Greater Wellington
Te Pane Matua Taiao

4 April 2024

File Ref: OIAPR-1274023063-26027

[redacted]

Tēnā koe [redacted]

Request for information 2024-039

I refer to your request for information dated 11 March 2024, which was received by Greater Wellington Regional Council (Greater Wellington) on 11 March 2024. You have requested the following:

"Currently doing some research into the construction of the Wainuiomata Water Treatment Plant for Auckland Uni (4th year civil engineer) and wondering if you guys have any digital information surrounding the construction and costs of the Wainuiomata water treatment plant (specifically 1993 plant construction, although details about later additions to the plant would be brilliant too if available)."

Greater Wellington's response follows:

Attached are five documents that we can release from archived sources in response to your request:

Document reference	**Content description**
Wainuiomata Treatment Plant Report	Value Analysis report
WWTP paper clipping	Newspaper Article – including overall cost of construction
WWTP - Project Statistics	Project Statistics
WWTP – Technical Info	Fact Sheet
Water Supply Asset Management Plan	2012 AMP (Bulk Water)

Those documents (attached) are supplied for your engineering research.

The following information has been withheld under the Local Government Official Information and Meetings Act 1987 on the following grounds:

- information pertaining to detailed digital construction information (or plans) has been withheld under section 7(2)(j) to prevent the disclosure or use of official information for improper gain or improper advantage.

We have considered whether the public interest in the requested information outweighs Greater Wellington's need to withhold certain aspects of the requested construction information. The Water Treatment plant is a critical strategic utility, and its security is of primary importance. As a result, we do not consider that the public interest outweighs Greater Wellington's reason for withholding parts of the document under the grounds identified above.

If you have any concerns with the decision(s) referred to in this letter, you have the right to request an investigation and review by the Ombudsman under section 27(3) of the Local Government Official Information and Meetings Act 1987.

Please note that it is our policy to proactively release our responses to official information requests where possible. Our response to your request will be published shortly on Greater Wellington's website with your personal information removed.

Nāku iti noa, nā

Julie Knauf
Kaiwhakahaere Matua Ratonga Rangapū | Group Manager Corporate Services

B/42/2/1

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

REPORT ON VALUE ANALYSIS

MORRISON COOPER LTD

JULY 1991

MORRISON COOPER LIMITED

Consultants in Engineering, Architecture, Economics

44-52 The Terrace, Wellington, New Zealand. P.O. Box 10-283
Telephone: (04) 734-265, Fax: (04) 733-369

Our Reference: 190068/7001

19 July 1991

The Wellington Regional Council
PO Box 11-646
WELLINGTON

Attention: Mr N Gillon

Dear Sir,

WAINUIOMATA WATER TREATMENT VALUE ANALYSIS

Please find enclosed a copy of the above report.

We would be grateful for the opportunity of discussing the report with the staff of Wellington Regional Council.

Yours faithfully
MORRISON COOPER LIMITED

G R J CLELAND

Encl.

grjc:nt

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

REPORT ON VALUE ANALYSIS

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WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

REPORT ON VALUE ANALYSIS

1. INTRODUCTION

The Wellington Regional Council proposes to build a new water treatment plant within the Wainuiomata Headworks Reserve to treat water taken from existing intakes in the Wainuiomata and Orongorongo valleys.

Morrison Cooper Limited was engaged to carry out a Value Analysis of the Project as part of the engagement for Consulting Services.

The Value Analysis team was completely separate and independent of the Design teams from the WRC, PWT & MCL.

2. THE VALUE ANALYSIS

Value Analysis (VA) is defined as:

"A systematic process for examining a proposed project, in order to reduce costs, while maintaining or enhancing function".

The VA for the Project was limited to the design of the proposed Water Treatment plant, its impact on the Wainuiomata Waterworks Reserve, and its operational relationship with the standby artesian pumping station at Gear Island.

The VA was divided into six phases:

Information Phase
Creative Phase
Judgement Phase
Development Phase
Recommendation/Reporting Phase
Follow-up Phase.

These are discussed in more detail in the Project Brief attached as Appendix A.

Three basic models were selected for the basis of the process comparison options for VA. The models were:

Option 1. Dissolved Air Flotation Filter (DAF) System. This was the process recommended by PWT and accepted by the WRC. The extent of DAF operation necessitated by the turbidity and colour of the raw water was estimated at 25% of yearly operation of the plant.

Option 2. MEMTEC Microfiltration System. The process model utilised the micro-filtration technology developed by MEMTEC Ltd, Australia.

Option 3. The Sand Filter System This model was the conventional sand filter process with the same bed area as the DAF-Filter Model.

In addition Option 1 was further analysed on the basis of the following sub-models which have variations on equipment and process.

Option 1a: DAF/Filter System with belt press in place of the plate press.

Option 1b: DAF/Filter System with on site hypochlorite generation.

Option 1c: DAF/Filter System with gravity backwash.

Option 1d: DAF/Filter System with DAF operated continuously but with normal chemical usage.

Option 1e: DAF/Filter System with DAF operated continuously and increased chemicals used.

The assumptions used for the comparisons are discussed in the paper "Comparison of Options" attached as Appendix B.

It is important to note that the costs per megalitre of water are comparative costs as cost items common to all the processes are not included e.g. office expenses, sludge handling, WRC overheads, sunk costs elsewhere etc. On the basis of a discount rate of 7%, the cost of water per megalitre for the various options is as follows:

Option	1	1a	1b	1c	1d	1e	2	3
Cost of Water $/Ml (Original Analysis)	119	116	117	119	121	150	226	114
Cost of Water $/Ml (Revised After Workshop)	125	-	-	-	127	156	229	119

The calculation sheets, supporting these results are contained in Tables 1 to 5, Appendix G.

In comparing the DAF-Filter and Sand Filter Models the following matters need to be taken into account.

1. The model for the Sand Filter has the same bed area as the DAF-Filter which means that the frequency of back washing is considerably increased.

2. The sand filter will have considerably reduced throughput at high levels of turbidity of the raw water input compared to the DAF-Filter. To maintain an equivalent throughput, the area of Sand Filter bed would need to be increased and hence capital costs increased also.

3. The period when the Sand Filter cannot be used due to high turbidity will be much greater than for the DAF-Filter. It is not possible to calculate the extent to which this will occur due to lack of information on the periods of high turbidity of raw water from the intake structures.

It should be noted that the capital costs for the Sand Filter and DAF-Filter are very similar and that this represents about 30% of the cost of treating a megalitre of water.

3. VALUE ANALYSIS WORKSHOP

A Value Analysis workshop was held on 18 December 1990 involving participarts from the PWT, WRC and MCL design teams for the Project together with the Value Analysis Team.

The aim of the workshop was to identify options/ideas that reduce costs and/or improve performance and reliability.

A number of options were introduced at the workshop for consideration and these together with an agenda for the workshop are attached as Appendix C.

The results of the workshop are set out in the notes attached as Appendix D. A number of decisions were made based upon the information and costs put foward for the workshop and some options were selected for further evaluation.

The later items included:

1. Preparation of a scheme for a lime slurry dosing system.
2. Review of the requirement for two backwash pumps, one of which is a standby.
3. Replacing of the building space requirements and particularly the mess room, meeting room, sick room (deleted), ablutions, control room, entrance foyer, chemical store and store.
4. Alternative materials suitable to replace the precast concrete baffles.
5. Revision of the filter gallery layout.
6. Ventilation of the filter enclosure.

4. COMPARISON OF COST OF WATER SUPPLIED FROM ALTERNATIVE SOURCES

The Value Analysis Project Brief required consideration of the operational relationship of the Wainuiomata Water Treatment Plant with the standby artesian pumping station at Gear Island.

The existing Gear Island plant supplies water via a connection to the Wainuiomata and Orongorongo Mains and this was taken as the base point for the study.

In order to determine the operational relationship between the two plants, the unit cost of water from each was calculated. The cost basis used was the "long run marginal cost" and the "short run marginal cost" of water. These are discussed in detail in the attached Appendix E.

The long run marginal cost of water may be used for comparing the unit charges or investment costs of alternative sources of water which may be constructed.

The short run marginal costs however may be used to make a decision on production of water from existing alternative sources where there is surplus capacity in the system.

The results of the analysis are given in Tabels 8, 9, 10 which show the life cycle costings for the long run and short run costs of water, from the Wainuiomata Orongorongo system and the Gear Island Pumping Station.

The results of the analysis show that the long run marginal costs for WWTP, are $298/Ml, of water produced which may be compared with $201/Ml of water produced from GIPS.

However for the short run marginal costs, when all capital costs are ignored, and only short run operating costs are included, the cost of water from the WWTP is estimated to be $97/Ml compared with $45/Ml from GIPS.

5.1 ELECTRICITY GENERATION

The feasibility of the generation of electricity from the Orongorongo source, which is approximately 100 metres above the Wainuiomata Water Treatment Plant, is examined in Appendix F to this report.

The feasibility study concludes that it is technically feasible to produce electricity from the Orongorongo source, however no field examination has been undertaken by Morrison Cooper Limited.

The internal rate of return, (IRR) in real terms for the generation of electricity, over the 60 year life of the plant in approximately 19%. The effects of the major assumptions discussed in Appendix F, on the IRR, are as follows:

		IRR
i)	Generation for 5000 hours per year with surplus electricity exported to HVEB at 50% of the purchase cost.	19%
ii)	Generation for 6000 hours per year with surplus electricity exported to HVEB at 50% of the purchase cost.	23%
iii)	Generation for 5000 hours per year with no income from surplus electricity to HVEB.	12%

These results suggest that the investment in an electricity generating scheme would be in WRC's economic interest, and suggest that further investigation should be undertaken.

5.2 EFFECT ON THE COST OF WATER PRODUCED

If the capital and operating costs and revenue, discussed in Appendix F, are applied to Option 1, the DAF-Filter System, operating 25% of the time, the effects on the cost of water, at a 7% discount rate are as follows:

		Cost of Water Produced $/Ml	Difference from base case $/Ml
i)	DAF/Filter with no power generation	124.86	0
ii)	DAF/Filter with power generation, but <u>no</u> allowance for revenue for power.	127.15	+2.29
iii)	DAF/Filter with power generation, for 5000 hours per year, and surplus electricity sold to HVEB, at 50% of purchase cost.	123.86	-1.00
iv)	DAF/Filter with power generation for 6000 hours per year, and surplus electricity sold to HVEB, or 50% of purchase cost.	123.25	-1.61
v)	DAF/Filter with power generation for 5000 hours per year, but no surplus sold to HVEB.	124.84	-.02

These results show that the generation of electricity can have a small but positive effect on reducing the cost of water produced by the Wainuiomata Orongorongo Water System.

