horizons regional council

Reasonable Stock Water Requirements

Guidelines for Resource Consent Applications

Technical report ~ December 2007

AQUAS Consultants Ltd

AQUALINC RESEARCH LIMITED

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Technical report prepared for Horizons Regional Council

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HORIZONS REGIONAL COUNCIL

Reasonable Stock Water Requirements
Guidelines for Resource Consent Applications

EXECUTIVE SUMMARY

Under Council's proposed One Plan, farms with water-use requirements greater than $30m^3$/day will need to have a resource consent for the taking of water. To fairly assess resource consent applications, Horizons Regional Council (HRC) needs to determine that the volume applied for is consistent with what is reasonably required by that type of farming enterprise.

The purposes of this study were to:

- review the scientific literature to establish standard estimates of drinking-water requirements of a range of farm animals
- gather additional information on water requirements and use as needed from related industry associations (Codes of Practice, etc.)
- recommend *reasonable* levels of water use that HRC can apply as a standard for resource consent applications, and
- devise a simple procedure which HRC can use when processing applications.

This work builds on a 2004 report prepared for Council by Aqualinc Research Limited. It examines stock drinking water requirements and related water use for eight farm animals/fowl: dairy cattle, beef cattle, sheep, deer, horses, goats, pigs and poultry. Pertinent information was searched via scientific and agricultural databases, websites of related organisations and direct contact with key agricultural professionals and nine industry organisations.

To summarise the information gathered, the report provides tables noting estimated average day demand and peak day demand for each stock category along with relevant details from the research literature and resource materials reviewed. A brief discussion concludes the section on each stock type and includes a suggested *range* for drinking-water requirements which Council can use as a basis for determining a *standard*.

The report also provides a draft of simple form that resource consent applicants could complete to document their water requirements. The use of such a form would make it easy for them to provide the necessary information *and* simplify and standardise procedures for Council in assessing it.

Given that farmers will need to install a water meter to track actual use, there is an opportunity as a part of this process to improve on-farm management of water and reduce water loss. Several methods are proposed for this and support information is provided.

Efficient use of water in all sectors will contribute to sustainable management of this finite natural resource. A clear understanding of stock water requirements and associated on-farm uses will help to provide a sound basis for water-use planning and management in the region.

Report prepared by AQUAS Consultants Ltd and Aqualinc Research Ltd

December 2007

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1 Background

Horizons Regional Council's One Plan sets out a policy framework for managing resource use activities in an integrated manner across the region.

The One Plan identifies four priority – or 'keystone' – issues for the region:

- surface water quality degradation
- increasing water demand
- unsustainable hill country land use, and
- threatened native habitats.

This report addresses the issue of *increasing water demand*, with a particular focus on stock water requirements (and complementary water use) in farming operations.

Surface water and groundwater are abstracted for a variety of uses, including community water supplies, industry, electricity generation and agriculture. While the amount of water used for power generation has not changed significantly in the last decade, other uses have steadily increased.

The total volume of permitted water takes has increased dramatically between1997 and 2004 – up 45% for groundwater and 108% for surface water. Increase in surface water takes by sector during the period are as follows:

- water supply – up 34%
- industry – up 44%
- agriculture – up 313%.

Agricultural use moved from 23% of the total permitted water takes (by volume) in 1997 to 29% in 2004. (For surface water takes, the shift was from 32% to 51% of the total during the same period.) While the increase in agricultural use is mainly irrigation for dairy farms, stock drinking water and other on-farm requirements are a part of the added demand. Where land-use changes involve conversion to dairy farming the additional water requirements can be considerable, given the drinking-water needs of lactating cows and water used for milk cooling and plant and yard wash down.

While the overall increase in demand is a concern, timing of the abstraction is particularly important. Rivers experience natural low flows during summer, which coincides with greatest demand – for outdoor residential use, for key industries in the region *and* for agriculture.

Efficient use of water in all sectors will contribute to sustainable management of this finite natural resource. A clear understanding of stock water requirements and associated on-farm uses will help to provide a sound basis for water-use planning and management.

1.1 Purpose of the Work

Under the proposed One Plan, farms with water-use requirements greater than 30m^3/day will need to have a resource consent for the taking of water. To fairly assess resource consent applications, HRC needs to determine that the volume applied for is consistent with what is reasonably required by that type of farming enterprise.

The purposes of this study were to:

- review the scientific literature to establish standard estimates of drinking-water requirements of a range of farm animals
- gather additional information on water requirements and use as needed from related industry associations (Codes of Practice, etc.)
- recommend *reasonable* levels of water use that HRC can apply as a standard for resource consent applications, and
- devise a simple procedure which HRC can use when processing applications.

The drinking water estimates considered – and standards suggested – are based strictly on the needs for livestock production *and* health and welfare of the animals. The guidance provided here is based on the premise that other initiatives (such as nutrient management programmes) adequately address issues such as stocking rates and capacity of the land to handle the farming enterprise.

1.2 Format & Contents of the Report

The remainder of the report is structured as follows:

Section 1.3 following outlines the steps taken to gather information summarised in Part 2.

Part 2 provides water-use data and information for eight farm animals/stock and fowl. These are: dairy cattle, beef cattle, sheep, deer, horses, goats, pigs and poultry. A summary table is provided for each category along with relevant details from the research literature and resource materials reviewed. A brief discussion concludes each section along with a suggested range for drinking-water requirements which Council can use as a basis for determining a standard.

Part 3 summarises information on the range of drinking water requirements – and ADD and PDD figures – for different stock types detailed in Part 2 and provides some supporting comments. It also considers how water use will be reported for resource consent applications and proposes a simple form to be used for this purpose. It concludes with some suggestions for water-use monitoring and loss reduction.

The **References** list includes all materials reviewed in preparation of this report. A binder with copies of the reviewed materials has been assembled for HRC as a reference base.

The **Appendices** provide support information for Part 3. Appendix A includes a Draft "Annual Farm Water-Use Requirements" recording form for use by resource consent applicants. Appendix B confirms rates of water loss in a farm water supply system for different size leaks. This latter information is provided in support of efforts to reduce unnecessary wasting of water.

1.3 Research Steps

A report prepared for Horizons Regional Council by Aqualinc Research Limited has served as a starting point for the current work aiming to capture any additional relevant information. The Aqualinc report, submitted in September 2004, is entitled *Water Allocation Project – Stage 1*. Appendix B of that report includes a detailed table on "Livestock water demand – parameters and assumptions" derived from information supplied by J Hargreaves of Massey University (also cited in this report's Reference list).

