Applicant's response to the further information request by Horizons dated 29 April 2020 (the "s92 Response").

B. CODE OF CONDUCT

8 I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise.

C. SCOPE OF REPORT

9 My report focuses on issues related to the earthworks and erosion and sediment control methodology and practices associated with the construction of the Project, and covers the following topics:

(a) A description and understanding of the receiving environment as it is relevant to the erosion and sediment control components of the construction;

(b) The potential estimated sediment yields calculated by the Transport Agency, and an assessment of the sediment yield determining factors;

(c) The erosion and sediment control methods, practices and standards proposed to be implemented during construction in order to avoid, remedy or minimise potential effects during construction of the Project;

(d) Review of the Assessment of Environmental Effects ("**AEE"**) and related technical assessments of the Transport Agency (in particular, Technical Assessment A);

(e) Submissions relating to issues concerning erosion and sediment control; and

(f) Proposed Mitigation (Conditions).

10 In addition to my own observations, I rely on the report of Mr Logan Brown for Horizons on Water Quality and the report of Ms Deborah Ryan for Horizons on dust effects.

11 As I noted above, I have also reviewed and referred to the information provided by the Transport Agency in the following technical assessments and management plans:

(a) Technical Assessment A – Erosion and Sediment Control;

(b) Technical Assessment C – Water Quality;

(c) Technical Assessment D – Hydrology;

(d) Technical Assessment E – Air Quality;

(e) Technical Assessment H – Freshwater Ecology.

(f) Erosion and Sediment Control Plan (ESCP);

(g) Erosion and Sediment Control Monitoring Plan (ESMP);

(h) Chemical Treatment Management Plan (CTMP);

(i) Concept Erosion and Sediment Control Drawings; and

(j) Example Site Specific Erosion and Sediment Control Plans (SSESCPs).

D. EXECUTIVE SUMMARY

12 The Universal Soil Loss Equation ("**USLE**") has been used to determine an estimated sediment yield for the Project in order to assess the earthworks and sediment related effects on the receiving environment. The assumptions used, and the values generated, in the USLE calculation apply a conservative scenario for sediment generation, while using industry accepted values for sediment control devices.

13 The Project's approach to erosion and sediment control ("**ESC**") design and implementation is to ensure that all erosion and sediment control measures are designed, constructed and maintained in accordance with *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region Guidance Document 2016/005 Incorporating Amendment 1*, and any subsequent amendments to that document. This is currently regarded as industry best practice when undertaking earthworks activities and contains a 'toolbox' of measures that can be employed to minimise erosion and control sediment within the earthworks site. Should implementation of these measures across the Project not achieve the required minimisation of impacts on the receiving environment, further consideration should be given to non-structural approaches in any particular catchment where these impacts are occurring.

14 The Transport Agency has also proposed a comprehensive management plan structure to manage the adverse effects associated with the proposed development. This comprises of an overarching Construction Environmental Management Plan

("**CEMP**") and Erosion and Sediment Control Plan ("**ESCP**"), with Site Specific Erosion and Sediment Control Plans ("**SSESCP**") to be developed for every discrete area of works in line with the consent conditions and guidance documents.

15 The management and monitoring system proposed for the Project covers a range of matters, and is intended to ensure that measures have been designed, installed, and managed in accordance with consent conditions and guidance documents. There are a number of performance outcomes, standards and reporting requirements proposed for management plans, which are better suited for conditions of consent.

16 I have recommended imposition of a performance standard to determine the end of pipe sediment load from sediment control devices. This performance standard will ensure the Transport Agency and Horizons obtain a more accurate indication of the sediment discharge from site and the related effects of the Project on the receiving environment. This will also ensure the effects are consistent with those assessed as part of the Application. An appropriate discharge standard would be one on which the potential adverse effects on the environment have been considered in the Application.

E. BACKGROUND

17 The Project comprises the construction, operation and maintenance of approximately 11.5km of State Highway connecting Ashhurst and Woodville via a route over the Ruahine Ranges. The purpose of the Project is to replace the indefinitely closed existing State Highway 3 ("**SH3"**) through the Manawatū Gorge.

18 The Project comprises a median separated carriageway that includes two lanes in each direction over the majority of the route and will connect with State Highway 57 ("**SH57**") east of Ashhurst and SH3 west of Woodville (via proposed roundabouts). A shared use path for cyclists and pedestrian users is proposed as well as a number of new bridge structures including a bridge crossing over the Manawatū River.

19 The Project will require approximately 195ha of earthworks, including bulk structural cut to fill of approximately 4,600,000m^3 and cut to waste with disposal of surplus material (undercut and unsuitable) of approximately 1,200,000m^3. Additional earthwork volumes associated with site establishment will be generated in discrete

areas within the footprint of works to create access, yards and establish ESC measures.[1]

20 The total earthworks area includes the main alignment and access tracks, Te Āpiti Wind Farm tracks, spoil disposal sites, and any temporary stockpiling, laydown and yard areas.[2]

21 Of the 195ha of total earthworks, on an aerial basis approximately 66% occurs directly within tributary streams that discharge directly to the Manawatū River. Approximately 30% is expected to occur within the Mangamanaia Stream Catchment (referred to in the Application as Catchment 2), noting that the Mangamanaia flows to the Manawatū River upstream of the Manawatū Gorge. A small area (approximately 7.78ha, or 4%) will fall into the catchment of the Pohangina River which in turn flows to the Manawatū River downstream of the Manawatū Gorge. Ultimately all flows end up in the Manawatū River.[3]

22 The Project will include new bridge crossings of the Manawatū River and the Mangamanaia Stream, an Eco Bridge that spans an existing wetland area and a tributary stream, and a major culvert at Chainage 7840 that will convey a significant catchment flow under the alignment.[4]

F. EXISTING ENVIRONMENT

23 The topography of the alignment (when crossing the southern end of the Ruahine Range to the north of the Manawatū Gorge) is described in paragraphs 39 and 40 of Technical Assessment A. Key topographic elements include the Manawatū River, which is crossed at the western end of the alignment and into which all sub-catchments flow, moderately rolling to steep hill country on the eastern and western side of the Ruahine Range with a flat to rolling plateau across the top, and flat land where the alignment connects to the existing SH3 west of Woodville. While the alignment will follow ridges and the plateau where practicable and for the most part will be constructed within grazed farmland, it will cross multiple deeply incised gullies that contain remnant or regenerating native vegetation and areas of exotic scrub.