6. CONCLUSIONS

1. On the basis of the Value Analysis of the three water treatment processes modelled, it is concluded that the DAF-Filter process is the currently the most appropriate technically and financially for the Wainuiomata site.
2. The long run marginal cost and short run marginal costs of water favour the use of the Gear Island source over that from the Wainuiomata - Orongorongo sources by a wide margin. However, other considerations such as technical and environmental issues including effects of long term pumping from the Gear Island artesian source, will undoubtedly determine the actual operational relationship of the two plants.

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

APPENDIX A

PROJECT BRIEF

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT VALUE ANALYSIS

PROJECT BRIEF

1. AIM

To carry out a Value Analysis (VA) of the proposed Water Treatment Plant at Wainuiomata.

2. LIMITS OF THE ANALYSIS (PROJECT CONSTRAINTS)

The VA shall be limited to the design of the proposed water treatment plant, its impact on the Wainuiomata Waterworks Reserve and its operational relationship with the standby artesian pumping station at Gear Island.

3. VALUE ANALYSIS JOB PLAN

(a) Information Phase

Definition of the Project. Collect information on the catchment environment, water quality and water standards required, WRC objectives for the plant, future development, proposed process and alternatives, review background data and assumptions, visit Te Marua water treatment plant, discussions with client and designer.

(b) Creative Phase

Determine capital and operating costs of the proposed plant, viable alternatives (conventional sand filtration and micro-filtration) and carry out a brief life-cycle costing for comparison purposes. Meet with Client to discuss results and confirm proposed plan.

Consider the proposed plant in detail and produce new and different possible creative ideas for the process, equipment, structures and siting. Meet with client to discuss these ideas.

(c) Judgement Phase

Carry out an initial screening of ideas using appropriate criteria. Conduct a workshop consisting of Client's policy, design and operating staff, plant designers, environmental and landscaping consultants and VA team to consider the ideas from the Creative Phase and suggest additional ideas.

Iteration with the Creative Phase is considered desirable. Select the ideas which have the potential for the greatest cost savings and improvement of the project for further development.

(d) Development Phase

Develop the ideas from the Judgement Phase into workable solutions including life cycle costing.

Hold a shorter workshop with the previous participants to confirm the ideas as workable solutions and provide feedback.

(e) Recommendation/Reporting Phase

Produce a report setting out the recommendations derived from the VA systems/phases for consideration by the client and designers for acceptance and incorporation in the final design.

(f) Follow-up Phase

Carry out any additional VA work on the recommendations that may arise during the final design of the project.

Morrison Cooper Limited
44-52 The Terrace
P O Box 10-283
Wellington

21 November 1990

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

APPENDIX B

COMPARISON OF OPTIONS - ASSUMPTIONS

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

COMPARISON OF OPTIONS - ASSUMPTIONS

1. ASSUMPTIONS COMMON TO ALL OPTIONS

1.1 Capital Costs

(a) Allowance is made for site works, foundations and buildings necessary for each plant option.

(b) The reservoir is not included for any option.

(c) All other items are assumed to be common to all options and are not considered.

(d) Capital costs include engineering and commissioning.

(e) All costs exclude GST.

(f) An allowance of 5% of the capital cost is included for spare parts.

(g) Construction commences 1 May 1991 and the plant is in full production 1 November 1993.

1.2 Replacement Costs

(a) Equipment is assumed to wear out steadily and then be replaced at the end of its economic life.

Lifetimes of 10 years for control equipment and instrumentation, 15 years for rotating equipment (e.g. pumps, press), 20 years for pipe and valves with severe duty, and 30 years for normal duty are assumed. (An allowance is made under operating costs for day to day maintenance (e.g. oil changes) and breakdown repair).

(b) Buildings are assumed to last the life of the plant. For all options this is assumed to be 60 years.

1.3 Decommissioning Costs

Decommissioning costs allow for the demolition and removal of the plant and buildings and landscaping of the site at the end of the plant's life. Plant is assumed to have nil value.

1.4 Operating Costs

Operating costs include labour, energy, chemicals, maintenance and insurance. For all the options considered the plant is assumed to operate at 45 Ml/day, for 360 days per year.

1.4.1 Labour A multiplier of 1.8 times gross salary is used to estimate the full costs of employment, including administration, accommodation, clothing, sickness benefits, holidays etc.

The gross salaries are assumed to be as follows:-

Supervisors	$40,000 p.a.
Workers	$25,000 p.a.

Energy Electrical energy costs are estimated using the installed power from the motor lists. Electricity rates are based on energy and demand charges for the Hutt Valley Energy Board (HVEB). These are:-

Maximum demand charge	$155.28/kVA/year
and	$ 6.24 cents kW/hr

Chemicals Chemical costs are specific to each option.

Maintenance Maintenance includes both maintenance labour and consumables, for normal maintenance but does not include the replacement of items at the end of their expected lives which are included under "replacement". Specific cost estimates are made for maintenance for each item, where possible, and for the remaining items, maintenance is estimated as 1% p.a. of the original capital cost of the plant or building.

Insurance Insurance premiums are calculated as 0.5% p.a. of the original capital cost of the total plant and buildings.

2. ASSUMPTIONS SPECIFIC TO EACH OPTION

2.1 Option I : P.W.T. DAF/Filter Plant

(a) Capital Costs: Mechanical and electrical costs are as detailed and costed in P.W.T. draft design report C1853 received by MCL 1 November 1990.

(b) Replacement Costs: Replacement costs are estimated using PWT costs and the PWT equipment list contained in the design report.

(c) Operating Costs

(i) Costs are generally as shown in the PWT report with estimates made for labour, electricity etc as noted below. It is assumed that for 35% of the time the plant operates as "Direct Filtration without Coagulant" (PWT report) but without Chlorine Dioxide. For 40% of the time it is as above but with Chlorine Dioxide and 25% of the time the DAF operates with coagulant.

(ii) Labour

The plant is unattended for 5 days at a time (PWT report), at the end of which 3 men (2 workers plus supervisor) spend a day on site. Only the portion of the operator's time on site (i.e. 1 day in 6) is allowed for.

(iii) Chemicals

Chemical costs are taken from the PWT report, Appendix A. Specific sections are "Direct Filtration without Coagulant" and "DAF Operations, using an Alum Coagulant". The proportion of operation in each mode is as 2.1.C(1).

Costs from the column marked "Total cost per month at 45 Ml/d rate" are multiplied by these proportions and then scaled up for a 360 day year to arrive at a yearly cost. Alum is assumed to be the selected coagulant.

2.2	Option 1a	DAF/Filter System with Belt Press in place of the Plate Press.
2.3	Option 1b	DAF/Filter System with on-site hypochlorite generation.
2.4	Option 1c	DAF/Filter System with gravity backwash.
2.5	Option 1d	DAF/Filter System with DAF operated continuously but with normal chemical usage.
2.6	Option 1c	DAF/Filter System with DAF operated continuously and chemicals increased from $530,000 p.a. to $931,000 p.a.

3. OPTION 2 - MEMTEC MICROFILTRATION SYSTEM

3.1 Capital Cost

(a) Costs for Memtec supplied equipment (membrane modules, some engineering and commissioning costs) are based on advice from Mr R. Wale of Memtec.

(b) Costs for auxiliary equipment associated with Memtec plant (CIP system, air compressor package, fine screening etc.) derived from R. Wale process description and MCL cost data.

(c) Other mechanical and electrical costs are adapted from PWT draft design report C1853 received 1 November 1990.

(d) Allowance is made for site works, foundations and buildings necessary for this plant.

(e) All other items are assumed to be common to all options and are not considered.

(f) Capital costs include engineering and commissioning.

3.2 Replacement Costs

(a) Membranes are assumed to last 4 years on average.

3.3 Operating Costs

(a) It is assumed that for 75% of the time the plant operates as "Direct Filtration without Coagulant" (PWT report) but without Chlorine Dioxide. For 25% of the time chemical use is as if the DAF were operating but Alum, Polyelectrolyte and additional lime are reduced to 15% of the PWT figures. Allowance is made for chemical cleaning costs.

As for the PWT system, the plant is unattended for 5 days at a time, at the end of which 3 men (2 workers plus supervisor) spend a day on site.

(c) Energy Energy costs are assumed to be as PWT (Option 1) except allowance is made for fine screening and the membrane system (0.1kW hr/m^3), while flocculation, DAF, filtration, backwash and air scour are deleted.

(d) Chemicals Chemical costs are adapted from the PWT report, Appendix A. Specific sections are "Direct filtration without Coagulant" and "DAF Operations, using an Alum Coagulant". The proportion of operation in each mode and adjustments are as 3.3a above.

Costs from the column marked "Total cost per month at 45 Ml/d rate" are multiplied by these proportions and then scaled up for a 360 day year to arrive at a yearly cost. Alum is assumed to be the selected coagulant.

(e) Maintenance Building maintenance is taken as 1% p.a. of the capital cost. Plant maintenance is taken at ½% p.a.

4. OPTION 3 - SAND FILTER PLANT

4.1 Capital Costs

Mechanical and electrical costs are as detailed and costed in PWT draft design report C1853 received 1 November 1990, except that:-

(i) DAF is deleted and an additional washwater Recovery Tank is allowed for on the assumption that filters will need to be cleaned twice as often during the time when the DAF would have been operated.

(ii) The plate type press (assumed to cost $500,000 installed) is replaced by a belt filter press.

(iii) The electrical and instrumentation cost is reduced because of the deletion of the DAF.

(iv) The service air/pneumatic cost is also reduced because of DAF deletion.

4.2 Replacement Costs

Replacement costs are estimated using PWT costs and the PWT equipment list in their design report. (Except for adjustments as 4.1, above).

4.3 Operating Costs

(a) Costs are generally as shown in the PWT report with estimates made for labour, electricity etc as noted below. It is assumed that for 35% of the time the plant operates as "Direct Filtration without

Coagulant" (PWT report) but without Chlorine Dioxide. For 40% of the time it is as above but with Chlorine Dioxide and 25% of the time with chemicals as if the DAF were operating and with twice as many backwashes.

(b) Labour Labour is assumed to be the same as Option 1.

(c) Energy Energy use is assumed to be as Option 1 except the DAF is deleted and the backwash/air scour cost doubled. Installed powers are taken from the PWT motor list and backwash use is doubled for 25% of the plant use.

(d) Chemicals Chemical costs are assumed to be as Option 1 and are taken from the PWT report, Appendix A. Specific sections are "Direct filtration without Coagulant" and "DAF Operations, using an Alum Coagulant". The proportion of operation in each mode is as 4.3a, above.

Costs from the column marked "Total cost per month at 45 Ml/d rate" are multiplied by these proportions and then scaled up for a 360 day year to arrive at a yearly cost. Alum is assumed to be the selected coagulant.

(e) Maintenance Building maintenance is taken as 1% p.a. of the capital cost. Plant maintenance is also taken at 1% p.a.

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

APPENDIX C

OPTIONS FOR THE VALUE ANALYSIS WORKSHOP

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

Notes on Value Analysis Workshop 18 December 1990.