In terms of water use on dairy farms the Lincoln Environmental (2003) report, *Water Requirements on Dairy Farms*, provides comprehensive information (citing 24 sources). It is described as a 'rapid assessment desktop approach' accessing a variety of information, including:

- a literature search of scientific journals at the Ruakura Research Centre, Hamilton
- review of national and regional guidelines on water use in the dairy industry
- consultation with consultants and professionals with ARC, Fonterra, Dexcel, Qconz and Massey University, plus with two milking plant suppliers.

The report addressed both stock water requirements and use of water in the dairy shed.

The current review has been carried out to:

- locate any relevant research/information subsequent to 2004
- look for greater detail in the other farm stock areas (similar to the extensive information on dairying), and
- identify any other resources and information that might be helpful.

A number of steps were taken to track down relevant information.

Searches of the National Library of New Zealand and USDA Agricola databases (key words: stock water requirements, farm animal water requirements, etc) elicited a number of relevant articles which were then sourced from the publisher or through the public library system.

The SciQuest (Online Science Journals – Veterinary, Animal and Agricultural Sciences) database of 17 journals/sources was also searched using the same key words. A Google search identified a number of potential sources and relevant information was downloaded.

Ministry of Environment, Biosecurity New Zealand, Ministry of Agriculture and Forestry (including MAF Technical Papers), LIC and CSIRO websites were scanned for pertinent information.

Key contacts at AgResearch, Fonterra and Dexcel were informed of the work and have provided helpful information.

The reference lists of earlier research articles were examined for related articles and any potentially useful ones were secured.

Nine industry organisations were contacted with a request for any relevant information. These were:

- NZ Sheepbreeders' Association
- Meat & Wool New Zealand
- Alpaca Association of New Zealand Inc
- Deer Industry New Zealand
- NZ Dairy Goat Breeders Association Inc
- NZ Equine Research Foundation
- NZ Ostrich Association Inc
- NZ Pork Industry Board
- Poultry Industry Association of NZ.

Some of these organisations responded with helpful information, including animal welfare policies and codes of practice. The Massey University Monogastric Research Centre, contacted regarding pig and poultry information, provided a summary table on water requirement for poultry under New Zealand conditions.

All of the information was reviewed and assessed in the process of summarising the data and discussion points in Part 2.

2 Data, Details & Discussion

Fleming (2003) in Lincoln University's *Farm Technical Manual* notes, "Investigations in New Zealand and overseas have resulted in data on water consumption by livestock. Because of the nature of the factors influencing consumption, there is quite a divergence of opinion on this matter".

Lincoln Environmental (2003) notes that little recent research has been carried out in New Zealand on dairy cattle drinking water requirements, surprising given the size and importance of the sector to the national economy. It notes, however, that there is a reasonable body of work carried out in the 1970s and early 1980s. (The estimates that do exist vary widely as noted in Section 2.1 below.)

Stevens (2003), introducing research on water requirements for deer, says quite simply, "The water intake of deer is not well documented".

Hargreaves (undated) confirms the many factors that affect water consumption by livestock. These include:

- size, type, condition and individual characteristics of the animal
- food intake, in particular its dry matter content, protein content, digestibility and salt content
- temperature, humidity and rainfall, and
- frequency of watering (i.e. how long since the animal last had access to water).

The 2004 Aqualinc report for Horizons Regional Council used a 'stock units' approach when calculating water demand on an overall regional basis. The stock unit (SU) is based on relativity to sheep equivalents, with a medium weight ewe rearing a lamb equal to 1 SU. Stock unit equivalents depend on the type, breed and size, with a milking cow, for example, being 8 to 9 SU and a beef cow 6 to 7 SU.

The Aqualinc report notes, "Generally, for determination of *on-farm* water supplies, the assessment of stock water needs is based on a per head requirement for the main stock types and classes".

The current work takes that lead and reports water use estimates on a *per head* basis. This follows the approach in virtually all the sources reported here. It is also an approach well suited to the intended application, which is at the farm level and can easily be applied from farm stock records.

In the sections following:

- Relevant *data* is included in table form estimating *drinking water* in litres per head per day (l/h/d), except in the case of poultry where it is in litres per 100 birds per day.
- Estimates are noted as average day demand (ADD) and/or peak day demand (PDD) as provided by the sources quoted. By definition, ADD is the *average* use over the year (derived from total annual consumption divided by 365), while PDD is the highest *single day* consumption during the year.
- Overseas sources are included at the bottom of tables, with the information appearing in *italics.* (This is interesting for comparison purposes, but less useful in developing standards given the varying types of feed used and climatic conditions experienced.)
- Information on water needs for milk cooling and plant/yard wash down is included in Section 2.1 (dairy cows) and Section 2.6 (dairy goats). Section 2.8 (pigs) includes estimates of water use for cleaning. Water for cleaning is also an issue for poultry and possibly horses.

- *Details* are provided following the tables, either explanatory/support information from the sources cited in the table *or* information from other sources that doesn't fit the table format but is worth noting.

A brief *discussion* concludes each section. It covers *details* relevant to proposing a range for stock water drinking requirements, with the range encompassing a low end of water use (set as an estimate of average day demand) to a high end (set at peak day demand).

2.1 Dairy Cattle

Data

Drinking water requirements for dairy cows drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD* (l/h/d)	PDD** (l/h/d)
Aqualinc (2004a)	Milking cows (450 kg = 8.0 LSU)	36.0	72.0
	Jersey yearling	15.8	32.0
	Friesian yearling	20.3	41.0
	Jersey calf	9.0	18.0
	Friesian calf	11.3	23.0
Aqualinc (2004b)	Milking cows	40	70
	Dry cows	30	40
	Calves	20	30
Dexcel (2007c)+	Milking cows	70	
Jago (2005)	Milking Friesians (grass fed)	53.7	
	Milking Friesians (total mixed ration)	73.0	
Fleming (2003)+	Milking cows	70	
	Dry cows	45	
ANZEC*C* (2000)	Milking cows	70	85
	Dry cows	45	60
Lincoln Environmental (2003)	Milking cows	40	
	Dry cows	20	
Harrington (1980)	Milking Friesians	22	60
	Milking Jerseys (Massey, 1952)	27	52
	Milking cows (Tga Council, 1964)		70
	Milking Friesians (Ruakura, 1977)	26	58
	Dry Friesian & yearlings (Ruakura)	15	40
	Friesian calves (Ruakura)	8	30
Cummings (2002) AUSTRALIA	*Milking cows*	*69*	
	Dry cows	*44*	
Looper & Waldner (2002) USA	*Milking cow (18 kg/day milk, 19 kg/day DMI, 12°C)*	*97*	
	Milking cow (27 kg/day milk, 22 kg/day DMI, 12°C)	*110*	
Lardy (1999) USA	*Milking Jersey (12 kg milk/day)*	*49-59*	
	Dry cows	*24-49*	
	Holstein heifers (up to 24 months)	*28-36*	