[1] Technical Assessment A, para 23.
[2] Technical Assessment A, para 23(b).
[3] Technical Assessment A, para 23(c).
[4] Technical Assessment A, para 24.

24 Geology is summarised in paragraph 42 of Technical Assessment A as mainly papa sandstone/siltstone/mudstone and alluvial gravel and silts with some shallow colluvium. Soils are also described (in paragraph 42 of Technical Assessment A):

Alluvium:

- *Clayey silts, silty clays, fine to coarse sandy gravels. Mixture of well-rounded gravels and medium well sorted sands. The alluvial deposits are variable. The upper near surface layers are more cohesive.*
- *Typically encountered at the western end to CH 3600 (Manawatū River) and at the eastern end from CH 12600 to CH 13800.*

Conglomerate:

- *Rounded greywacke gravels (10- 50mm). Clasts are matrix supported to clast supported.*
- *Fines (clay and silt) 5% to 25%, sands up to 40%, gravels 50% to 75%.*
- *Typically encountered from CH 3900 to CH 4000, and CH 5500 to CH 6900.*

Mudstone:

- *Typically, interbedded sandstone/siltstone/mudstone.*
- *Grading expected to be similar to overburden soils (refer below).*
- *Typically encountered from CH 6900 to CH 12600.*

Overburden:

- *Residually weathered mudstones/sandstone: Typically clays, silts and sandy silts (however will be variable).*
- *Fines (clays and silts) 50% to 90%, sands 10% to 50%, gravels <1%.*
- *Typically encountered from CH 3900 to CH 12600, typically at the upper 1m to 3m.*

Rainfall

25 Paragraphs 133 to 137 of Technical Assessment D provide a detailed analysis of the existing and design rainfall depths across a range of frequencies for the alignment, with a mean annual rainfall in the order of 1200-1300mm.

Freshwater environment

26 Descriptions of the freshwater receiving environments of the Project are provided in Technical Assessments C and H, and summarised in Technical Assessment D.

27 As outlined in Technical Assessment C, baseline water quality monitoring has been undertaken to determine base line water clarity, turbidity, total suspended solids ("**TSS**"), aluminium and pH during wet and dry conditions, along with measurements of aquatic macroinvertebrate and deposited sediment. The baseline monitoring found that most sites had relatively low visual clarity, moderately high turbidity, and high deposited sediments, with the exception of Catchment 7, which had a relatively low proportion of fine sediment on the stream bed.[5]

28 Technical Assessment H describes the ecological function of the streams within each of the nine sub-catchments affected by the alignment based on macroinvertebrate, fish and stream ecological valuation ("**SEV**") data. Based on Technical Assessment H[6], the Manawatū River, part of the Mangamania (Sub-catchment 2C), and Catchments 4 and 9 are considered to have high ecological value. The other parts of Mangamanaia (Catchment 2), Catchments 3, 5, 6, and 7 are considered to have moderate ecological value and Catchments 1 and 8 are considered to have low value. Catchment 9 is also considered to have high ecological value, but the areas in which works are being undertaken are considered low value and the area of works draining to that catchment is small.

29 Mr Logan Brown addresses the existing freshwater environment in his s87F report, and I defer to his conclusions in this regard.

G. EFFECTS OF PROPOSAL

30 The high-level construction programme provided with the Application indicates that bulk earthworks will be required over four years, or four earthworks construction

[5] Technical Assessment A, para 47.
[6] Technical Assessment H, Table H.11.

seasons.[7] The Application has provided an estimate of the average earthworks area that will be exposed per earthworks season based on the current construction programme. This area varies between 30ha and 80ha in size, with earthworks construction season 2 having the largest exposed area, followed by constructions seasons 3, 1 and 4 respectively.[8]

31 The construction programme also separates out four construction "zones" so as to break the Project down into manageable sizes for construction and environmental management. Staff and resources will be dedicated to each zone, with overall environmental management to take place under a dedicated Environmental Management Team.[9]

Erosion and Sedimentation

32 Paragraph 52 to 59 of Technical Assessment A details the erosion and sedimentation process and how erosion and sediment control can manage resultant effects on the receiving environment. I agree with this part of Technical Assessment A.

33 In my view, the environmental effects associated with the discharge of sediment into watercourses are well documented and accepted, and can include adverse effects on the aquatic flora and fauna of an area. These effects can extend substantial distances downstream from the works area and range from the smothering of aquatic life, the injury to the mouths and gills of aquatic animals, and the destruction of spawning grounds. An increase in turbidity within a stream can also stop animals feeding due to poor visibility, can increase heat absorption and stop light penetrating the water reducing photosynthetic activity. The deposition of sediment from such works can also result in a disruption to stream hydraulics, which may result in an increase in extent and/or frequency of flooding and changes to in-stream habitat.

34 Significant quantities of sediment may be discharged from bare/disturbed earth surfaces where appropriate erosion and sediment control measures are not implemented. Undertaking works within watercourses has a very high potential for erosion and discharge of sediment. This is due to the fact that such work is undertaken in or near flowing water which is the major cause of erosion. Flowing

[7] Technical Assessment A, para 29.
[8] Technical Assessment A, table A.2.
[9] Technical Assessment A, para 25-28.

water causes on-going scour and provides the transport mechanism to allow sediment to be dispersed downstream of the works and ultimately, into the marine environment.