1. OVERALL PROJECT AIM

The aim of the various teams involved in the project is as follows:-

To produce a design for the facility which fulfills the WRC requirements and results in the best balance between cost, performance and reliability (Ref Zimmerman).

2. AIM OF THE WORKSHOP

The aim of the workshop is to identify options/ideas that reduce cost and/or improve performance and reliability.

3. IDENTIFICATION OF OPTIONS

Options which achieve the aim will be sought and identified at the Workshop. Lateral thinking to identify options is vital for the success of this stage. It is important that 'judgement' be deferred until options are ranked and selected for further evaluation.

Seeding options to be introduced at the Workshop for review include:-

A. SITING AND ENVIRONMENT

1. Siting of the plant to the north west to reduce the quantity of excavation.

B. PROCESS AND EQUIPMENT

1. Belt filter press in place of a plate and frame filter press.
2. Lime silos rearrangement or a reduction in the number of silos.
3. Reassessment of the cost of chlorine generation on site.

4. The use of a high level storage tank and gravity flow for backwashing.

5. The necessity for a standby generator since the plant is not in the 'vital' category.

6. The reduction in the number of treatment trains from 5 to 4 or possibly 3.

7. The necessity to duplicate equipment items since the plant is not in the 'vital' category.

C. BUILDING AND CIVIL WORKS

1. An alternative single storey building sited clear of the treatment trains.

2. A reduction in building areas as a result of "tightening" the planning brief requirements.

3. The use of precast concrete to the tanks in place of cast-in-situ construction.

4. The use of Armco troughing or pipes to replace cast-in-situ RC flumes to the inlet and outlet.

5. Replacement of the pipe gallery in timber framing or alternative construction from cast-in-situ concrete.

6. The necessity to roof over the filter beds.

4. RANKING OF OPTIONS

The options which are identified in 3 above should be considered and those which are not practical eliminated. The remainder should then be ranked by the Workshop members.

5. SELECTION OF OPTIONS

The options which have been ranked should be selected for further evaluation by the VA procedure including life cycle costing. Some elements of 'judgement' of the option will be required in this stage.

6. FOLLOW UP PROCEDURE

The follow-up procedure after the workshop including reporting back by the VA team will need to be agreed at the workshop to allow the VA review to be completed.

7. PARTICIPANTS

Participants in the Workshop will be:-

PWT	Malcolm McLean	
	James MacKenzie	
	Bill MacMillan	
WRC	Neil McDougall	
	Rob Blakemore	
	Weston Roberts	
	Choon Soh	
	Ross Jackson	
	John Morrison	
	Neil Gillon	
	John Duggan	
	Paul Wedge	
-	Angela Porteous	(Part)
MCL	Arthur O'Leary	
	Bill Wakelin	
	George Butcher	

8. AGENDA

The agenda for the Workshop is attached.

Morrison Cooper Limited
Consulting Engineers
P.O. Box 10-283
WELLINGTON

14 December 1990

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS WORKSHOP

9 a.m. Tuesday 18 December 1990

AGENDA

ITEM	SUBJECT	RESPONSIBILITY	TIMINGS
1.	Introduction to Value Analysis, the aim of the workshop and workshop procedures.	G.W. Butcher	9.00- 9.15
2.	Siting and environmental aspects.	G.W. Butcher	9.15-10.00
3.	Results of comparison of three process/models.	W.S. Wakelin	10.00-10.15
4.	DAF Process - Review of equipment and process options.	W.S. Wakelin	10.15-12.30
5.	Lunch		12.30- 1.15
6.	DAF Process - Review of building and civil engineering options.	G.W. Butcher	1.15- 3.00
7.	Selection of options for further evaluation and procedure to complete the VA review.	W.S. Wakelin G.W. Butcher	3.00-3.30
8.	Evaluation of workshop format and results.	J. Morrison	3.30- 4.00

MORRISON COOPER LIMITED

13 December 1990

Distribution

1. WRC
2. PWT
3. A. Porteous
4. MCL

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

APPENDIX D

Notes of the Wainuiomata Water Treatment Plant
Value Analysis Workshop

WELLINGTON **REGIONAL** COUNCIL

18 December 1990
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NOTES OF THE WAINUIOMATA WATER TREATMENT PLANT VALUE ANALYSIS WORKSHOP HELD IN THE COMMITTEE ROOM, WELLINGTON REGIONAL COUNCIL OFFICE, ON TUESDAY 18, DECEMBER 1990

PRESENT

PWT New Zealand Ltd	Malcolm McLean, James MacKenzie, Bill MacMillan, Ian Meyle
Morrison Cooper	Arthur O'Leary, Bill Wakelin, George Butcher
Angela Porteous	Angela Porteous (Part)
Wellington Regional Council	
Bulk Water	Neil McDougall, Rob Blakemore, Weston Roberts, Choon Soh
Recreation	Ross Jackson (Part)
Technical Services	John Morrison, Neil Gillon, John Duggan, Paul Wedge

1. INTRODUCTION/AIM

Project Aim: To produce a design for the Wainuiomata Water Treatment Plant which fulfils the Wellington Regional Council requirements and results in the best balance between cost, performance and reliability.

Workshop Aim: To identify options/ideas that reduce cost and/or improve performance and reliability.

The Value Analysis procedure:

- Information
- Creative
- Judgement
- Development
- Recommendation/Reporting
- Follow-up

2. SITING AND ENVIRONMENTAL ASPECTS

Two options were evaluated for positioning the structure on the site. The forward option involved 12,000 cubic metres of excavation at an approximate cost of $100,000.00. The rear siting involved an extra 7,000 cubic metres of excavation with an approximate cost of $56,000. There could be one or more benches in the cut batter.

The rear siting with four or five benches would cost an extra $80,000.00 compared with the forward siting with only one bench. Angela Porteous preferred the rear siting as the majority of the stand of bush in front of the site will remain undisturbed. Also the option of four or five benches is preferred for revegetation of the cut batter. Narrow benches would be acceptable. Ross Jackson highlighted the potential for recreational development in the area. Revegetation of disturbed areas with native bush is preferred.

Transplanting of existing bush areas that will be cleared is not considered practical. The treatment plant site is the proposed terminus to the recreation area. The excavated material will be disposed of on site.

The group consensus was that the small saving on the siting options is not considered critical relative to the visual aspects and impact on the recreational potential. The additional costs of a rear siting is acceptable if the treatment plant will sit better in the environment.

3. RESULTS AND COMPARISONS OF THREE PROCESS/MODELS

The evaluated costs do not include Wellington Regional Council costs or costs of existing capital works eg. river intakes. Three options were considered:

- DAF/Filter Plant
- Memtec Microfiltration
- Filter plant without DAF

(Refer to "Comparison of Options Assumptions" handout).

The following comments refer to details in the handout. It is proposed to have three technicians on site during normal working hours, five days per week. The labour costs calculated for the three treatment plant options financial analysis involved three technicians on site only one day in six. The life times for heavy equipment are generally 30 to 40 years. The controls could be replaced every 10 to 20 years. Electricity charges were determined from $12.94/kVA/month and 6.24c/kWhr.

Lifetime for the DAF plant was assumed to be 60 years with 4 years construction.

The Memtec Microfiltration plant costings are approximately twice that of the DAF/filter plant. This is due to high capital and maintenance costs.

The filter plant without DAF would involve three to four times the frequency of backwashing when treating dirty water. The quantity of backwash water in this situation would be excessive. This plant would have a greater shut down period due to unacceptable raw water conditions.

The appropriate discount rate for the Wellington Regional Council is 6 to 7 percent.

Based upon the current investment costs and proposed operating regime, the DAF/filter plant is considered the most appropriate for Wainuiomata.

MCL to revise the financial analysis for the three models accordingly.

4. REVIEW OF EQUIPMENT AND PROCESS OPTIONS FOR DAF PROCESS

(1) Sludge Dewatering

The centrifuge was the preferred option in the previous process review meeting. The capital cost is relatively low. The smallest production model is larger than that required for Wainuiomata. This therefore gives additional capacity if required. A centrifuge requires little operator input. The structural costs associated with a centrifuge are low. Centrifuge design has improved and the maintenance costs have been reduced.

Plate and frame filter press is not considered appropriate due to the high capital cost.

A belt filter press is not as affective in dewatering water treatment plant sludge as sewage treatment plant sludge due to the lack of fibre. Also more water is required for washing the belt filter press.

(2) Lime Silo/Dosing

The option of using a lime slurry system for dosing lime shall be pursued by Morrison Cooper Ltd. The bulk water experience with lime slurry was with a changing concentration which caused precipitation and a blocking of the pipes. The previous process review meeting concluded that the 17.5 tonne lime silo from Hutt park would be used for the bulk lime silo at the Wainuiomata Water Treatment Plant.

(3) Chlorine Generation on Site

PWT's estimated cost of $200,000.00 for on site chlorine generation did not deduct the cost of chlorinators compared with dosing pumps. At the assumed dose rate of 72kg per day at 45 megalitres per day it is marginally economic to generate chlorine on site. A relatively inexpensive emergency standby chlorinator would be required. The capital cost of a chlorine generation plant would be approximately $150,000.00 more than using chlorine gas dosing.

Bulk water supply finances will be greatly restricted for the next five years. It would be more cost effective to install a chlorine generation plant at Te Marua rather than at Wainuiomata.

It was concluded that a chlorine gas dosing system should be installed at Wainuiomata with space allowance for future on site chlorine generation if finances become available.

(4) Siting of Wash Water Tank

PWT's proposal is for a directly pumped wash water system from a tank incorporated in the treatment plant structure. An alternative to this system is a 290 cubic metre elevated wash water tank with smaller pumps filling over a longer period. There is no cost saving for the alternative of an elevated wash water tank. It was concluded that the pumped backwash system with a storage tank incorporated in the treatment plant structure will be used at Wainuiomata.

(5) Standby Generator

The proposed standby generator would cost approximately $160,000.00 and the room to house the generator would cost an additional $20,000.00. The purpose of this generator is to fully power the treatment plant in a civil emergency. In a civil defence emergency the Region could be without power for at least one week. The Wainuiomata water supply has the least power demand of the water supplies in the Wellington Region. In a civil defence emergency it is likely the pipelines will also be out for equal or longer periods than the power supply. The cost of the generator may be better spent on improving lifelines.

It was concluded that the generator room shall be included in the treatment plant and allowance made for connecting a future generator to the main switchboard but the standby generator will not be installed at this stage. A small generator or the existing generator from the Strainer building will be installed for powering essential equipment and enabling the plant to be shut down in a power cut. A UPS for the control system shall be included.

(6) Number of Modules

The flexibility of operating at low flows will be lost if the number of modules is reduced. PWT have fully assessed the requirements for the treatment process with the aim of reducing costs and concluded that five is the optimum number of modules.