* **ADD** = average day demand ** **PDD** = peak day demand
\+ Suggested as drinking water needs, but not specifically as an *ADD* figure

Water Use in the Dairy Shed

Source	Water Requirements
Aqualinc (2004a)	65 l/h/d – shed and yard requirements
Aqualinc (2004b)	Total use: 70 l/h/d
Dexcel (2007a)	Wash down water *per cleaning event*: 50 l/h/d (150 in herd); 48 l/h/d (250 in herd); 43 l/h/d (500 in herd)
Dexcel (2007b)	50 l/h/d but could range from 30 to 100 l/h/day (2 wash downs/day)
Dexcel (2007c)	70 l/cow/day
NZSFA (2007)	70 l/h/d
Lincoln Environmental (2003)	*Estimates based on research/consultation:* Milk cooling: At upper ratio of cooling water to milk volume (3:1), peak cooling requirements approach 70 l/h/d. Average requirements are likely to be 40 to 50 l/p/d. Plant washing: 3.5 to 5.5 l/h/d Yard wash down: 50 l/h/d adopted by ARC based on 1999 study of wastewater on 20 farms in Franklin District. (Other research shows variability and range from 20 to 80 l/p/d.)
Fleming (2003)	70 l/h/d

Details

Aqualinc (2004a): Appendix B information is based on Hargreaves (undated) data and calculations.

Aqualinc (2004b): Noted in Appendix E – "Parameters and Assumptions for Agricultural Water Demand" in a water demand forecasting study of the North Auckland Region.

Fleming (2003): Stated as average daily stock water requirements and put forward as a reasonable basis for design.

ANZECC (2000): Suggested as an estimate of water requirements while recognising that it can vary based on a range of factors, including climate and type of feed consumed.

Dexcel (2007c): Figures proposed for water supply planning purposes.

Jago (2005): The study also looked at the frequency and timing of drinking. Cows on TMR (total mixed ration) drank more often (5.2 times/24 h v 3.5 times/24 h for grass fed) and 76.8% on TMR drank between 2000 h and 0700 h v 24.5% for grass.

Lincoln Environmental (2003): Also draws on the earlier work by Hargreaves. Cites empirical equations to estimate total water intake (TWI) and voluntary water intake (VWI). Notes that energy intake/dry matter intake (DMI) is a major determinant of milk production and DMI is highly correlated with water consumption.

Notes that current estimates of 70 l/h/d and 45 l/h/d for milking and dry cows respectively should be retained as the basis for peak daily water requirements. For average water requirements, suggests values of 40 l/h/d and 20 l/h/d for lactating and dry cows respectively should be adopted.

Water use in the dairy shed is estimated at 50 to 70 l/h/d. It acknowledges, however, it can be highly variable, citing another source noting a range of 20 to 80 l/h/d. See table above for more information.

Harrington (1980): Includes figures from several earlier studies as well as a range of measures from Ruakura.

Looper & Waldner (2002): Stated that cows may consume 30 to 50 percent of their daily water intake within 1 hour of milking. They also note that the amount of water a cow drinks depends on her size and milk yield, quantity of dry matter consumed, temperature and relative humidity of the environment, temperature of the water, quality and availability of the water and amount of moisture in her feed.

AQUAS (2006): A study on nine farms on the Hauraki Plains and in the Thames Valley (Waikato region) measured total annual water use on each farm. Two farms were excluded from the final analysis (one had augmented supply from a drainage canal, the other known significant leaks). For the remaining seven farms, the line of best fit gives daily water requirement per head of 107 l. Estimated summer use is 140 l/h/d (measured at the farm gate so this includes leaks and losses and would thus overestimate drinking/wash down water requirements).

BC Ministry of Agriculture and Lands (2007): Citing *Farm Water Supply Requirements* (Alberta Agriculture), it estimates total daily use (drinking and wash water) for milking Holsteins at 136 l/p/d.

Phillips (1983): For non-lactating cows, 1 kg of dry matter required three to five litres of water. Water intake is a function of temperature, thus a rise from 10°C to 20°C represents a 30% increase in intake.

Growing Today (2001), a New Zealand rural lifestyle magazine, puts daily water requirements at 70 l/h/day for milking Friesians and 55 l/h/d for milking Jerseys (no source documentation is provided).

Discussion

Milking cows. Several sources propose 70 l/h/d for average drinking water needs and as a figure for water supply design purposes. This is considerably higher than ADD in the research sources cited in the table and higher than PDD in all but two cases. This would be a generous top end of the range for a standard. It easily encompasses water use throughout the year, including bulls on the property and calves on site for a short time (increasing overall demand) recognising that milking cows are dried off for a portion of the year (decreasing demand). The low end of the range for a standard could be set at 45 l/h/d. (Calves retained for herd replacement are included in 'dry stock' as discussed below.)

The same 70 l/h/d figure recurs in the literature for water use in the dairy shed and is the amount generally accepted for water-use planning. This is the *peak* milk cooling requirements suggested by Lincoln Environmental (2003) so, again, would be the high end of the range for a standard. A commonly cited water use level for the low end of the range would be 50 l/h/d. Reuse of milk cooling water for plant and yard wash down is common on farms throughout New Zealand, so *absolute* water use (i.e. draw on supply) in the dairy shed is driven by milk cooling volumes given that wash down requirements generally do not exceed milk cooling water use (as noted in the 'Water Use in the Dairy Shed' table above).

While udder washing is a use of water noted in some sources, dairy farmers confirm this is not a current practice. Wash down of feed pads is also an issue, but little is apparently known about feed pad wash down methods and frequency (and hence water use needs). Similarly, it is uncertain the number of dairy operations that rely on feed pads. Lincoln Environmental (2003) reports that about 25% of dairy farms in the Auckland region have a feed pad, but there is no comparable figure for the Horizons region. With the current high

dairy payouts, it is possible the use of feed supplements may become more common and the number of feed pads in the region increase.