35 The proposed earthworks will generate excess unsuitable material that will be placed into spoil disposal sites. Spoil disposal sites are considered as part of the overall earthworks operation and erosion and sediment control will be maintained to the same standard as 'typical' site earthworks. I understand that a condition is to be proposed requiring spoil sites to be managed to ensure that they do not lead to any uncontrolled instability or collapse affecting either the spoil site or adversely affecting watercourses, and I agree with that recommendation.

36 Design and planning consideration for permanent watercourse crossings needs to take into account the permanent nature of the crossing in question. In order to minimise the effects of sediment mobilised during stream works, it is important to avoid working in flowing water, minimise the disturbed areas adjacent to the stream works and to promptly stabilise all areas upon completion of the works.

Approach to Erosion and Sediment Control

37 The key principles to follow when planning for and undertaking earthworks activities are:

(a) Minimise disturbance;

(b) Stage construction to minimise area exposed at any one time;

(c) Protect steep slopes;

(d) Protect receiving environments;

(e) Stabilise exposed areas rapidly on completion of works;

(f) Install perimeter controls to prevent clean water entering the works area;

(g) Employ sediment detention devices to limit sediment migration off site;

(h) Develop training and experience in erosion and sediment control;

(i) Make sure the erosion and sediment control plan evolves with the project; and

(j) Inspect, assess, and adjust erosion and sediment control measures regularly, particularly during and after heavy rainfall events.

38 The Transport Agency has proposed the following management plan structure to manage the adverse effects associated with the Project:

(a) The CEMP which is, in summary, an umbrella environmental management document. The CEMP will detail the environmental management strategy to ensure compliance with conditions of consent, and includes performance criteria, management actions, monitoring, auditing, incident response, and reporting requirements. The CEMP will also specify areas of responsibility for the construction phase of the Project;

(b) An ESCP to guide the overall principles and methodologies for erosion and sediment control to be adopted. The ESCP documents a framework for the management, mitigation, and monitoring measures to be implemented on site; and

(c) The SSESCPs which will be developed in line with the consent conditions, ESCP and Auckland Council Guidance Document 05 *"Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region Guidance Document 2016/005 Incorporating Amendment 1"* ("**GD05**") to focus on the management of specific sites and activities throughout the Project.

39 Technical Assessment A details the Project's approach to ESC design and implementation. All ESC measures will be designed, constructed and maintained in accordance with GD05 and any subsequent amendments to that document. This is consistent with Designation Condition 15, and I generally agree with this approach.

40 GD05 is currently regarded as industry best practice when undertaking earthworks activities and contains a 'toolbox' of measures that can be employed to minimise erosion and control sediment within the earthworks site. In my view a condition should be included requiring all works to be undertaken at a minimum in accordance with GD05 and any subsequent amendments to that document unless a higher standard is proposed. It is important that subsequent amendments to GD05 are included as this will further improve best practice methods over time, and also allow the site to employ higher standards should they be proposed or required by the consent.

41 The Transport Agency proposes to use GD05 ESC measures to minimise the potential for erosion and subsequent sediment generation. The Transport Agency also proposes to monitor the effectiveness of ESC measures to ensure the minimisation of potential adverse effects from the discharge of sediment from the Project.

42 The Project proposes a two-stage hierarchical approach.[10] Firstly, by minimising erosion and subsequent sediment generation through physical measures and methodologies and secondly, by utilising sediment control measures to treat sediment laden discharges.

43 The overarching ESC management framework is provided in the ESCP submitted with the Application. The ESCP details ESC measures that will meet GD05 requirements. The Application also contains high level ESC drawings showing how GD05 measures will be employed across the Project. The ESC drawings indicate that Sediment Retention Ponds (primarily) and Decanting Earth Bunds ("**DEBs"**) will be utilised as the predominant sediment control devices for the project. Chemically treated Sediment Retention Ponds ("**SRPs"**) are considered to be the most efficient sediment control device, while DEBs can be less effective. In order to achieve the highest possible sediment treatment efficiency, all runoff practicable should be directed to Sediment Retention Ponds for treatment.

44 The ESCP and Technical Assessment A also detail how SSESCPs will be developed in line with the ESCP and GD05. These plans will focus on the management of specific sites and activities throughout the Project. The plans propose to use the detail in the ESCP, concept drawings and GD05, and focus on implementation and management of the ESC devices while allowing for future flexibility and the ability to adapt appropriately to changing site conditions. This SSESCP structure allows the site to implement the most effective ESC solution to a changing site; effectively employing the GD05 principle of adjusting the ESCP as needed at any given time.

45 Prior to earthworks or stream works commencing at any given location, the Environmental Management Team will prepare and submit a SSESCP to Horizons for certification against the resource consent conditions, ESCP, and GD05. Work will only commence in any given area once the SSESCP has been certified by Horizons. The SSESCP will take into account the specific construction activity; the area, volume and nature of the earthworks and the downstream receiving environment; methods for

[10] Technical Assessment A, para 69.

managing effects; the duration, the time of year and any additional specific measures required; stabilisation methods and timing; and chemical treatment. In my view a condition should be included requiring SSESCPs to be certified in writing by Horizons prior to the commencement of works in the area covered by the SSESCP.

46 Although Technical Assessment A is silent on winter works, Section 3.8.1 of the AEE details that there is likely to be works undertaken in winter. As earthworks during winter are more susceptible to wetter weather and a resultant increase in sediment discharge risk, a seasonal restriction is considered appropriate. The proposed consent conditions in Appendix D of the AEE indicate that SSESCPs will also be utilised to manage winter works throughout the Project, and will be certified as winter works through SSESCP certification process. In my view a condition should be included requiring any winter works to be approved in writing by Horizons.