(7) Duplication of Equipment

Essential items, e.g. chlorine dosing requires full backup.

Equipment

DAF recycle pumps:	Four pumps, one pump a standby and allowance for additional capacity.
Air Saturators:	Two required for flexibility.
Backwash Pumps:	Two pumps with one a standby. The standby pump could be deleted if spare parts or a replacement is readily available.
Blower:	Two blowers with one a standby.
Bulk Alum Tanks:	All four tanks required.
Alum Dose Pumps:	One on standby. Dose pumps are not costly and have high maintenance requirements.
Polyelectrolyte Pumps:	One on standby.
Carbonator Boost Pumps:	Two pumps with one a standby. The standby pump could be deleted if spare parts or a replacement is readily available.
Carbonator Units:	One only unit required.
Air Supply:	Essential equipment full backup required.
Chlorine Dosing Equipment:	Essential equipment full backup required.
Lime Feeders:	Essential equipment full backup required.

(8) PAC

Tests on Wainuiomata water have indicated a PAC dose 80 percent that of alum. Accounting for the reduced lime dose alum is still the cheaper coagulant to use. Both alum and PAC could be stored in the tanks on site. Alternatively ferric salts could also be used in the treatment plant.

(9) Process Water

The bulk of the process water is used continuously as carrier water for chemicals. The option of an elevated tank is not considered appropriate as this better suits intermittent use of water.

(10) PLC/DCS

PWT have proposed the use of PLC controls in the Wainuiomata water treatment plant. PLC's can recover quicker from a total crash. The number of IO's for the plant is approximately 500. The costs and advantages of the two systems is to be assessed further by the Wellington Regional Council.

5. REVIEW OF BUILDING AND CIVIL ENGINEERING OPTIONS

(1) Structural Shape

An alternative of a single storey structure separate to the filter/flocculator block to house the chemical and control equipment was considered. This has the potential of saving up to $130,000. The treatment plant structures would have a greater visual impact on the environment.

The separate structure would require extra control cabling and chemical dosing lines. Access from the control room to the filters would be more difficult. The approximate cost of the proposed two storey building including filter/flocculator modules is approximately $2,900,000.00

It was concluded that a separate single storey structure is not acceptable.

(2) **Reduction in Building Requirement**

The cost of the building area is approximately $1,000 per square metre.

Mess Room: This provides a location for contact between outside and inside staff and is considered a necessary requirement. The area should accommodate 10 people.

Meeting Room: The meeting room is sized to accommodate 12 people around a single table. Included in this room is document storage and a photocopying machine.

Sick Room: There is no regulatory requirement for this room. The BA sets could have separate storage. The first aid kit could be stored in the mess room. The sick room is deleted.

Ablutions: Only one common shower is required. Two female lockers and five male lockers shall be provided.

Control Room: Space for up to 15 people viewing the control terminal is required.

Entrance Foyer: The entrance area is required for a display of the process and for addressing groups.

Chemical Store: Locating the dose pumps along the chemical store wall will allow pipe work to pass directly from the day tanks to the pumps.

Store: It is preferable to locate the store between the light and heavy workshops.

External Store: A room will be available in the existing depot for the storage of outside tools and equipment, e.g. mowers, rakes, etc.

The form of the structure shall allow for future extensions for additional processes.

The size and location of the carbon dioxide, chlorine dioxide and chlorine structures are still to be determined.

(3) **Precast Construction**

Precast concrete construction of the filter and flocculator tanks is more expensive than in situ concrete construction, hence in situ construction is proposed.

The baffle between the flocculation zones does not need to be a structural element. A flexible membrane wall is acceptable.

The baffle in the aeration zone should be stiff to maintain laminar flow into the filter area. Alternative materials shall be considered for fabrication of this baffle.

The use of timber is acceptable for baffles and the flocculator paddles.

(4) Use of Armco Troughing for Flumes

The cost of Armco is approximately $353 per metre and the cost of a concrete flume is approximately $1,600 per metre.

The inlet trough is designed to maintain equal flow distribution into the flocculators. There would be difficulty with the Armco to concrete connections. The changing section size of the Armco troughing may induce turbulence and prevent an even distribution of flow. The reinforced concrete inlet trough as proposed was confirmed. Consideration of fibre reinforced plastic was also discounted.

The filtered water trough and filter gallery requires further study. PWT will produce a revised proposal for this area.

Morrison Cooper shall supply PWT with a proposed cross section of the pump blower filter gallery area.

(5) Filter Gallery Construction

The nature of the filter gallery construction shall be determined after PWT have revised the layout.

(6) Filter Roof

A roof over the filters is required to avoid damage to the float by wind and rain. A wall between the filter and flocculation basins is required. Natural and forced ventilation of the enclosed filters is required.

(7) General Construction

Morrison Cooper propose the ground floor walls to be constructed from concrete block. The office and control room area will be domestic type construction, i.e. timber framing. Lightweight lining and claddings are proposed with colour steel roofing. The noisy equipment is located at one end of the plant with soundproofed rooms.

6. SELECTION OF OPTIONS FOR FURTHER EVALUATION

The items identified in this workshop as requiring further investigation will be assessed in the normal design procedure.

Item	Action
Lime slurry	MCL
Backwash pump duplication	PWT
Space requirements	MCL
Alternative materials for baffles	MCL
Filter gallery layout	PWT
Filter enclosure ventilation	MCL

Details of the lime slurry dosing system shall be prepared by Morrison Cooper. The stirrers in the lime slurry tank should be included in the essential items powered by the standby generator. A system enabling flushing of the slurry lines in a power failure should be provided. Wellington Regional Council shall advise Morrison Cooper of the size of the existing generator at Wainuiomata and also existing cost of electricity to the Wellington Regional Council.

The use of timber is acceptable for baffles and the flocculator paddles.

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Further value analysis may be required for the control system.

Workshop concluded at 3.25 pm with afternoon tea and informal discussions.

JOHN DUGGAN
Engineer, Technical Services

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

APPENDIX E

Notes on the basis for the Comparison of the Unit cost
of water supplied from the Wainuiomata Orongorongo Source
to that from the Gear Island Pumping Station

1. THE BASIS FOR INCLUSION OR EXCLUSION OF COSTS

The costs which are included, or excluded in the comparison of the production of a product such as water (or for instance electricity) from alternative sources, depends on the context of the comparison.

For the proposed facility, where no development has yet taken place, the total capital and operating costs should be included. The decision is "to build or not to build". No product will be produced unless the facility is built, and hence all costs are included. This is the long run cost.

However for an existing facility, all of the capital development (less any salvage value) is a "sunk cost".

In the very short term the costs of producing an additional unit of product are simply the direct operating costs and the cost of raw material input. These are the costs which could be avoided if that unit was not produced. If for instance an expense had to be incurred, overheads, rent on land, wages etc regardless of whether the product was produced or not, that cost should be excluded from the short run marginal cost.

As the length of run is increased, more of the costs should be included. If one has the opportunity of shutting down a plant for say three months during a period of low seasonal demand, then the decision would be made on the costs which can be avoided during that three months period. There will be no raw material costs, short-term labour may be dismissed and rehired. Hence the short-term costs savings will include these costs but should not include costs which will continue during the period of the shut down.

2. VALUING PRODUCTIVE ASSETS

The value of an asset (such as a hydro-dam) which cannot be sold for an alternative use, is its productive value in use. This is calculated as the nett present value (at the appropriate discount rate), of the stream of income that will be produced over the asset's lifetime. This requires an estimate of quantity demanded, price and operating costs. Where the product is a freely traded commodity such as apples, this is relatively straight forward. However where the product is sold by a monopoly supplier (such as government) there may be no free market price and the price may be based on the value of the assets. Clearly this gives rise to a circular argument, between price and asset value.

An alternative approach is to use the depreciated value of the asset. For instance, this would be appropriate where a productive asset is being taken over from Government by a state owned enterprise or is to be privatised. It is also regarded as appropriate in this case for the long run cost comparison between two existing sources of water.

3. THE LONG RUN UNIT COST OF WATER

In this approach the total costs of water from each alternative source (the Wainuiomata and Orongorongo rivers, and the Hutt Valley aquifer respectively) via treatment and pumping to a common point in the distribution network (the Gear Island Pumping Station junction) are included.

The assets are valued at their depreciated 1991 values i.e. the installed cost of the assets in 1991 prices is estimated and then depreciated on a linear basis over the estimated life of the asset. The nett present value of the total costs is then divided by the nett present value of quantity of water produced, to derive a cost of water from that source, expressed in 1991 $ per megalitre. {$/Ml). The higher the discount rate the greater the cost per megalitre of water, as a higher price is required to provide a greater return on the asset. This figure may then be used to compare alternative sources of water on a long run basis for investment purposes or for water charges.

4. THE SHORT RUN MARGINAL UNIT COST OF WATER

The short run marginal cost may be used to make a decision on production of water from alternative sources where there is surplus capacity in the system. Assuming that both the Wainuiomata/Orongorongo and the Gear Island sources are developed the costs which may be avoided in the short run by closing one facility are calculated. The capital costs of both facilities are excluded as these are sunk costs and will not alter, whether the facility is producing or not. The question to be asked is what are the additional costs of producing water from this facility today, compared with not producing water today?.

Equipment, tunnels, pipes and structures are assumed to be relatively unaffected by their use, or non use and hence their replacement cost is not included in the short run marginal costing.

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

APPENDIX F

Feasibility of the Generation of Electricity from the Orongorongo Source

MORRISON COOPER LIMITED

FEASIBILITY OF THE GENERATION OF ELECTRICITY FOR THE ORONGORONGO SOURCE

1. INTRODUCTION

The Wainuiomata Treatment Plant takes approximately half its total flow from the Orongorongo Stream. The intake at the stream is 104 metres above the plant hence considerable potential energy is available at the treatment plant. This energy must either be dissipated in the plant control valves or alternatively the water could be used to power a turbine and to generate electricity. This Appendix to the Value Analysis report examines the feasibility of the generation of electricity from the Orongorongo source.

2. FLOW

The Orongorongo stream currently provides between 9 and 19 million litres of water per day to Wellington[1]. The existing water right permits the taking of up to 22.7 Ml/day. This is about half the total inflow required by the treatment plant which has a maximum capacity of 45 Ml/day.

Flow is governed by the treatment plant throughput which is, in turn, related to water demand and water quality. The present water rights held by the WRC do not allow water, surplus to treatment plant requirements, to be discharged to the Wainuiomata river (which is below the treatment plant level). Thus under present arrangements power generation could only take place while the treatment plant is operating. The analysis is based on the plant taking Orongorongo water 5,000 hours per annum at 22.7 Ml/day[2].

With a new pipeline (as proposed to be installed in approximately 10 years) more power would be available at the same flow due to lower line friction loss, and this could be further increased if water flows could be increased. For the purposes of the analysis it has however been assumed that generator output will remain at the initial level even after line replacement.