Suggested range as a basis for determining a standard for milking cows

- Low end (ADD) – 45 l/h/d drinking water + 50 l/h/d dairy shed = 95 l/h/d
- High end (PDD) – 70 l/h/d drinking water + 70 l/h/d dairy shed = 140 l/h/d

Dry stock. This would include cows at various stages of growth en route to becoming part of the milking herd. Devising a standard for reasonable use requires consideration of drinking water only. Fleming (2003) and ANZECC (2000) both suggest drinking water needs of 45 l/h/d, with other sources putting ADD in the 20-30 l/h/d and PDD at 40 (with ANZECC showing a PDD figure of 60 l/h/d. These estimates suggest a fair range of 30 to 45 l/h/d.

Suggested range as a basis for determining a standard for dry stock

- Low end (ADD) – 30 l/h/d drinking water
- High end (PDD) – 45 l/h/d drinking water

2.2 Beef Cattle

Data

Drinking water requirements for beef cattle drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD (l/h/d)	PDD (l/h/d)
Aqualinc (2004a)	Breeding cows (450 kg = 6.3 LSU))	28	57
	Weaners (135-270 kg = 3.5 LSU)	16	32
	Heifers, steers & bulls (600 kg = 6 LSU)	27	54
Aqualinc (2004b)	Cows	30	45
	Yearlings	20	30
	Calves	10	20
Fleming (2003)	Cattle	45	
	Calves	25	
ANZEC*C* (2000)	Cattle	45	60
	Calves	22	30
Harrington (1980)	Angus (dry)	15	49
	Angus (in calf)	17	31
	Angus (suckling calves)	31	65
	Angus (heifers 93-156 kg) citing Wright	14	24
Cummings (2002) AUSTRALIA	*Cattle*	*44*	
	Calves	*22*	
NSW (2007)	*Dry stock*	*35-80*	
	Young stock	*25-50*	
Sekine (1989) JAPAN	*Holstein steers (hay fed)*	*39*	
	Holstein steers (fresh forage)	*17*	

Details

Aqualinc (2004a): Appendix B table notes four liveweight categories and 'slow' and 'fast' growing types for heifers, steers and bulls. For the lightest weight and slow growing, ADD and PDD are 17 and 33 l/h/d. It ranges up from there to the values shown in the table for a maximum weight stock of 600 kg.

Fleming (2003): Stated as average daily stock water requirements and put forward as a reasonable basis for design.

ANZECC (2000): Derived from Burton (1965) and used as the basis for estimated drinking water consumption in MAF (2003).

Harrington (1980): The dry Angus beef cattle at Lincoln College were monitored for 137 days in the period September to March. The breeding cattle (in calf) were feeding on dry barley straw, so water intake from food would be minimal. For the cattle suckling calves, if calves are considered one-quarter of a cow on the basis of body weight, the figures in the table drop to 52 and 25 for ADD and PDD respectively. A further estimate (not considered as relevant for the current study) was for Hereford cattle in a rangeland situation in the Mackenzie Basin where they travelled a considerable distance (up to 2 km) for their dry food. Water intake in this situation was 46 l/h/d (ADD) and 76 l/h/d (PDD).

NSW (2007): Consumption levels shown in the table affected by dry/drought conditions, temperature and feed.

Sekine (1989): Figures for eight Holstein steers (14-16 months of age), four each fed first cut orchardgrass-red clover mixed with hay (hay group) or fresh cut orchardgrass-red clover (fresh forage group). Each group also given 2 kg of concentrate.

Discussion

Sources cite a range of figures for ADD: 28 l/h/d (Aqualinc, 2004a), 30 (Aqualinc, 2004b), 15 for Angus dry and 31 Angus suckling calves (Harrington, 1980). PDD figures for the same sources are 57, 45, 49 and 65 respectively. Both Fleming (2003) and ANZECC (2000) suggest estimated daily requirements for beef cattle of 45 l/h/d.

Aqualinc (2004a) puts ADD and PDD for heifers, steers and bulls at 27 and 54 respectively, while Harrington cites lower levels. The Aqualinc estimates are quite similar to those for mature (breeding) cows, suggesting a similar standard for *all* beef cattle stock would be reasonable.

The low end of the range would cover stock watering under normal conditions, while the high end provides for cows when suckling calves *and* for drinking water for calves during the few months before they are sold off (when the breeding herd would be dried off and consuming less water).

Suggested range as a basis for determining a standard for mature beef cattle, herd replacement stock and bulls

- Low end (ADD) – 30 l/h/d
- High end (PDD) – 55 l/h/d

2.3 Sheep

Data

Drinking water requirements for sheep drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD (l/h/d)	PDD (l/h/d)
Aqualinc (2004a)	Ewe (55 kg = 1.0 LSU)	2.0	4.0
	Ewe (65 kg = 1.25 LSU)	2.5	5.0
	Hogget (30 kg pre-winter, .7 LSU)	1.4	2.8
	Hogget (50 kg pre-winter, 1.2 LSU)	2.4	4.8
	Ram (75 kg pre-winter, .80 LSU)	1.6	3.2
Aqualinc (2004b)	Ewes	3.0	4.5
	Hoggets	3.0	4.5
Fleming (2003)	Breeding ewes	3.0	
ANZECC (2000)	Nursing ewes on dry feed	9.0	11.5
	Mature sheep on dry pasture	7.0	8.5
	Mature sheep on green pasture	3.5	4.5
	Fattening lambs on dry pasture	2.2	3.0
	Fattening lambs on green pasture	1.1	
Harrington (1980) (Citing various sources)	Romney at Lincoln (Clarke)	2.0	4.5
	Romney at Masterton (Bircham)	2.9	4.0
	Coopworth at Ruakura	1.3	3.8
NSW (2007)	*Adult dry sheep (on grassland)*	*2-6*	
	Adult dry sheep (on saltbrush)	*4-12*	
	Ewes with lambs	*4-10*	
	Weaners	*2-4*	
Lardy (1999) USA	*Rams and dry ewes*	*7.6*	
	Ewes with lambs	*11.4*	
	Feeder lambs	*5.8*	

Details

Aqualinc (2004a): Appendix B table notes three liveweight categories for ewes, all water consumption figures are with lambs weaned. Three hogget liveweights are noted (30, 40 and 50 kg with slow, medium and fast growth rates respectively).

Fleming (2003): Stated as average daily stock water requirements and put forward as a reasonable basis for design. Provides just one figure, for breeding ewes.