47 Chemical treatment (flocculation) is considered a key tool to assist in the sediment control efficiency of the SRPs and DEBs. The ESCP contains a CTMP which details bench testing results undertaken on a range of soils throughout the Project. These bench testing results indicate that the soils tested react well to chemical treatment, which will assist with the efficiency of the SRPs and DEBs. The CTMP also contains a management framework that provides for ongoing bench testing and the implementation of chemical treatment for the Project. In my view a condition should be included requiring ongoing bench testing and chemical treatment of all sediment impoundment devices.

48 Technical Assessment A and the ESCP also focus on progressive and rapid stabilisation of disturbed areas using measures aligned with GD05 such as mulch, aggregate, and geotextiles. Temporary and permanent stabilisation will be key to ongoing erosion control on completed areas.[11] In my view a condition should be included requiring progressive stabilisation of completed earthworks areas.

49 The Project includes piling, earthworks, and stream works that will require dewatering by pumping. The ESCP contains a Dewatering Management Procedure to ensure that the required level of sediment treatment is achieved on site during dewatering operations. Pumping will either be via a sediment control device such as an SRP or

[11] I note that para 146(b) of Technical Assessment A assumes the full catchment is exposed for the full season; being a 'worst case' scenario.

DEB, or directly from the excavation or stream diversion works to the receiving environment. I note the following:

(a) If dewatering is via a sediment control device such as an SRP or DEB, the decants of the device will be raised and water impounded within the SRP or DEB will be stored and batch dosed with flocculent to achieve greater than 100mm clarity and pH of 5.5 – 8.5 prior to discharge to the receiving environment.

(b) If dewatering is to occur directly to the receiving environment, the impounded water is to have a clarity of greater than 100mm at all times and the pump must be able to remove the impounded water without disturbing any sediment.

50 The Dewatering Management Procedure contains a Dewatering and Pumping Record Sheet that is to be completed and signed off by a site manager prior to any pumping. The Dewatering and Pumping Record Sheet ensures that any dewatering is undertaken in accordance with the Dewatering Management Plan. In my view a condition should be included requiring any dewatering to be undertaken to meet a clarity standard or via a sediment treatment device provided that the device is not currently in use and can impound water to achieve the required clarity.

Sediment Yield

51 Paragraph 123 to 141 of Technical Assessment A provides detail on various tools that can be used to estimate sediment yield from earthworks sites. In order to determine an estimated sediment yield for the Project, the Universal Soil Loss Equation ("**USLE**") has been used. The USLE is a tool that has been used by regional councils throughout New Zealand to estimate the potential annual soil loss from earthwork projects using rainfall pattern, soil type, topography, vegetation cover and management practices. The equation can help identify the comparative scale of potential effects on receiving environments, and the risk associated with those sedimentation effects.

52 Technical Assessment A contains eight USLE estimates of typical SRP catchments within the Project area. The USLE assessments cover varying topography contained within the Project area including steeper land, the central plateau, and flat land across the Project. Paragraphs 143 to 146 contain the assumptions that form the basis of the USLE calculations which are I consider accurate for the Project. I agree with the

assumptions, which apply a conservative scenario for sediment generation while using industry accepted values for sediment control devices.

53 Technical Assessment A provides detail on other estimating tools such as the Groundwater Loading Effects of Agricultural Management Systems and the Construction Water Assessment Report used on the NZTA Puhoi to Warkworth project and comparisons between these tools and the USLE. The report concludes *"the USLE outputs derived specifically for this Project will not underestimate sediment yield and can be relied on by various experts to inform their assessment of likely downstream sediment-related effects of the Project."*

54 I agree with the conclusion regarding ULSE outputs. The USLE is the most commonly used estimating tool when calculating estimated sediment loss from earthworks sites, and I agree that the outputs calculated for the Project can be considered conservative (i.e. not underestimated) in this context.

55 Paragraphs 103 to 113 of Technical Assessment A discuss parameters for monitoring the performance of ESC devices on earthwork projects, including a discussion on turbidity versus total suspended solids ("**TSS**") and clarity. All measures have been used on various large-scale projects in recent years, with TSS having been employed as a performance standard in some cases. The significant difference between the three parameters is that turbidity and clarity can be measured on site in real time while TSS requires sampling and analysis in a laboratory before results can be reported.

56 Technical Assessment C contains a correlation between TSS and turbidity, being TSS = turbidity / 0.61. It is possible that this relationship can be used to estimate the TSS based on instant turbidity readings taken on site. However, the s92 Response clarified that Technical Assessment C used relationships between TSS, turbidity, and water clarity derived from data from the Manawatū River and that although there appears to be a lineal relationship between TSS and turbidity, this relationship gets weaker at higher concentrations. Therefore, it is my view that caution needs to be applied if such a relationship is to be used when calculating a TSS from turbidity (or vice versa).

57 Technical Assessment A recommends that turbidity and clarity are the most time and cost-effective measures for monitoring ESC performance on site. As a result, the Project proposes to implement continuous sampling of two SRPs for turbidity at the inlet and outlet of the SRP to measure ESC performance, with manual sampling of all SRPs to correlate an understanding of ESC performance across the site. This is

intended to provide a measure of how the ESC devices are performing to meet a target of 90% efficiency sediment removal.

58 Mr Stewart considers that a separate TSS performance standard is *"unnecessary and unrelated to the likely effects of the Project"*, and that imposition of GD05 standard controls is an appropriate performance standard for the Project. As I explain below, I disagree. In my view, an 'end of pipe' discharge standard is the only way to ensure minimisation of effects on the receiving environment.