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[1] WRC letter 5 October 1990.

[2] This flow is close to that at which peak power output is attained from the present pipeline.

The present pipeline is severely tuberculated which limits the flow. Annex 1 gives details of flow, pressure drop and potential power output for the existing line.

Based on the flow/head data provided in the WRC letter of 5 October, potential electrical output has been calculated for a range of flows between 10 and 25 Ml/day[1]/. Because of the effects of line pressure drop power production is maximised at approximately 22 Ml/day (available head 63m). For a new line the conditions are rather different with more head available and the potential for larger flows.

The same turbine would be suitable for both duties, however a new alternator would be required to take advantage of the increased power output.

3. POWER USAGE/PRICING

The treatment plant power demand is dependent on both throughput and, more particularly, treatment mode. While operating in filtration only mode, power demand will be less than generator output (unless the backwash pumps are operating). Under these circumstances power will need to be exported to the HVEB. The export of power has not been discussed with HVEB, however it is expected that some discount will be applied (i.e. exported power will be purchased at less than the supply price from the HVEB). For the water treatment plant analysis power has been priced at 13.1 c/kWh and this rate has been adopted for power used in plant. For exported power a reduction of perhaps ½ is appropriate to reflect the rate HVEB can buy at from Electricorp. Estimating the running time under export conditions is difficult. However it is possible that up to 50% of the generated power would need to be exported[2]/. This gives an average price for generated power of 8.74 cents/kWh.

---

[1]/ There appears to be a discrepancy between the roughness quoted in the letter of 5 October and the calculated flows given. We have assumed that the flow/head data is correct.

[2]/ The plant is expected to run in DAF mode 25% of the time (power requirements in this mode are greatly in excess of generator output), while running on filtration only there will be intermittent demands for power from backwash pumps, blowers, sludge plant as well as base load plant.

4. OPERATING HOURS

Operating hours are also difficult to estimate. Not only does the water demand fluctuate throughout the year but decisions on sources of supply are made on the basis of treatment costs, stream flows, water quality, pipeline capacities etc. For this analysis 5,000 operating hours at a flow of 22.7 Ml/day has been assumed producing a mean electric power output of 122 kW. This gives an annual generator output of 610,000 kWh with a value of $53,726[1].

5. PLANT REQUIREMENTS

The scheme proposed includes a horizontal style Turgo Impulse turbine unit coupled to an induction alternator running in parallel with the mains. This choice is lowest in capital cost as it makes use of the mains supply to sychronise supply rather than special control equipment. (This does mean that the set cannot supply power when mains power is unavailable).

6. CAPITAL COSTS

Costs allow for the turbine, generator, (including civil works) and electrical connections. No credit has been allowed, nor costs included for, piping, inlet valve, flow control valves, bypass valves, etc as a broadly similar arrangement will be required irrespective of whether or not a generator is included.[2]

7. CONTROLS

The generator selected can only run in parallel with the mains which provides syncronisation. Controls can therefore be simple. It will however be necessary to provide controls to

(a) protect the unit from overcurrent etc.

[1] An alternative calculation based on obtaining nothing for exported power shows savings of $37,655.

[2] The WRC letter of 5 October 1990 suggests that savings of $15,000 could be made in flow control valves if the generator is installed. Only if no provisions are included to bypass the generator could these savings be realised.

(b) regulate water flow through the unit to match plant requirements (unless surplus water is diverted, via a weir say, to the Wainuiomata river). The controller and measuring elements for this are already incorporated in the water treatment plant.

(c) valving to isolate the generator for servicing (unless this can be done from the inlet).

(d) if required a bypass control valve to regulate flow to the plant when the generator is being serviced.

For the purposes of costing the "with and without generation case" a, b, and c above have been included in the generator price. (In the case of "b" we have allowed to control the flow at the generator). No costs for "d" are included it being assumed a suitable control valve is already included in plant costs.

8. COST ESTIMATES

8.1 Capital Costs

Twin turbine unit and alternator	$285,000
Civil works and installation	$ 10,000
Electrical including modifications to switchboard, metering etc.	$ 30,000
	$325,000

8.2 Operating Costs

Additional normal maintenance	$ 2,000
Major overhaul every 15 years (Plant life 60 years)	$ 30,000

Revenues

Electricity produced 610,000 kWh.
Value $53,726

(Alternatively based on no income from power sales to HVEB $37,655).

8.3 The economic conclusions to be drawn from these results are included in the main report at Section 5.

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

VALUE ANALYSIS

ANNEX 1

Details of Flow and Pressure Drop

APPENDIX F: ANNEX 1

FLUID FLOW CALCULATIONS (EXISTING PIPELINE)

FLUID PROPERTIES				
Enter fluid number (from table on right)	1			
Temperature C				
or enter properties here				
Density (kg/cu.m)				
Viscosity (Pa.s)				
VALUES FOR CALCULATION				
Density kg/cu.m	999.73			
Viscosity Pa.s	0.001306			
Pipe dia. m	0.525			
Absolute Roughness m	0.01			
vol. flow rate cu.m/sec	0.115741	0.173611	0.262731	0.289352
vol. flow rate Ml/day	10	15	22.7	25
Reynold no.	214999	322498	488047	537497
Velocity m/s	0.53	0.80	1.21	1.34
1/sqrt(f) (eqn C4.8 CIBS Guide)	9.135542	9.141481	9.145526	9.146253
Friction Factor f	0.011982	0.011966	0.011956	0.011954
Press loss Pa	13.04	29.31	67.07	81.34
Orongorongo dam line hydro potential				
pipe length	5700	5700	5700	5700
Loss over length, m head	7.44	16.71	38.23	46.36
Total head	102	102	102	102
Available head for generation	94.56	85.29	63.77	55.64
Theoretical power, kW	107.37	145.26	164.36	157.93
Efficency	0.76	0.76	0.76	0.76
Power produced	81.60	110.40	124.91	120.02

Calculated from flow data in WRC letter 5/10/90

Design flow

FLUID FLOW CALCULATIONS (POSSIBLE REPLACEMENT PIPELINE)

FLUID PROPERTIES				
Enter fluid number (from table on right)	1			
Temperature C				
or enter properties here				
Density (kg/cu.m)				
Viscosity (Pa.s)				
VALUES FOR CALCULATION				
Density kg/cu.m	999.73			
Viscosity Pa.s	0.001306			
Pipe dia. m	0.7			
Absolute Roughness m	0.000013			
vol. flow rate cu.m/sec	0.115741	0.173611	0.289352	0.405093
vol. flow rate Ml/day	10	15	25	35
Reynold no.	161249	241874	403123	564372
Velocity m/s	0.30	0.45	0.75	1.05
1/sqrt(f) (eqn C4.8 CIBS Guide)	15.59327	16.20088	16.95242	17.43455
Friction Factor f	0.004113	0.00381	0.00348	0.00329
Press loss Pa	1.06	2.21	5.62	10.41
Orongorongo dam line hydro potential				
pipe length	5700	5700	5700	5700
Loss over length, m head	0.61	1.26	3.20	5.93
Total head	102	102	102	102
Available head for generation	101.39	100.74	98.80	96.07
Theoretical power, kW	115.12	171.57	280.44	381.76
Efficency	0.76	0.76	0.76	0.76
Power produced	87.49	130.39	213.13	290.14

New epoxy lined steel or similar pipe

Design flow

6. Emergency Backwash

The possible use of raw water from the Orongorongo pipeline for emergency backwashing of the treatment plant filters was suggested. The estimated cost of the extra pipework to allow for this proposal is $75,000.

7. Generation of Electricity from Orongorongo Supply

The exiting Orongorongo - Karori (OK) pipeline is a 525 mm unlined steel main that is severely tuberculated with an apparent "k" roughness value >30 mm. The length of this pipeline from the Orongorongo River Intake to the site of the proposed Wainuiomata Water Treatment Plant, is 5700 m. The water level at the Orongorongo River Intake is 244 m and the inlet level to the treatment plant is 142 m.

With an unrestricted outlet at the treatment plant the maximum expected flow through this pipeline is approximately 400 l/s (35 Ml/d).

The existing flow through the Orongorongo pipeline is in the range 8 to 19 Ml/d. With sufficient water at the intakes the expected head at the treatment plant is:

Flow Rate (Ml/d)	10	15	20	22.7	25
Head (m)	94	84	71	61	50

The estimated cost of destroying this head using two 200 mm pressure reducing valves in series is $15,000. This does not include the cost of a flow measuring orifice plate or the 400 mm flow controlling butterfly valve which would be required for any plant inlet pipework arrangement.

8. Future Developments

The Wellington Regional Council propose to replace the Orongorongo pipeline from the intake to the Wainuiomata Water Treatment Plant and also upgrade the existing Orongorongo River Intake within the next 10 years. This would potentially increase the available power output from a generating plant.

The current Orongorongo water supply abstraction is covered by water right WGN 770101 as a notified use in terms of Section 21 of the Water and Soil Conservation Act 1967. This records an abstraction rate of up to 5 million gallons per day (22.7 Ml/d). This water right may be surrended by the Wellington Regional Council and an application made for a new right when the Orongorongo River Intake is upgraded. The application would be for an increase in the maximum abstraction rate but allowance made for a compensation flow.

For clarification of any of these matters please contact the undersigned.

Yours faithfully

JOHN DUGGAN
for Manager, Technical Services

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

REPORT ON VALUE ANALYSIS

APPENDIX G

TABLES

WELLINGTON REGIONAL COUNCIL

WAINUIOMATA WATER TREATMENT PLANT

REPORT ON VALUE ANALYSIS

APPENDIX G

TABLES

Table 1.

Wainuiomata Water Treatme[illegible]lant Value Analysis
Table of Costs and Discounted Cashflow
Option 1: DAF/Filter System, 25% DAF, (with centrifuge)

year beginning year	1-Jul-90 1	1991 2	1992 3	1993 4	1994 5	1995 6	1996 7to11	2001 12	2002 13	2003 14	2004 15to18	2008 19	2009 20	2010 21to23	2013 24	2014 25to27	2017 28	2018 29to33	2023 34
output (Ml/day)	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
operating days/yr	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
filtration only (35%)	0	0	0	84	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126
filtration and ClO2 (40%)	0	0	0	96	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
DAF (25%)	0	0	0	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
output (Ml/year)	0	0	0	10800	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
capital costs ($000's) *	1374	3759	3318	1253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	0	0	0	0	20	0	1680	0	729	20	0	2963	0	20	0	3606
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
operating costs																			
labour	0	0	0	108	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
energy	0	0	0	92	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138
chemicals	0	0	0	356	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534
maintenance	0	0	0	145	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217
insurance	0	0	0	32	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
total cost	1374	3759	3318	1986	1099	1099	1099	1119	1099	2779	1099	1828	1119	1099	4062	1099	1119	1099	4705

* including building costs and civil works	3716
mechanical, electrical & control costs	5988
total capital costs	9704

discount rate (%)	6	7	8	9	10
net pres. value total costs ($000)	25753	22666	20258	18340	16780
net present value output (Ml)	215548	181535	155194	134378	117625
Cost of Water ($/Ml) 3/	119	125	131	136	143

Components of costs ($/Ml) discount rate (%)	6	7	% (@7%)	8	9	10
capital costs	39.06	45.35	36	51.87	58.60	65.50
replacement costs	12.53	11.64	9	10.80	10.02	9.29
decommisioning costs	0.01	0.01	0	0.01	0.00	0.00
labour	10.01	10.01	8	10.00	10.00	10.00
energy	8.52	8.52	7	8.52	8.52	8.52
chemicals	32.96	32.96	26	32.96	32.96	32.96
maintenance	13.38	13.38	11	13.38	13.38	13.38
insurance	2.99	2.99	2	2.99	2.99	2.99
total cost	119.48	124.86	100	130.53	136.48	142.65

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies, sludge handling) are not included.
3. Cost of water is not the total cost, but only the cost of water treatment.