ANZECC (2000): Derived from Burton (1965), notes significant (double) ADD water consumption by mature sheep on dry v green pasture. Nursing ewes have highest consumption level (figure in table indicates on dry feed).

Harrington (1980): Various local and overseas estimates provided. Relevant examples included in table above. The Clarke citing is for few sheep on dry pasture and hay. For Bircham, it's few sheep again on (unspecified) pasture. For the Coopworth, water consumption monitoring was done on 190 days over a 13-month period. The mob size was normally between 400 and 500, but ranged up to 1,100. Access to water affects intake and there appears to be considerable flexibility in the demand for water by sheep.

Environment Waikato (2007) summarises saying ANZECC notes 3.5 l/h/day for mature sheep on green pasture, while Fleming references 3 /l/h/d for breeding ewes. There are higher rates referenced, but these tend to be for peak seasonal use or lactating ewes on dry feed or dry pasture.

Discussion

There is a consistency in New Zealand ADD figures cited in the table (including the ANZECC estimate for mature sheep on green pasture). Several sources put ADD for ewes at 3 l/h/d and PDD in the 4.0 to 5.0 l/h/d range. The high end of the range would be a reasonable amount to cover nursing ewes and weaned lambs for the period of time until they are sold off.

Drinking water requirements of hoggets are similar to mature sheep as per sources in the table, with the water needs of rams slightly less. This suggests there could be the same standard for all stock, regardless of whether they are ewes, hoggets or rams.

Suggested range as a basis for determining a standard for ewes, hoggets and rams

- Low end (ADD) – 3.0 l/h/d
- High end (PDD) – 4.5 l/h/d

2.4 Deer

Data

Drinking water requirements for red deer drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD (l/h/d)	PDD (l/h/d)
Aqualinc (2004a)	Mature hind (100 kg = 1.9 LSU)	5.7	11.0
	Hind 15-27 mo (~90 kg = 1.8 LSU)	5.4	11.0
	Mature stag (185 kg = 2.2 LSU)	6.6	13.0
	Stag 15-27 mo (~125 kg = 2.1LSU)	6.3	13.0
Aqualinc (2004b)	Adult	15.0	22.5
	Yearling	10.0	15.0
NAWAC (2007)	Weaners (up to 85 kg)	0.5 – 1.5	
	Hinds (dry, 100-120 kg)	1.5 – 2.0	
	Hinds (lactating, 100-120 kg)	5.5 -7.0	
	Stags (180-250 kg)	3.0 – 4.0	

Details

Aqualinc (2004a): Mature hinds are noted as fawning, while mature stags are recorded at 59.9% dressing and 2.5 kg velvet. It is noted that the water requirements are quite similar between younger and mature animals.

Aqualinc (2004b): These figures are higher than those in Aqualinc (2004a) sourced from Hargreaves and significantly higher than those proposed in the NAWAC (2007 Animal Welfare Code.

NAWAC (2007): Daily consumption of water can vary widely according to species, body weight, age, sex, climatic conditions, type of diet and feed intake. In excessively hot weather conditions, all classes of deer will require more water as deer drink water to mitigate heat stress.

Water consumption figures in the table are for red deer when fed forage (pasture, silage or a brassica crop). Water intake when on concentrate is higher: up to 2.5 l/day for weaners, 4.0 for dry hinds, 10.0 for lactating hinds and 7.0 for stags. Assumptions made:

- The table refers to ambient temperature up to 20°C.
- For temperatures over 20°C, approximately 1.0 l/day should be added per 100 kg liveweight for every 5°C increase in temperature.
- The dry matter concentration of a forage diet is assumed to be up to 30% DM (while that of a concentrate diet is assumed to be greater than 80% DM.)
- At low DM concentrations (under 15% DM in forages such as spring pastures or brassica crops) animals may not use additional drinking water.
- Water requirements of hinds are based on a maintenance feed intake of 2 kg DM/day and a lactation feed intake of 4 kg DM/day.
- For lactating hinds an additional water requirement of 1 l/kg milk produced has been added.
- Stag water requirements are based on a maintenance feed intake of 4 kg DM/day.

Stevens (2003): The introduction notes that water intake of red deer is not well documented. Several experiments were carried out by AgResearch Invermay for Deer Industry NZ to document water intake under different feeding conditions.

One experiment examined feed and water intake of weaner stags on silage and silage plus concentrate. Water intakes, when expressed per kg DMI, ranged between 2.0 •/kg DMI for no concentrate to 3.0 •/kg DMI for 900 g/day/head concentrate added to the diet. The decline relates to the decreasing amount of silage with high electrolyte concentration and the increasing amount of supplement with lower electrolyte concentration, since it takes more water to produce urine when diets are high in electrolytes.

Another experiment looked at water intake in winter by hinds reared indoors or out. Water intake when expressed per kg DMI ranged between 1.1 •/kg DMI for hinds spending 16 hours per day outside to 1.9 •/kg DMI for indoor hinds without access to puddles. (Weather conditions affected intake of provided water.)

The summary of the study suggests the following water requirement relative to DMI: 2-3 •/kg DMI for weaners (at temperatures 0-15°C); 4-5 •/kg DMI for pregnant hinds (at 0-25°C), and 6-7 •/kg DMI for lactating hinds (10-25°C).

NZ Deer Farming Annual (2003): Provides interim recommendations later adopted in the NAWAC (2007) Animal Welfare Code.

Discussion

NAWAC (2007) notes a range of factors that affect drinking water requirements, while Stevens (2003) focuses on DMI and access to rain water sources and its impact on need for provided water.

The Aqualinc (2004a) report and NAWAC (2007) guideline provide somewhat similar estimates and can be used together to devise a standard for reasonable use. The Aqualinc (2004a) estimate for mature hinds is 5.7 l/h/d ADD, while the NAWAC guideline for lactating hinds is 5.5-7.0 l/h/d. While the NAWAC estimates don't include PDD figures, Aqualinc (2004a) puts this in the 11-13 l/h/d range. This top end of the range would cover water intake of weaners until they are sold off *and* allow for any higher DM concentrations in the diet.

The Aqualinc (2004a) report notes that younger animals have similar water requirements to mature animals and the water needs of stags are similar to hinds. This would mean there could be one overall standard for deer farming – for mature hinds and stags and for younger animals retained in the herd.