59 Measuring the efficiency standard of ESC measures cannot give an accurate indication of the sediment discharge from site or the related effects of discharges from the Project on the receiving environment. For example, a catchment with a very high sediment loading could still be operating at 90% efficiency but discharging a high volume of suspended sediment due to the high volume of suspended sediment coming into the SRP. This could in turn be contributing to a high sediment loading in the receiving catchment and a more than minor effect. While there are some limitations with a TSS discharge standard (as with any method) in my view a TSS performance standard will ensure the parties obtain a more accurate indication of the sediment discharge from site and any resultant effects on the receiving environment.

60 Paragraph 95 of Technical Assessment C provides an estimation of a median TSS discharge from sediment treatment devices in the range of 50mg/L to 120mg/L based on the USLE calculations, or 48mg/L to 153mg/L based on the bench testing undertaken in the CTMP. These are the assumptions on which the receiving environment effects are considered no more than minor. Mr Logan Brown considers these values (and the implications for the receiving environments) in his report, and I rely on his conclusions for the purposes of my report.

61 It is my view that a condition should be included providing a discharge standard for the proposed sediment retention devices based on the TSS discharge calculations derived from the USLE. This will ensure the effects on the receiving environment are consistent with the assumptions used in Technical Assessment C.

62 The s92 Response further details that there are currently two continuous turbidity monitors in place gathering baseline data in catchments 2 and 7. In the event that a turbidity standard was considered at any stage, it is possible that this data could be correlated to the output from continuously monitored SRPs. This approach could be considered an alternative to the preferred TSS performance standard.

H. EROSION AND SEDIMENT CONTROL MONITORING

63 The ESCP contains an ESCMP that details the ESC management and monitoring system to be implemented for the Project. The ESCMP covers site management structures, weather monitoring and triggers, and ESC monitoring for sediment control performance, along with event and annual reporting procedures.

64 The ESCMP is also designed to ensure that the ESC measures have been designed, installed, and managed in accordance with GD05, the conditions of consent, and any management plan requirements.

65 The ESCMP details a process for the implementation of ESC devices in accordance with the SSESCP and GD05. Once a SSESCP has been certified by Horizons, the Construction Team and the Environmental Management Team will review the control location and requirements of the relevant SSESCP on site and oversee the construction of ESC devices. Once construction is complete, the Environmental Management Team will certify device compliance with the SSESCP and GD05 with 'as built' certification. These 'as built' certifications will then be submitted to Horizons. In my view a condition of consent should be included requiring 'as builts' for all ESC measures to be submitted prior to any earthworks which contribute to the catchment of the ESC device. All 'as builts' should be in accordance with industry 'as built' requirements to ensure accurate detail that can be used to determine compliance with GD05 standards.

66 The monitoring proposed under the ESCMP includes routine (at a minimum weekly) inspections by the Environmental Management Team of the site and all ESC devices. There are also daily inspections proposed to be undertaken by ESC Foremen. There will also be pre rain event inspections where more than 20mm of rainfall is forecast over a 24 hour period in addition to standard pre forecast rain event inspections. There will also be post rainfall event monitoring during or immediately after trigger rainfall events, where an inspection will be made of all SRPs and DEBs. There will be manual turbidity and pH testing of the inlet and outlet flows of all SRPs and DEBs in addition to the general inspection of ESC devices. This may assist in determining compliance with a proposed discharge standard and triggers to ensure the discharge standard can be met, however care will need to be taken when correlating turbidity with TSS.

Monitoring Targets

67 The ESCMP details that continuous monitoring of two SRPs will be assessed against an average efficiency of 90% across a rainfall trigger event, with the average efficiency being calculated from the inlet and outlet turbidity measures. Where 90% efficiency is not achieved further investigation will be undertaken into the device and catchment and further measures employed to improve the efficiency of the device, including potential additional ESC measures, refinement of chemical treatment, stabilisation in sub catchments, and increased maintenance.[12]

68 Clarity monitoring of sediment control devices will either be with a black disc or clarity tube, although the ESCMP is silent on what the target clarity should be. Generally, clarity should be 100mm or greater, and this can be correlated with turbidity sampling data. Clarity monitoring should only be used as a last resort or when dewatering, and not relied upon as a discharge standard for all sediment control devices.

69 pH measurements will be taken with a calibrated pH meter. pH readings will be recorded and correlated with the pH measurements from the CTMP to ensure the baseline pH is not changed beyond +/- 1 unit, and within the parameters set by resource consent conditions. In my view a condition should be included to ensure the pH does not fall outside of the range of 5.5 and 8.5 when measured at the device outlet.

70 In addition to the treatment efficiency measures above, the monitoring inspections will check the operational integrity of all ESC devices. Should there be a failure or overtopping of any ESC device that results in a visible discharge to a watercourse, remedial action will be undertaken to reinstate devices to prevent further discharges and event based ecology and water quality monitoring as described in the Aquatic Monitoring Protocols of the Ecology Management Plan will be implemented.

71 ESC monitoring detailed by the Applicant will assist the Applicant in determining triggers that can ensure compliance with the proposed discharge standard. In the absence of a discharge standard, further conditions will be required to demonstrate compliance with ESC monitoring standards. This will help ensure that sediment control devices are achieving the efficiency standards that have been assumed in determining the effects on the receiving environment in the Application.