Table 1. (continued)

Option 1: DAF/Filter System, 25% DAF, (with centrifuge)

year beginning	2024	2025	2026	2033	2034	2038	2039	2041	2042	2043	2044	2053
year	35	36	37to43	44	45to48	49	50to51	52	53	54	55to63	64
output (Ml/day)	45	45	45	45	45	45	45	45	45	45	45	0
operating days/yr	360	360	360	360	360	360	360	360	360	360	360	0
filtration only (35%)	126	126	126	126	126	126	126	126	126	126	126	0
filtration and ClO2 (40%)	144	144	144	144	144	144	144	144	144	144	144	0
DAF (25%)	90	90	90	90	90	90	90	90	90	90	90	0
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
capital costs ($000's) *	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	20	0	2963	0	729	0	20	0	4531	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	120
operating costs												
labour	162	162	162	162	162	162	162	162	162	162	162	83
energy	138	138	138	138	138	138	138	138	138	138	138	0
chemicals	534	534	534	534	534	534	534	534	534	534	534	0
maintenance	217	217	217	217	217	217	217	217	217	217	217	0
insurance	49	49	49	49	49	49	49	47	47	47	47	0
total cost	1099	1119	1099	4062	1099	1828	1099	1118	1098	5629	1098	203

discount rate (%)
net pres. value total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Components of costs ($/Ml)
discount rate (%)
capital costs
replacement costs
decommisioning costs
labour
energy
chemicals
maintenance
insurance
total cost

Table 2. Wainuiomata Water Treatment Plant Value Analysis
Table of Costs and Discounted Cashflow
Option 1d: DAF/Filter System, 100% DAF, unaltered chemicals, (with centrifuge)

year beginning	1-Jul-90	1991	1992	1993	1994	1995	1996	2001	2002	2003	2004	2008	2009	2010	2013	2014	2017	2018	2023
year	1	2	3	4	5	6	7to11	12	13	14	15to18	19	20	21to23	24	25to27	28	29to33	34
output (Ml/day)	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
operating days/yr	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
filtration only (0%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
filtration and ClO2 (0%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAF (100%)	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
output (Ml/year)	0	0	0	10800	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
capital costs ($000's) *	1374	3759	3318	1253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	0	0	0	0	20	0	1680	0	729	20	0	2963	0	20	0	3606
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
operating costs																			
labour	0	0	0	108	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
energy	0	0	0	116	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174
chemicals	0	0	0	356	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534
maintenance	0	0	0	145	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217
insurance	0	0	0	32	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
total cost	1374	3759	3318	2010	1135	1135	1135	1155	1135	2815	1135	1864	1155	1135	4098	1135	1155	1135	4741

* including building costs and civil works	3716
mechanical, electrical & control costs	5988
total capital costs	9704

discount rate (%)	6	7	8	9	10
net pres. value total costs ($000)	26232	23069	20603	18638	17041
net present value output (Ml)	215548	181535	155194	134378	117625
Cost of Water ($/Ml) 3/	122	127	133	139	145

Components of costs ($/Ml) discount rate (%)	6	7	% (@7%)	8	9	10
capital costs	39.06	45.35	36	51.87	58.60	65.50
replacement costs	12.53	11.64	9	10.80	10.02	9.29
decommisioning costs	0.01	0.01	0	0.01	0.00	0.00
labour	10.01	10.01	8	10.00	10.00	10.00
energy	10.74	10.74	8	10.74	10.74	10.74
chemicals	32.96	32.96	26	32.96	32.96	32.96
maintenance	13.38	13.38	11	13.38	13.38	13.38
insurance	2.99	2.99	2	2.99	2.99	2.99
total cost	121.70	127.08	100	132.76	138.70	144.88

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies, sludge handling) are not included.
3. Cost of water is not the total cost, but only the cost of water treatment.

Option 1d: DAF/Filter System, 100% DAF.

year beginning	2024	2025	2026	2033	2034	2038	2039	2041	2042	2043	2044	2053
year	35	36	37to43	44	45to48	49	50to51	52	53	54	55to63	64
output (Ml/day)	45	45	45	45	45	45	45	45	45	45	45	0
operating days/yr	360	360	360	360	360	360	360	360	360	360	360	0
filtration only (0%)	0	0	0	0	0	0	0	0	0	0	0	0
filtration and ClO2 (0%)	0	0	0	0	0	0	0	0	0	0	0	0
DAF (100%)	360	360	360	360	360	360	360	360	360	360	360	0
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
capital costs ($000's) *	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	20	0	2963	0	729	0	20	0	4531	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	120
operating costs												
labour	162	162	162	162	162	162	162	162	162	162	162	83
energy	174	174	174	174	174	174	174	174	174	174	174	0
chemicals	534	534	534	534	534	534	534	534	534	534	534	0
maintenance	217	217	217	217	217	217	217	217	217	217	217	0
insurance	49	49	49	49	49	49	49	47	47	47	47	0
total cost	1135	1155	1135	4098	1135	1864	1135	1154	1134	5665	1134	203

discount rate (%)
net pres. value total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Components of costs ($/Ml)
discount rate (%)
capital costs
replacement costs
decommisioning costs
labour
energy
chemicals
maintenance
insurance
total cost

Table 3.

Wainuiomata Water Treatment Plant Value Analysis
Table of Costs and Discounted Cashflow
Option 1e: DAF/Filter System, 100% DAF, with increased chemicals, (with centrifuge)

year beginning	1-Jul-90	1991	1992	1993	1994	1995	1996	2001	2002	2003	2004	2008	2009	2010	2013	2014	2017	2018	2023
year	1	2	3	4	5	6	7to11	12	13	14	15to18	19	20	21to23	24	25to27	28	29to33	34
output (Ml/day)	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
operating days/yr	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
filtration only (0%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
filtration and ClO2 (0%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAF (100%)	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
output (Ml/year)	0	0	0	10800	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
capital costs ($000's) *	1374	3759	3318	1253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	0	0	0	0	20	0	1680	0	729	20	0	2963	0	20	0	3606
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
operating costs																			
labour	0	0	0	108	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
energy	0	0	0	116	174	174	174	174	174	174	174	174	174	174	174	174	174	174	174
chemicals	0	0	0	663	995	995	995	995	995	995	995	995	995	995	995	995	995	995	995
maintenance	0	0	0	145	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217
insurance	0	0	0	32	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
total cost	1374	3759	3318	2317	1596	1596	1596	1616	1596	3276	1596	2325	1616	1596	4559	1596	1616	1596	5202

* including building costs and civil works	3716
mechanical, electrical & control costs	5988
total capital costs	9704

discount rate (%)	6	7	8	9	10
net pres. value total costs ($000)	32366	28235	25019	22462	20388
net present value output (Ml)	215548	181535	155194	134378	117625
Cost of Water ($/Ml) 3/	150	156	161	167	173

Components of costs ($/Ml) discount rate (%)	6	7	% (@7%)	8	9	10
capital costs	39.06	45.35	29	51.87	58.60	65.50
replacement costs	12.53	11.64	7	10.80	10.02	9.29
decommisioning costs	0.01	0.01	0	0.01	0.00	0.00
labour	10.01	10.01	6	10.00	10.00	10.00
energy	10.74	10.74	7	10.74	10.74	10.74
chemicals	61.42	61.42	39	61.42	61.42	61.42
maintenance	13.38	13.38	9	13.38	13.38	13.38
insurance	2.99	2.99	2	2.99	2.99	2.99
total cost	150.15	155.53	100	161.21	167.16	173.33

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies, sludge handling) are not included.
3. Cost of water is not the total cost, but only the cost of water treatment.

Table 3. (continued)

Option 1e: DAF/Filter System, 100% DAF, with increased chemicals, (with centrifuge)

year beginning year	2024 35	2025 36	2026 37to43	2033 44	2034 45to48	2038 49	2039 50to51	2041 52	2042 53	2043 54	2044 55to63	2053 64
output (Ml/day)	45	45	45	45	45	45	45	45	45	45	45	0
operating days/yr	360	360	360	360	360	360	360	360	360	360	360	0
filtration only (0%)	0	0	0	0	0	0	0	0	0	0	0	0
filtration and ClO2 (0%)	0	0	0	0	0	0	0	0	0	0	0	0
DAF (100%)	360	360	360	360	360	360	360	360	360	360	360	0
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
capital costs ($000's) *	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	20	0	2963	0	729	0	20	0	4531	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	120
operating costs												
labour	162	162	162	162	162	162	162	162	162	162	162	83
energy	174	174	174	174	174	174	174	174	174	174	174	0
chemicals	995	995	995	995	995	995	995	995	995	995	995	0
maintenance	217	217	217	217	217	217	217	217	217	217	217	0
insurance	49	49	49	49	49	49	49	47	47	47	47	0
total cost	1596	1616	1596	4559	1596	2325	1596	1615	1595	6126	1595	203

discount rate (%)
net pres. value total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Components of costs ($/Ml)
discount rate (%)
capital costs
replacement costs
decommisioning costs
labour
energy
chemicals
maintenance
insurance
total cost

Tab

Wai[illegible]nata Water Treatment Plant Value Analysis
Table of Costs and Discounted Cashflow
Option 2: Memtec Microfiltration system.

year beginning	1-Jul-90	1991	1992	1993	1994	1995	1996	1997	1998	2001	2002	2005	2006	2008	2009	2010	2013	2014	2017	2018	2021
year	1	2	3	4	5	6	7	8	9to11	12	13to15	16	17to18	19	20	21to23	24	25to27	28	29to31	32
output (Ml/day)	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
operating days/yr	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
filtration only (75%)	0	0	0	180	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
filtration with Alum(25%)	0	0	0	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
output (Ml/year)	0	0	0	10800	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
capital costs ($000's)	2173	9442	9442	3148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	0	0	0	0	2650	0	2650	0	2650	0	6065	2650	0	5151	0	2650	0	5151
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
operating costs																					
labour	0	0	0	108	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
energy	0	0	0	145	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217
chemicals	0	0	0	205	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307
maintenance	0	0	0	83	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
insurance	0	0	0	81	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121
total cost	2173	9442	9442	3769	932	932	932	3582	932	3582	932	3582	932	6997	3582	932	6083	932	3582	932	6083

* including building costs and civil works	1973
mechanical, electrical & control costs	22232
total capital costs	24205

discount rate (%)	6	7	8	9	10
npv total costs ($000)	46733	41607	37591	34380	31763
net present value output (Ml)	215548	181535	155194	134378	117625
Cost of Water ($/Ml) 3/	217	229	242	256	270

Components of costs ($/Ml) discount rate (%)	6	7	% (@7%)	8	9	10
capital costs	96.84	112.30	49	128.33	144.83	161.72
replacement costs	62.58	59.46	26	56.43	53.54	50.82
decommisioning costs	0.01	0.01	0	0.01	0.00	0.00
labour	10.01	10.01	4	10.00	10.00	10.00
energy	13.40	13.40	6	13.40	13.40	13.40
chemicals	18.95	18.95	8	18.95	18.95	18.95
maintenance	7.72	7.72	3	7.72	7.72	7.72
insurance	7.31	7.35	3	7.39	7.42	7.43
total cost	216.81	229.20	100	242.22	255.85	270.04

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies, sludge handling)are not included.
3. Cost of water is not the total cost, but only the cost of water treatment.