Suggested range as a basis for determining a standard for young and mature hinds and stags

- Low end (ADD) – 6.0 l/h/d
- High end (PDD) – 12.0 l/h/d

2.5 Horses

Data

Drinking water requirements for horses drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD (l/h/d)	PDD (l/h/d)
ANZECC (2000)	Working Grazing	55 35	70 45
Fleming (2003)	Working Grazing	55 35	
Cummings (2002) AUSTRALIA	Working Grazing	55 35	
NSW (2007) AUSTRALIA	Horses	40 - 50	
Lardy (1999) USA	Lactating Mare Working (moderate level)	37 – 55 37 - 45	

Details

ANZECC (2000): Stock water requirements are noted as derived from Burton (1965). Accompanying text notes that water intake varies widely among different forms of livestock and is also influenced by factors such as climate and type of feed. No specific information is provided on horses beyond the figures in the table above.

Two Australian sources and one USA source put the ADD for water in a similar range to ANZECC estimates.

Discussion

Two New Zealand sources and one Australia source put drinking water estimates (ADD) at 55 l/h/d for working horses and 35 l/h/d for grazing horses. ANZECC (2000) puts PDD for working and grazing horses at 70 and 45 l/h/d respectively, with no other sources providing high-end estimates.

Suggested range as a basis for determining a standard for working horses

- Low end (ADD) – 55 l/h/d
- High end (PDD) – 70 l/h/d

Suggested range as a basis for determining a standard for grazing horses

- Low end (ADD) – 35 l/h/d
- High end (PDD) – 50l/h/d

Where stables are involved and water for cleaning is necessary, this could be roughly measured (flow rate for hosing x duration) and included in the 'Other Uses' section of the report form in Appendix A.

2.6 Goats

Data

Drinking water requirements for goats drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD (l/h/d)	PDD (l/h/d)
Aqualinc (2004a)	***Dairy***		
	Does (50-60 kg = 2.0 LSU) grass	5.0	10.0
	Does (56 kg = 1.5 LSU) browsing	3.8	7.5
	Angoras		
	Does - breeding (100 kg = 1.0 LSU)	3.8	7.6
	Bucks - stud (50 kg = 2.1LSU)	2.0	4.0
	Hoggets	1.0	2.0
	Cashmere		
	Does (25-35 kg = 0.7 LSU)	1.4	2.8
	Bucks (30-60 kg = 0.7 LSU)	1.4	2.8

Details

Aqualinc (2004a): Water requirements of dairy goats are considerably higher than for angoras or cashmeres as would be expected.

Mohair New Zealand (2007): This source indicates there are very few large operations in New Zealand for the purposes of obtaining angora (mohair) and cashmere fibres. Most tend to run smaller herds complementary to sheep or beef cattle farming. Goats for angora are more common than for cashmere and because of its current value a high percentage of the does would be considered breeding stock. This source also indicates that boer goats (grown for meat only) are generally bigger animals, so water requirements would be more along that of stock for angora than cashmere.

Growing Today (2001) indicates daily water requirements at 20 l/head/day for milking goats (includes for milk cooling and plant and yard wash down) and dry goats at 4 l/head/day, but no source documentation is provided.

Discussion

The one source including ADD and PDD figures for milking goats bases drinking water needs on body weight and feeding regime. Using the higher weight as a basis for determining a standard would put water consumption in the 5 to 10 l/h/d range. If the same amount again is used for milk cooling/wash down as estimated in dairying, total daily requirement is 10 to 20 l/h/d (top end same as cited in *Growing Today*). This covers water requirements for off-spring on the property for a short period of time before being sold off and certainly allows for varying diets and water needs on dry, hot days. Young goats held for herd replacement can be included in 'dry' goat numbers for calculating water needs.

Based on the information provided by Mohair New Zealand (2007) noted above, the standard for dry goats should focus on (the higher) drinking water needs of angoras. Requirements vary between does and bucks, so, again, the standard should address the

top-end needs of does. A suitable range would be in the 3.5 to 7 l/h/d range. This would generously cover the water needs of hoggets and mature goats for cashmere and give one simple standard for reasonable water use for all dry goats.

Suggested range as a basis for determining a standard for milking goats

- Low end (ADD) – 5 l/h/d drinking water + 5 l/h/d dairy shed = 10 l/h/d
- High end (PDD) – 10 l/h/d drinking water + 10 l/h/d dairy shed = 20 l/h/d

Suggested range as a basis for determining a standard for dry goats

- Low end (ADD) – 3.5 l/h/d
- High end (PDD) – 7.0 l/h/d

2.7 Pigs

Data

Drinking water requirements for pigs drawn from the literature are noted in the table.

Drinking Water Estimates

Source	Animal Description	ADD (l/h/d)	PDD (l/h/d)
Aqualinc (2004a)	Mature pigs Brood sows	11 22	
Aqualinc (2004b)	Pigs	10	15
ANZECC (2000)	Mature pigs Brooding sows	11 22-25	15 30
NAWAC (2005)	Pigs up to 10 kg Pigs 26-50 kg Pigs 51-120 kg Boars Gilt Pregnant sow or gilt Lactating sow	1.2-1.5 3.0-5.0 6.0-8.0 5.0-10.0 5.0-8.0 5.0-10.0 15.0-50.0	
Fleming (2003)	Pigs Sows	11 25	
Cummings (2002) AUSTRALIA	*Mature pigs* *Brood sows*	*11* *22*	
DPI (2007) AUSTRALIA	*Weaners* *Growers* *Finishers* *Dry sows* *Lactating sows*	*3* *5* *6* *11* *17*	
Lardy (1999) USA	*Pig 55 kg* *Pig 132 kg* *Gilt* *Pregnant sow* *Pregnant gilt*	*1.9* *5.7* *12* *17* *21*	
Pigsite (2007)	*Pigs 25 kg* *Pigs 50 kg* *Pigs 90 kg* *Sows dry* *Sows lactating*	*2.5* *5.0* *8.9* *9.0-18* *18-36*	

Water Use for Cleaning

Source	Water Requirements
Hargreaves (undated)	1,500 l/day per 100 m^2 of area to be cleaned
DPI (2007) AUSTRALIA	*Wash down water – 20 l/sow/day*

Details

ANZECC (2000): Data is from Burton (1965) and is consistent with the Aqualinc data citing Hargreaves.

NAWAC (2005): Daily intake varies according to environmental temperature and liveweight. Figures in the 'Drinking Water Estimates' table above are a guide to daily water consumption by various classes of pig assuming normal ambient temperatures in New Zealand.