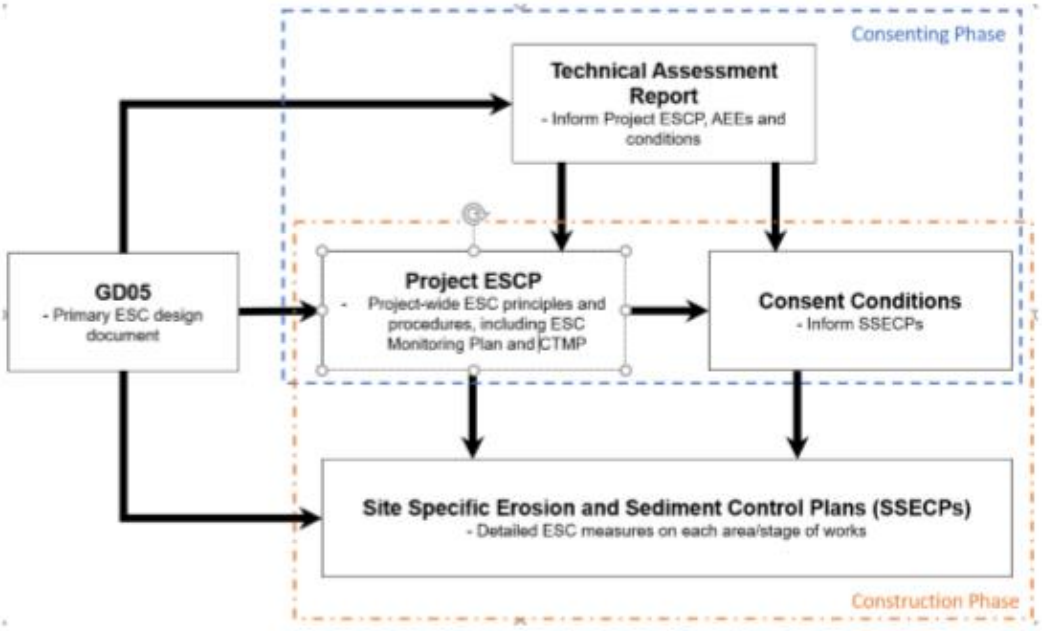
[12] See ESCMP at Section 2.

Assessment of CEMP, ESCP, and SSESCPs

72 As outlined earlier, the CEMP is an umbrella environmental management document. It is the ESCP that guides the overall principles and methodologies for erosion and sediment control to be adopted. The ESCP documents a framework for the management, mitigation, and monitoring measures to be implemented on site.

Note: The star (*) denotes those sub-management plans of the CEMP that then contain sub-management plans or appendices of their own.

73 SSESCPs will be developed in line with the consent conditions, ESCP, and GD05 to focus on the management of specific sites and activities throughout the Project.



74 GD05 provides technical guidance for the selection, design and use of ESC practices and measures for a range of land disturbing activities. GD05's ultimate goal is *"to minimise erosion, sediment discharge and sedimentation that occurs as a consequence of land disturbance".* GD05 is a two-part document:

(a) Part 1 – Principles - contains the overarching principles of ESC, erosion and sedimentation and a process for selecting and using ESC practices; and

(b) Part 2 – Practices - contains specific practices including a range of ESC options for ESC along with the benefits and applicability of each practice.

75 GD05 is currently regarded as industry best practice for ESC on earthworks sites. Provided the Project implements ESC through the ESCP and SSESCPs in accordance with GD05 Principles and Practices the Transport Agency expects that the Project will be able to minimise the potential for sediment generation and maximise the effectiveness of ESC measures associated with earthworks. The Application and supporting documents all promote the use of GD05 as a standard for ESC practices for the site.

76 However, implementation of GD05 also requires consideration of all key principles of erosion and sediment control, including non-structural approaches such as:

(a) Minimising disturbance;

(b) Staging construction;

(c) Protecting steep slopes; and

(d) Protecting watercourses (and other sensitive features).

77 Should implementation of GD05 measures not achieve (based on the recommended discharge standard) the required minimisation of impacts on the receiving environment, further consideration will need to be given to non-structural approaches in any catchment where these impacts are occurring. For example, this may require consideration of a more staged approach where parts of the catchment are rapidly stabilised or earthworks are undertaken in stages to minimise the sediment laden flows to a treatment device. In the absence of a discharge standard, further conditions around staging of the proposed earthworks should be considered for the management of the scale of sedimentation effects.

78 I also note that while GD05 includes a comprehensive selection of current best practice ESC measures that have proven their effectiveness in the field, ongoing development and innovation of ESC measures is dynamic and evolving. Consideration needs to therefore be given to the use of new emerging ESC practices and innovations not explicitly included in GD05, where performance can be demonstrated to be an appropriate alternative in line with the principles of GD05. In my view a condition should be included allowing for changes in GD05 to be implemented on site, along with higher standards if approved in the SSESCPs.

79 As discussed earlier, undertaking works within watercourses has a very high potential for erosion and discharge of sediment. This is due to the fact the work is undertaken in or near flowing water which is the major cause of erosion. Flowing water causes on-going scour and provides the transport mechanism to allow sediment to be dispersed downstream of the works and ultimately, into the Manawatū River. Works within watercourses can also have a direct impact on watercourse habitat through habitat disturbance or destruction, and on watercourse ecology through sediment and temperature-related effects.

80 Greater care is therefore required for works in and around watercourses to minimise actual and potential effects as much as possible. Where this work is unavoidable, specific construction methodologies and control measures are required to minimise potential adverse impacts. In order to minimise the effects of sediment mobilised

during stream works, it is important to avoid working in flowing water using the dam and divert principles detailed in GD05, to minimise the disturbed areas adjacent to the stream works and to promptly stabilise all areas upon completion of the works. In my view a condition of consent should be included requiring all works in a watercourse to be undertaken only when all flows can be diverted around the works area and rapid stabilisation of areas on completion of the works.

81 The Project has the potential to impact all watercourses along the alignment. More specifically, the Project includes new bridge crossings of the Manawatū River and the Mangamanaia Stream, an Eco Bridge that spans a wetland and tributary stream, and a major culvert at chainage 7850.

82 The s92 response contained three SSESCPs referred to in the AEE, so as to demonstrate the level of detail that will be provided in these site specific plans. The three SSESCPs were intended to provide for a range of activities, and included:

(a) The Eco Bridge area;

(b) Culvert 8 at chainage 7850; and

(c) A 'typical' cut to fill from chainage 12100 to chainage 12900.