Option 2: Memtec Microfiltration system.

year beginning	2022	2023	2024	2025	2026	2029	2030	2033	2034	2037	2038	2039	2040	2041	2042	2045	2046	2049	2050	2053
year	33	34	35	36	37to39	40	41to43	44	45to47	48	49	50	51	52	53to55	56	57to59	60	61to63	64
output (Ml/day)	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	0
operating days/yr	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	0
filtration only (75%)	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	126	126	126	126	0
filtration with Alum(25%)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	144	144	144	144	0
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
capital costs ($000's)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	16286	0	2650	0	2650	0	5151	0	2650	6065	0	0	2650	0	2650	0	2650	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120
operating costs																				
labour	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162	83
energy	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	0
chemicals	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	307	0
maintenance	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	0
insurance	121	121	121	121	121	121	121	121	121	121	121	121	47	47	47	47	47	47	47	0
total cost	932	17218	932	3582	932	3582	932	6083	932	3582	6997	932	858	3508	858	3508	858	3508	858	203

discount rate (%)
npv total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Components of costs ($/Ml)
discount rate (%)
  capital costs
  replacement costs
  decommisioning costs
  labour
  energy
  chemicals
  maintenance
  insurance
  total cost

Table 5.

Wainuiomata Water Treatment Plant Value Analysis
Table of Costs and Discoun[illegible] Cashflow
Option 3: Sand Filter System.

year beginning year	1-Jul-90 1	1991 2	1992 3	1993 4	1994 5	1995 6	1996 7to11	2001 12	2002 13	2003 14	2004 15to18	2008 19	2009 20	2010 21to23	2013 24	2014 25to27	2017 28	2018 29to33	2023 34
output (Ml/day)	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
operating days/yr	0	0	0	240	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
filtration only (35%)	0	0	0	84	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126
filtration and ClO2 (40%)	0	0	0	96	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
DAF (25%)	0	0	0	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
output (Ml/year)	0	0	0	10800	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
capital costs ($000's) *	1294	3509	3509	1170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	0	0	0	0	0	0	0	0	1022	0	0	2951	0	0	0	2317
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
operating costs																			
labour	0	0	0	108	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
energy	0	0	0	91	138	138	138	138	138	138	138	138	138	138	138	138	138	138	138
chemicals	0	0	0	356	534	534	534	534	534	534	534	534	534	534	534	534	534	534	534
maintenance	0	0	0	141	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211
insurance	0	0	0	32	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
total cost	1294	3509	3509	1897	1093	1093	1093	1093	1093	1093	1093	2115	1093	1093	4044	1093	1093	1093	3410

* including building costs and civil works	3665
mechanical, electrical & control costs	5817
total capital costs	9482

discount rate (%)	6	7		8	9	10
net pres. value total costs ($000)	24625	21678		19385	17562	16082
net present value output (Ml)	215548	181535		155194	134378	117625
Cost of Water ($/Ml) 3/	114	119		125	131	137

Components of costs ($/Ml) discount rate (%)	6	7	% (@7%)	8	9	10
capital costs	38.12	44.24	37	50.60	57.15	63.86
replacement costs	8.66	7.72	6	6.87	6.10	5.42
decommisioning costs	0.01	0.01	0	0.01	0.00	0.00
labour	10.01	10.01	8	10.00	10.00	10.00
energy	8.51	8.51	7	8.51	8.51	8.51
chemicals	32.96	32.96	28	32.96	32.96	32.96
maintenance	13.03	13.03	11	13.03	13.03	13.03
insurance	2.93	2.93	2	2.93	2.93	2.93
total cost	114.24	119.41	100	124.91	130.69	136.73

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies, sludge handling) are not included.
3. Cost of water is not the total cost, but only the cost of water treatment.

Table 5. (continued)

Option 3: Sand Filter System.

Table 5 continued

year beginning	2024	2025	2026	2033	2034	2038	2039	2041	2042	2043	2044	2053
year	35	36	37to43	44	45to48	49	50to51	52	53	54	55to63	64
output (Ml/day)	45	45	45	45	45	45	45	45	45	45	45	0
operating days/yr	360	360	360	360	360	360	360	360	360	360	360	0
filtration only (35%)	126	126	126	126	126	126	126	126	126	126	126	0
filtration and ClO2 (40%)	144	144	144	144	144	144	144	144	144	144	144	0
DAF (25%)	90	90	90	90	90	90	90	90	90	90	90	0
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
capital costs ($000's) *	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	2951	0	1022	0	0	0	4531	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	120
operating costs												
labour	162	162	162	162	162	162	162	162	162	162	162	83
energy	138	138	138	138	138	138	138	138	138	138	138	0
chemicals	534	534	534	534	534	534	534	534	534	534	534	0
maintenance	211	211	211	211	211	211	211	211	211	211	211	0
insurance	47	47	47	47	47	47	47	47	47	47	47	0
total cost	1093	1093	1093	4044	1093	2115	1093	1092	1092	5623	1092	203

discount rate (%)
net pres. value total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Components of costs ($/Ml)
discount rate (%)
  capital costs
  replacement costs
  decommisioning costs
  labour
  energy
  chemicals
  maintenance
  insurance
  total cost

Table 6. **Wainuiomata Water Treatment Plant Value Analysis**

Summary of Treatment Costs ($/ Ml) (at 7% discount rate)

	DAF 25%	DAF 100%	Hi-Chemical	Memtec	Sand Filter
capital costs	45.35	45.35	45.35	112.30	44.24
replacement costs	11.64	11.64	11.64	59.46	7.72
decommisioning costs	0.01	0.01	0.01	0.01	0.01
labour	10.01	10.01	10.01	10.01	10.01
energy	8.52	10.74	10.74	13.40	8.51
chemicals	32.96	32.96	61.42	18.95	32.96
maintenance	13.38	13.38	13.38	7.72	13.03
insurance	2.99	2.99	2.99	7.35	2.93
total cost	124.86	127.08	155.53	229.20	119.41

Hi-Chemical is 100% DAF with increased chemicals.

Table 7. (continued)

Option 4: DAF/Filter System, 25% DAF, (with centrifuge) including power generation.

year beginning	2024	2025	2026	2033	2034	2038	2039	2041	2042	2043	2044	2053
year	35	36	37to43	44	45to48	49	50to51	52	53	54	55to63	64
output (Ml/day)	45	45	45	45	45	45	45	45	45	45	45	0
operating days/yr	360	360	360	360	360	360	360	360	360	360	360	0
filtration only (35%)	126	126	126	126	126	126	126	126	126	126	126	0
filtration and ClO2 (40%)	144	144	144	144	144	144	144	144	144	144	144	0
DAF (25%)	90	90	90	90	90	90	90	90	90	90	90	0
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
capital costs ($000's) *	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	50	0	2993	0	729	0	20	0	4531	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	120
operating costs												
labour	162	162	162	162	162	162	162	162	162	162	162	83
energy	138	138	138	138	138	138	138	138	138	138	138	0
chemicals	534	534	534	534	534	534	534	534	534	534	534	0
maintenance	229	229	229	229	229	229	229	229	229	229	229	0
insurance	50	50	50	50	50	50	50	47	47	47	47	0
electrical energy revenue	54	54	54	54	54	54	54	54	54	54	54	
total cost (less electrical revenu	1059	1109	1059	4052	1059	1788	1059	1076	1056	5587	1056	203

discount rate (%)
net pres. value total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Components of costs ($/Ml)
discount rate (%)
capital costs
replacement costs
decommisioning costs
labour
energy
chemicals
maintenance
insurance
electrical energy revenue
total cost (less electrical rev