Fleming (2003): Suggested as average daily water requirements – similar to Aqualinc and ANZECC figures.

DPI (2007): For figures in the table above, notes that daily consumption for individual pigs can vary 50% from the average.

Lardy (1999): Information from North Dakota State University. No details on feed or temperature conditions provided.

Hargreaves (undated): With regard to cleaning water for piggeries, this resource proposes a volume of water per area to be cleaned as noted in the table above.

Discussion

Estimates for New Zealand put ADD drinking water at about 11 l/h/d for mature pigs and 22 l/h/d for brood sows. Drinking water for younger pigs varies according to weight, with NAWAC (2005) putting those weighing 51-120 kg at 6-8 l/h/d. Overseas sources note similar levels of consumption.

Only two sources cited high-end (PDD) figures. The range of PDD estimates above ADD for the other stock types covered in this report varies widely, with 60% (above) being an approximate mid-point. In the absence of other information, this could be adopted as the top of the range as a basis for determining a standard.

Suggested range as a basis for determining a standard for mature pigs
- Low end (ADD) – 11 l/h/d
- High end (PDD) – 18 l/h/d

Suggested range as a basis for determining a standard for brood sows
- Low end (ADD) – 22 l/h/d
- High end (PDD) – 35 l/h/d

Suggested range as a basis for determining a standard for pigs up to 120 kg
- Low end (ADD) – 7 l/h/d
- High end (PDD) – 11 l/h/d

Water for cleaning has been estimated by Hargreaves at 1,500 l/day per 100 m^2 to be cleaned. Area measurements can be done and wash water requirements noted in the 'Other Use' section of the report form (draft in Appendix A).

2.8 Poultry

Data

Drinking water requirements for poultry drawn from the literature are noted in the table. Figures are provided in litres per 100 birds per day.

Drinking Water Estimates

Source	Animal Description	ADD (l/100 birds/d)	PDD (l/100 birds/d)
Aqualinc (2004a)	Laying hens	32	
	Non-laying hens	18	
	Turkeys	55	
Aqualinc (2004b)	Poultry	30	45
ANZECC (2000)	Laying hens	32	40
	Non-laying hens	18	23
	Turkeys	55	70
Fleming (2003)	Poultry	30	
	Turkeys	55	
Ravindran (2007)	Layer pullets (growing birds)	10-13	
	Layer hens (mature)	22	
	Breeder pullets (growing)	12-16	
	Breeder hens (mature)	30	
	Broiler chickens	16-25	
	Turkey broilers	29-54	
	Turkey breeders	38-64	

Details

Aqualinc (2004a): Drinking water estimates are in litres per 100 birds per day as drawn from Hargreaves.

ANZECC (2000): Same ADD figures as per Aqualinc with PDD figures also provided.

Ravindran (2007): These figures provided by Professor V (Ravi) Ravindran of the Monogastric Research Centre, Institute of Food, Nutrition and Human Health, Massey University – personal communication. Figure provided for laying hens less than Aqualinc data and ANZECC guidelines.

Discussion

As in the figures for pigs, there are reasonably consistent drinking water estimates for different types of poultry (ADD). These include 32 l/100 birds/d for laying hens (30 for 'poultry' and 30 for breeder hens), 18 l/100 birds/d for non-laying hens (layer pullets/growing birds) and 55 l/100 birds/d for turkeys.

Ravindran (2007) puts the consumption levels of all poultry below that of the other sources, so using the figures noted above for the low end of the range for a standard would be fair or

even generous. (Ravindran also provides an ADD for broiler chickens of 16-25, so for simplicity it could be pegged at the same level as non-laying hens.)

Top end of the range could be pegged at 45 l/100 birds/d for layer and breeder hens (Aqualinc 2004b) and 70 l/100 birds/d for turkeys (ANZECC 2000). There are no PDD estimates for non-laying hens and chickens, so if it were set at 60% above ADD (same convention as for pigs) this would allot 29 l/100 birds/d.

Suggested range as a basis for determining a standard for layer and breeder hens

- Low end (ADD) – 30 l/100 birds/d
- High end (PDD) – 45 l/100 birds/d

Suggested range as a basis for determining a standard for non-laying hens and chickens

- Low end (ADD) – 18 l/100 birds/d
- High end (PDD) – 29 l/100 birds/d

Suggested range as a basis for determining a standard for turkeys

- Low end (ADD) – 55 l/100 birds/d
- High end (PDD) – 70 l/100 birds/d

Wash water requirements will vary by type of operation and by set-up. Actual water use can be measured during typical cleaning and an annual allocation included in the 'Other Use' section of the report form.

3 Recommendations

Low end (ADD) and high end (PDD) figures for reasonable water use in different farming applications were noted in the various sections in Part 2. Section 3.1 summarises these, while Section 3.2 covers water-use reporting for applications (with a draft sample reporting form included in Appendix A). Section 3.3 offers suggestion for reducing water loss in farm water supply systems (with support information provided in Appendix B).

3.1 Standards for Reasonable Use

Key livestock operations in the region would be dairy, beef and sheep. Secondary operations (fewer of them and less demand with respect to water) would include deer, goats, pigs and poultry. Horses are also included. Information was sought on water use in alpaca, llama and ostrich farming, but nothing was found so they are not included in the listing.

The range for drinking-water requirements for the stock types studied are summarised in the following table.

Range for Devising a Standard for Stock Drinking-Water Requirements

Farming Enterprise	Type of Animal	ADD (l/h/d)	PDD (l/h/d)
Dairy	Milking cows	45	70
	Dry stock	30	45
Beef	Mature cattle, herd replacement stock and bulls	30	55
Sheep	Ewes, hoggets and rams	3.0	4.5
Deer	Hinds and stags (all ages)	6.0	12.0
Horses	Working horses	55	70
	Grazing horses	35	50
Goats	Milking goats	5.0	10
	Dry goats	3.5	7.0
Pigs	Mature pigs	11	18
	Brood sows	22	35
	Pigs up to 120 kg	7.0	11
Poultry ** all figures are for l/100 birds/d*	Laying and breeder hens	30*	45*
	Non-laying hens and chickens	18	29
	Turkeys	55	100

The ADD and PDD figures can be used as a basis for discussion when Council comes to set policy and standards for reasonable stock water use.

Average day demand comes into play – and can serve as a good guide – in the case of groundwater use. On the other hand, peak day demand is a helpful guide for surface water sources, given that the greatest demand tends to come at times of natural low flow.