83 The SSESCP for the Eco Bridge covers the activities associated with the construction of three stabilised all-weather access tracks and three staging units required for the construction of the Eco Bridge across an unnamed tributary and wetland of the Manawatū River. Due to the unique nature of the wetland area, and the presence of ecologically sensitive areas, the earthworks associated with the construction of the all-weather access tracks consist simply of placing geotextile along with aggregate and geogrid over the existing ground. These works will be contained with a silt fence, while the balance of the staging works consists of piling with minimal disturbance.

84 The SSESCP for Culvert 8 at chainage 7850 allows for the offline construction of triple 2m x 2m box culverts. The construction methodology generally follows GD05 guidance by creating a temporary stabilised offline diversion through which the watercourse can be diverted whilst the box culverts are being constructed. The SSESCP also allows for the construction of an SRP (later to be used for bulk earthworks) to allow for dewatering of the works area in accordance with the Dewatering Management Procedure. Silt Fences ("**SFs**") will be used to control a temporary stockpile and to protect the temporary diversion channel from any runoff.

85 The SSESCP for the 'typical' cut to fill from chainage 12100 to chainage 12900 provides for the construction and use of three SRPs and two DEBs. The three SRPs have been designed in accordance with the 3% criteria ($3m^3$ of storage for every $100m^2$ of contributing catchment) and will be chemically flocculated in accordance with the CTMP. The two DEBs are for smaller ($2,000m^2$ each) catchments that cannot be directed to an SRP. The DEBs have been designed in accordance with the 2% criteria ($2m^3$ for every $100m^2$ of contributing catchment) and will be chemically flocculated in accordance with the CTMP.

86 The s92 Response states, "*Best practice in this case entails as much worked area as possible discharging to chemically treated sediment retention ponds and open areas being progressively stabilised to limit the worked area that is exposed at one time*." It is expected that a well-constructed and maintained SRP designed and built in accordance with GD05 can achieve average efficiencies of 90% to 95%, while DEBs are generally considered to not be as efficient, especially on steeper slopes where runoff velocities can be greater. Therefore, careful consideration of where DEBs are to be utilised is necessary to ensure that specific DEB design can be implemented to improve DEB efficiencies where required. In my view a condition of consent should be included requiring any DEBs with a contributing catchment slope of greater that 18 degrees or a catchment greater than $3,000m^2$ to have increased storage capacity of 3%, and a 10% volume forebay with cloth lined spreader bar.

87 Dewatering will be required throughout the Project. GD05 contains a best practice procedure for dewatering that will be implemented throughout the Project through the procedures in the Dewatering Management Procedure that is part of the ESCP. As a minimum, 100 mm clarity (100mm clear water depth) within the water to be discharged is required to allow water to be discharged directly offsite. Otherwise water will need to be pumped to an SRP or DEB for treatment. Subject to the volumes pumped, the outlet may need to be blocked during pumping and the SRP/DEB treated in accordance with the CTMP following pumping. This is all documented in the Dewatering Management Procedure and is considered appropriate.

88 The Transport Agency have included performance outcomes, reporting requirements, and trigger response procedures in the CEMP and ESCP (through the ESCMP) rather than having these referenced in consent conditions. While some of the detail behind these outcomes/triggers can be included in the CEMP and ESCP, in my opinion there are a number of direct sediment related environmental effects on the receiving

environment that should be addressed by way of consent conditions. There are several reasons for this, including:

(a) Ensuring the adverse effects of a proposal are avoided, remedied or mitigated through enforceable conditions and not via the content of management plans;

(b) Ensuring the consent document is a transparent reference point for compliance when undertaking consent monitoring of key environmental (bottom line) outcomes, thereby avoiding having to search through management plans; and

(c) Ensuring that important elements of consent are not unintentionally changed through the management plan review and approval process; with conditions setting out bottom lines which are only able to change via the Review condition.

I. SUBMISSIONS

89 I have read the submissions that have been made on the Application. Many of the submissions cover topics that fall outside of my area of expertise and will be covered in the technical reports of other experts. Where submissions did cover areas that are in my area of expertise they are set out below:

Submission	**Subject related to Erosion and Sediment Control**
Submission 6 – Mr K C Barnett	Support the Application in full subject to the conditions proposed by the Transport Agency.
Submission 8 – Mr N Shoebridge	Potential adverse effects of runoff from spoil sites into local creek.
Submission 9 – DaSS Trust (Mr G D Speedy)	Support the Application in full subject to the conditions proposed by the Transport Agency.
Submission 10 – Transpower New Zealand Limited (Transpower)	Concerned over effects of proposed bulk earthworks on Transpower assets, and dust effects of proposed earthworks on existing Transpower assets.

Submission 13 – Meridian Energy Ltd (Meridian)	Concern of geotechnical effects of proposed earthworks and spoil sites on wind farm infrastructure.
Submission 15 – Royal Forest and Bird Protection Society Inc (Forest and Bird)	Concern over conditions, in particular the reliance on Management Plan objectives over consent conditions.
Submission 16 – Queen Elizabeth the Second National Trust (QEIINT)	Concern over sedimentation effects, and the lack of contingency measures if controls are inadequate.

90 I consider all the items raised in the submissions where they relate to ESC have been covered in this report. There are items raised in submissions 10 and 13 that are beyond the scope of the ESC Assessment as they relate to geotechnical considerations and impact on Transpower infrastructure beyond the earthworks proposed. I understand that further information is being provided by the Applicant in support of geotechnical considerations as they relate to the Meridian and Transpower submissions, as indicated in the s87F planning report of Mr St Clair.

J. DISCUSSION AND CONCLUSION

91 The Project's approach to ESC design and implementation is to ensure that all ESC measures are designed, constructed and maintained in accordance with GD05, and any subsequent amendments. GD05 is currently regarded as industry best practice when undertaking earthworks activities and contains a 'toolbox' of measures that can be employed to minimise erosion and control sediment within the earthworks site.