For simplicity, it makes sense for Council to adopt a *single* standard (l/h/d) for each stock type/sub-type as in the table. A standard toward or at the top end of the range makes sense for a number of reasons. It accommodates peak demand periods (varying climatic conditions) and different feeding regimes. It should also be viewed as 'fair and reasonable' by farmers, which would help in the new consenting process gaining acceptance.

A disadvantage of adopting a standard in the PDD range is that it 'locks up' water as 'allocated' but generally not used (given the difference between ADD and PDD figures). This may or may not be an issue – water for stock is essential and there are other water applications that could be restricted to accommodate peak demand periods.

Council will want to weight up these and other issues in order to set appropriate standards.

3.2 Water-Use Reporting for Applications

Under the proposed One Plan, farms with water requirements greater than $30m^3$/day will need to have a resource consent for the taking of water. It would be helpful to have a simple form applicants could complete to document their water requirements. This would make it easy for them to provide the necessary information *and* simplify and standardise procedures for Council in assessing it. A proposed format for such a form is included as Appendix A.

To fully account for water demand on the property, it will be necessary to include an allocation for domestic use, stock drinking water, and other farm uses as follows:

- ***Domestic*** – 300 litres per person per day for all residents on the property = 109.5 m^3/person/year (rounded to 110). This allocation is the same as the reasonable use allocation for individuals on properties served by public water supplies and is intended to cover all indoor and outdoor water use.
- ***Stock drinking water*** – Allocations as outlined in the table on the previous page. Council will determine where the standard is set (within or to an end of the range provided).
- ***Other uses*** – This will include for milk cooling (and plant and yard wash down) in dairy and milking goat farms, plus cleaning/wash down for pig and poultry operations. It might also include cleaning horse stables. Other uses could be identified as well.

Applicants can enter relevant figures on the reporting form, multiply by the annual allocation for each type of use (as appropriate), and sum them to determine total annual requirements. Simple instructions could be provided to help applicants complete the form (including how to calculate 'Other Uses' as discussed in Part 2 of the report).

3.3 Final Thoughts

Horizons Regional Council has indicated that farms using in excess of $30m^3$ of water per day will also need to install a water meter to track actual use. This will provide an opportunity to monitor farm water use over time and revise the standards for reasonable use if experience warrants this.

Install of a water meter also allows individual farms an opportunity to 'manage' their water use and minimise losses. Night and morning meter readings, for example, could show water running at a time when there is little or no actual demand for it (thus suggesting a loss in the system somewhere). HRC could encourage regular meter reading (via education) or even require it as a condition of consent (with an easy reporting system established).

Additional effective methods to alert the farmer to water loss include install of a pilot light on a pump sending water down the farm or a pressure gauge on the water line. Either of these makes it easy to know water is running when it shouldn't be. This can lead to speedy identification of the problem and repair. Either of these systems cost less than $100 installed and could greatly reduce water loss on the farm. A trough ballcock blown off in the wind in a

back paddock in winter could go weeks before it is discovered and repaired. The same goes for a leak in a line that isn't readily apparent by water pooling on the ground surface. Water losses such as these can be significant as shown in the figure in Appendix B. Again, these water loss 'alert' devices could be encouraged or required in the interest of efficient and sustainable water use.

The "Farm Water-Use Requirements" form (as per Appendix A) could be included as a Word document/template on the Council's website and available as printed copies for convenience along with other information pertaining to resource consent applications.

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APPENDIX A

Annual Farm Water-Use Requirements

This form is to be completed in support of resource consent applications for farm water use in excess of 30m^3 per day. Please indicate all types of water use and calculate the total annual requirement for your application.

Type of Use	**Numbers**	**Allocation*** (m^3/yr)	**Totals** (m^3)
Domestic (# permanent residents)	_____	x 110.0	= _____
Livestock Drinking Water (# head)			
Dairy Milking cows	_____	x 25.6	= _____
Dry stock	_____	x 16.4	= _____
Beef cattle Cattle (all)	_____	x 20.0	= _____
Sheep Ewes, hoggets & rams	_____	x 1.6	= _____
Deer Hinds & stags (all ages)	_____	x 4.4	= _____
Horses Working	_____	x 25.6	= _____
Grazing	_____	x 18.3	= _____
Goats Milking	_____	x 3.7	= _____
Dry	_____	x 2.6	= _____
Pigs Mature	_____	x 6.6	= _____
Brood sows	_____	x 12.8	= _____
Pigs up to 120 kg	_____	x 4.0	= _____
Poultry* Laying & breeder hens*	_____	x 16.4	= _____
Non-laying hens & chickens*	_____	x 10.6	= _____
Turkeys*	_____	x 25.6	= _____
* *Poultry allocation is in m^3* per 100 birds *so, for example, 1,000 birds would be '10' for 'Number' (10 x 100)*			
Other Uses (Specify)			
Milk cooling & wash down *(Dairy cattle & milking goats)*	_____	x _____	= _____
Wash down/stall cleaning *(e.g. Pigs, poultry, horses)*			_____
Total annual requirement (*Sum all figures in 'Totals' column*)			_____

* Current allocations are set at the high end of the range (~PDD) for estimates in the table on page 23

APPENDIX B

Small Leaks … Big Losses

Small leaks in water lines can lead to big losses over time. This figure shows different size leaks and the resulting water loss per day and per month. A leak the size of a small nail could lose as much as 14m^3 a day *every day* it is left unrepaired. One month's loss is in the range of 420m^3. Any significant leaks not attended to would quickly eat into a farm's water allocation as per their resource consent application, hence the value of a simple (and inexpensive!) 'alert' system.

WATER LOSS IN LITRES		
Leak this Size	Loss per Day	Loss per Month
	546	16,380
	1,637	49,110
	3,150	94,500
	5,455	163,650
	8,728	261,840
	14,074	422,220
	19,530	585,900
	30,185	905,550
	31,749	952,470
	38,296	1,148,880
	44,951	1,348,530
	51,479	1,544,370
	57,825	1,734,750
	67,972	2,039,160

The chart above was used in AQUAS Consultants' ***Smart Water Use … in Dairy Farming*** campaign conducted in Summer 2006 for Hauraki District Council and Thames Coromandel District Council. The chart was provided by the owner of Thames Tanks rural supply store who used it previously in his work with a District Council in the Auckland region. The chart was assessed by a water utilities engineer employed by TCDC and deemed to be an accurate and fair representation.