92 The Transport Agency has also proposed a management plan structure to manage the adverse effects associated with the proposed development. This comprises an overarching CEMP and ESCP, with SSESCPs to be developed for every discrete area of works in line with the consent conditions, ESCP, and GD05.

93 While implementing ESC measures through the ESCP and SSESCPs in accordance with GD05 is considered best practice, implementation of GD05 also requires consideration of all key principles of ESC, which includes non-structural approaches. Should implementation of GD05 measures within the Project not achieve the required minimisation of impacts on the receiving environment, further consideration may need

to be given to non-structural approaches in any particular catchment where these impacts are occurring.

94 The s92 Response for the Applicant suggests that a discharge standard for ESC measures utilised during earthworks is unnecessary because there is no quantified link between sediment yield and in-stream effects. A performance-based approach to ESC has instead been proposed through management plans and conditions, with continuous monitoring of two SRPs and event monitoring of all treatment devices. This monitoring will be assessed against an average efficiency of 90% across a rainfall trigger event. Where 90% efficiency is not achieved further investigation will be undertaken into the device and catchment and further measures employed to improve the efficiency of the device, including potential additional ESC measures, refinement of chemical treatment, stabilisation in sub catchments, and increased maintenance.

95 I am of the view that a TSS performance standard to determine the end of pipe sediment load from sediment control devices is appropriate to better manage the environmental effects from the Project. While there are some limitations (as with any method) this performance standard will ensure the parties obtain a more accurate indication of the sediment discharge from site or the related effects of the Project on the receiving environment and ensure the effects are consistent with those considered in the Application. An appropriate discharge standard would be one on which the potential adverse effects on the environment have been considered in the Application. This is addressed in the report of Mr Brown and I defer to his recommendations.

96 The ESCP contains an ESCMP that details the ESC management and monitoring system to be implemented for the Project. Along with covering a range of other matters, the ESCMP is designed to ensure that ESC measures have been designed, installed, and managed in accordance with GD05, the conditions of consent, and Management Plan requirements.

97 However, there are a number of performance outcomes, standards and reporting requirements proposed for management plans, which in my opinion are better suited for conditions of consent. While some of the detail around processes (or what will be done to achieve standards) can be included in the CEMP and ESCP, the standards or bottom lines should be secured through enforceable consent conditions.

K. RECOMMENDATIONS/CONDITIONS

98 I have reviewed the suite of consent conditions relating to earthworks and ESC for the Project. While not getting into the specifics of the wording of conditions, which will be addressed by Mr St Clair, there are a number of matters I comment on below.

99 I am of the view that there are several items contained within management plans that should be conditions of consent. These are also noted below.

100 GD05 is currently accepted as industry best practice, and it is appropriately referenced in conditions for the Project. The approach should still however allow for changes in GD05 to be implemented on site, along with higher standards if approved in the SSESCPs. This is consistent with Designation Condition 15(a)i), which provides that that ESC must be in accordance with GD05 unless designed, constructed and maintained in accordance with resource consent(s) from Horizons.

101 The information submitted by the Transport Agency contains the high level ESCP and concept ESC drawings. Earthworks should not commence in any discrete areas until a SSESCP is developed and certified. SSESCPs developed under the ESCP and concept drawings should be certified in writing by Horizons prior to the commencement of works in the area covered by the SSESCP.

102 The Transport Agency has proposed that winter works be approved through the SSESCP certification process. Given the increased risk of undertaking earthworks in winter, any winter works should be approved in writing by Horizons.

103 The CTMP provided by the Transport Agency contains bench testing on a range of soils throughout the project. In order to determine accurate dosage of all sediment retention devices, ongoing bench testing will be required for different soil types and chemical treatment should be undertaken on all sediment impoundment devices. This should also ensure the pH does not fall outside of the range of 5.5 and 8.5 when measured at the device outlet.

104 The longer an earthworks area is exposed to the environment, the greater the risk of sediment discharge. As such, progressive stabilisation of completed earthworks areas should be required. However, staging of earthworks has not been considered further at this stage subject to the recommended discharge standard and progressive stabilisation as part of the consent conditions. Absent a discharge standard, further consideration should be given to a staging limit being part of the conditions of consent.

105 Dewatering will be required throughout the Project and provides a risk to the receiving environment if not managed. Any dewatering should be undertaken to meet a clarity standard or through a sediment treatment device provided that the device is not currently in use and can impound water to achieve the required clarity.

106 While the Transport Agency is proposing an efficiency standard for sediment retention devices, there is not a standard provided for the ultimate discharge. As such, a discharge standard based on the recommendations in Mr Logan Brown's report should be provided for the proposed sediment retention devices.

107 It is important the ESC meet certain construction and specification standards. 'As builts' for all ESC measures should be submitted in accordance with Horizons as built requirements, and prior to earthworks commencing in the catchment of the ESC device.

108 ESC measures utilised throughout the Project will require routine and event monitoring of all ESC measures, with the Transport Agency proposing manual turbidity and pH testing of all SRPs and DEBs.

109 Given the increased risk when undertaking works in flowing water, all works in a watercourse should be undertaken only when all flows can be diverted around the works area and rapid stabilisation should be required on completion of the works.

110 While the Project proposes the majority of earthworks to be controlled by SRPs, there will be areas where DEBs will be required. DEBs can have a lower treatment efficiency than SRPs especially in larger and/or steeper catchments. Therefore, any DEBs with a contributing catchment slope of greater that 18 degrees or a catchment greater than 3,000m^2 should have increased storage capacity of 3%, and a 10% volume forebay with cloth lined spreader bar.

KERRY PEARCE

25 May 2020

L. REFERENCES

Leersnyder, H., Parsonson, M., Bunting, K., Stewart, C. (2018). Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region June 2016 Guideline Document 2016/005 Incorporating Amendment 1.