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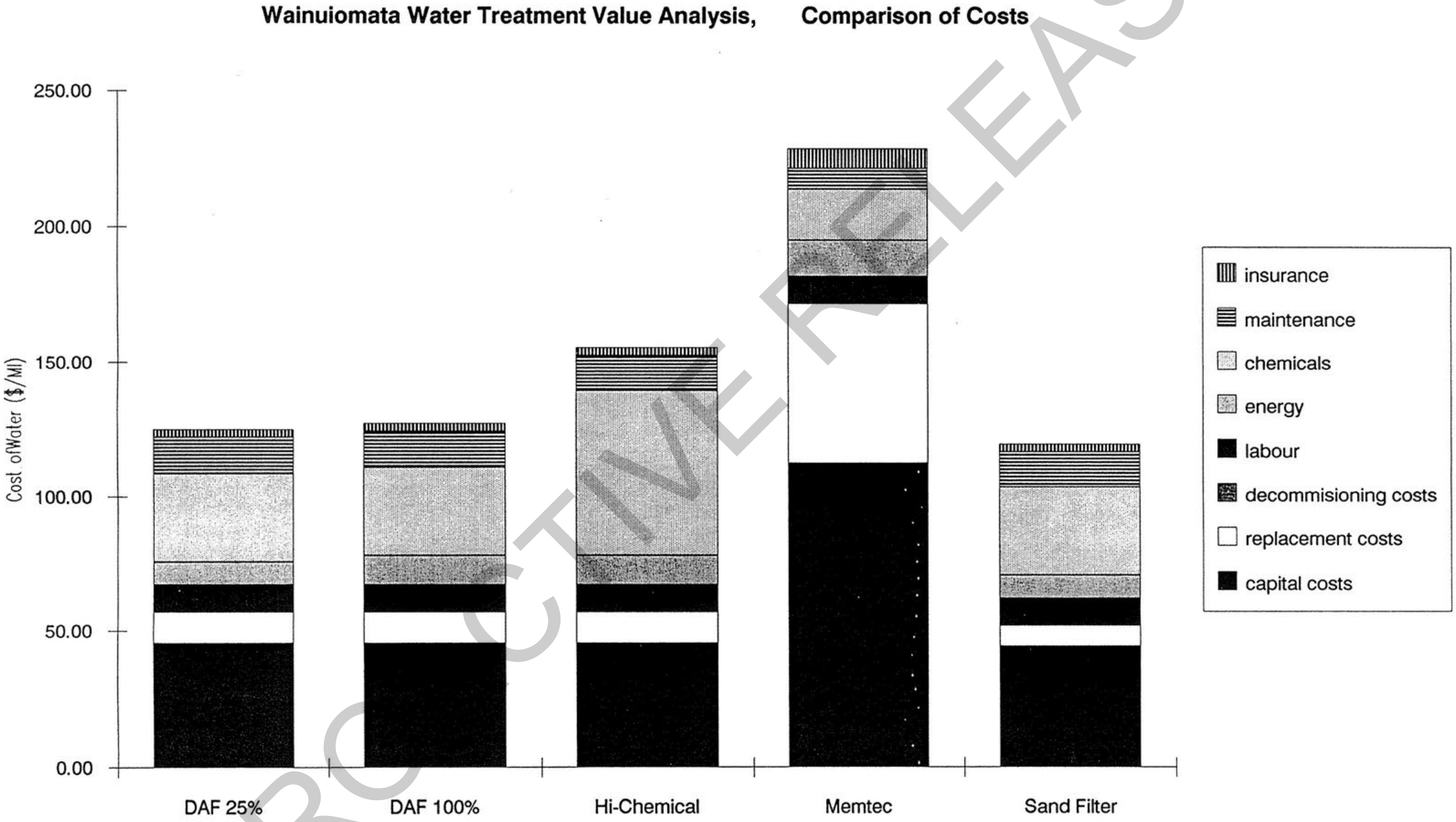
Wainuiomata Water Treatment Value Analysis, Comparison of Costs
Cost of Water ($/Ml)
250.00
200.00
150.00
100.00
50.00
0.00
DAF 25%
DAF 100%
Hi-Chemical
Memtec
Sand Filter
insurance
maintenance
chemicals
energy
labour
decommisioning costs
replacement costs
capital costs

Table 8 Wainuiomata Water Treatment Plant Value Analysis
Wainuiomata/ Orongrongo Water Su y Capital Costs
To Gear Island Pumping Station

Section	Type	Diameter mm	Year of Construction	Length(m)	Cost 1990 $	Cost 1991 $/m 1.03	Life Years	Depreciated Value in 1,991 $/m	Total Depreciated Value in 1,991 $	Replacement Cost in 1,991 $	Year for Replacement	Replacement Schedule	
												year	$
Orongorongo Supply													
Orongorongo Intake			1925		350,000		70		20,600	360,500	1995	1991	3,716,000
Intake Pipeline		525	1925	5,700		1,000	100	340	1,938,000	5,700,000	2025	1995	360,500
Orongorongo Tunnel			1925	3,250		3,700	200	2,479	8,056,750	12,025,000	2125	2025	18,980,000
WWTP to GIPS	Steel	525	1925	10,800		1,000	100	340	3,672,000	10,800,000	2025	2034	7,220,000
Total Orongorongo Supply									13,687,350	28,885,500		2040	66,950
												2060	370,800
Wainuiomata Supply												2078	1,100,000
Pipelines & Chambers			1990		690,000		100		710,700	710,700	2090	2091	722,000
Wainuiomata Intake			1990		250,000		70		257,500	257,500	2060	2090	710,700
George Creek Intake			1990		110,000		70		113,300	113,300	2060	2112	4,620,000
												2125	12,025,000
WWTP to Tunnel Gr.	C.I.conc line	750	1884	7,220		1,000	150	287	2,069,733	7,220,000	2034		49,891,950
	Steel	900	1925	900		1,000	100	340	306,000	900,000	2025		
Through tunnel	Steel	1,100	1925	1,210		1,000	100	340	411,400	1,210,000	2025		
Tunnel Grove to GIPS	Steel	1,050	1978	1,100		1,000	100	870	957,000	1,100,000	2078		
Hutt River		675	1925	370		1,000	100	340	125,800	370,000	2025		
				10,800									
Wainuiomata Tunnel			1912	1,100		4,200	200	2,541	2,795,100	4,620,000	2112		
Total Wainuiomata Supply									7,746,533	16,501,500			
Treatment Plant Site													
Road Widening			1990		65,000		50		66,950	66,950	2040		
Treated Water Resevoir			1991				100		722,000	722,000	2091		
Total Treatment Plant Site									788,950	788,950			
Total (excluding treatment plant)									22,222,833	46,175,950			
Treatment Plant													
Building Costs & Civil Works									0				
Mechanical, electrical & control costs									3,716,000				
Total Treatment Plant									3,716,000	3,716,000			
Total Wainuiomata/ Orongrongo Water Supply Capital Costs									25,938,833	49,891,950			

Assumptions

Lifetimes (years)

Pipelines	100
Tunnels	200
Intakes	70
Roads	50

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Table 9. Wainuiomata Water Treatment Plant Value Analysis
Table of Costs and Discounted Cashflow
WWTP.Total Water Supply System to GIPS

year beginning	1-Jul-90	1991	1992	1993	1994	1995	1996	2001	2002	2003	2004	2008	2009	2010	2013	2014	2017	2018
year	1	2	3	4	5	6	7to11	12	13	14	15to18	19	20	21to23	24	25to27	28	29to33
output (Ml/year)	0	0	0	10800	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
Treatment Plant																		
capital costs ($000's) *	1374	3759	3318	1253	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	0	0	0	0	0	0	0	20	0	1680	0	729	20	0	2963	0	20	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
operating costs																		
labour	0	0	0	108	162	162	162	162	162	162	162	162	162	162	162	162	162	162
energy	0	0	0	92	138	138	138	138	138	138	138	138	138	138	138	138	138	138
chemicals	0	0	0	356	534	534	534	534	534	534	534	534	534	534	534	534	534	534
maintenance	0	0	0	145	217	217	217	217	217	217	217	217	217	217	217	217	217	217
insurance	0	0	0	32	49	49	49	49	49	49	49	49	49	49	49	49	49	49
Outside Treatment Plant																		
tunnels, pipelines etc (Table 8)	0	22,223	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement	0	0	0	0	0	361	0	0	0	0	0	0	0	0	0	0	0	0
catchment contol	0	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
fluoridation ($7/Ml)	0	0	0	76	113	113	113	113	113	113	113	113	113	113	113	113	113	113
maintenance(2%)	0	444	444	444	444	444	444	444	444	444	444	444	444	444	444	444	444	444
insurance (0.5%)	0	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
total outside treatment plant	0	22,875	653	728	766	1,126	766	766	766	766	766	766	766	766	766	766	766	766
total cost	1,374	26,634	3,971	2,714	1,865	2,226	1,865	1,885	1,865	3,545	1,865	2,594	1,885	1,865	4,828	1,865	1,885	1,865

* including building costs and civil works	3716
mechanical, electrical & control costs	5988
total capital costs	9704

discount rate (%)	6	7	8	9	10
net pres. value total costs ($000)	59976	54084	49476	45792	42784
net present value output (Ml)	215548	181535	155194	134378	117625
Cost of Water ($/Ml) 3/	278	298	319	341	364

Table 9. (continued)

WWTP.Total Water Supply System to GIPS

year beginning	2023	2024	2025	2026	2033	2034	2038	2039	2040	2041	2042	2043	2044	2053
year	34	35	36	37to43	44	45to48	49	50	51	52	53	54	55to63	64
output (Ml/year)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200	0
Treatment Plant														
capital costs ($000's) *	0	0	0	0	0	0	0	0	0	0	0	0	0	0
replacement costs	3606	0	20	0	2963	0	729	0	0	20	0	4531	0	0
decommisioning costs	0	0	0	0	0	0	0	0	0	0	0	0	0	120
operating costs														
labour	162	162	162	162	162	162	162	162	162	162	162	162	162	83
energy	138	138	138	138	138	138	138	138	138	138	138	138	138	0
chemicals	534	534	534	534	534	534	534	534	534	534	534	534	534	0
maintenance	217	217	217	217	217	217	217	217	217	217	217	217	217	0
insurance	49	49	49	49	49	49	49	49	49	49	49	49	49	0
Outside Treatment Plant														
tunnels, pipelines etc (Table 8)	0	0	0	0	0		0	0	0	0	0	0	0	0
replacement	0	0	18,980	0	0	7,220	0	0	0	67	0	0	0	200
catchment contol	97	97	97	97	97	97	97	97	97	97	97	97	97	0
fluoridation ($7/Ml)	113	113	113	113	113	113	113	113	113	113	113	113	113	0
maintenance(2%)	444	444	444	444	444	444	444	444	444	444	444	444	444	
insurance (0.5%)	111	111	111	111	111	111	111	111	111	111	111	111	111	
total outside treatment plant	766	766	19,746	766	766	7,986	766	766	766	833	766	766	766	200
total cost	5,471	1,865	20,865	1,865	4,828	9,085	2,594	1,865	1,865	1,952	1,865	6,396	1,865	403

discount rate (%)
net pres. value total costs ($000)
net present value output (Ml)
Cost of Water ($/Ml) 3/

Wainuiomata Water Treatment Plant Value Analysis
Table of Costs and Discounted Cashflow
WWTP.Total Water Supply System to GIPS

Table 9. (continued)

Components of costs ($/Ml) discount rate (%)	6	7	% (@7%)	8	9	10
Treatment Plant						
capital costs	39.06	45.35	15	51.87	58.60	65.50
replacement costs	12.53	11.64	4	10.80	10.02	9.29
decommisioning costs	0.01	0.01	0	0.01	0.00	0.00
labour	10.01	10.01	3	10.00	10.00	10.00
energy	8.52	8.52	3	8.52	8.52	8.52
chemicals	32.96	32.96	11	32.96	32.96	32.96
maintenance	13.38	13.38	4	13.38	13.38	13.38
insurance	2.99	2.99	1	2.99	2.99	2.99
Outside Treatment Plant						
tunnels, pipelines etc (Table 8)	91.76	106.92	36	122.77	139.19	156.14
replacement & decommisioning	15.50	13.36	4	11.47	9.84	8.46
catchment contol	6.77	6.95	2	7.12	7.29	7.45
fluoridation ($7/Ml)	7.00	7.00	2	7.00	7.00	7.00
maintenance(2%)	31.03	31.84	11	32.63	33.39	34.15
insurance (0.5%)	7.76	7.96	3	8.16	8.35	8.54
total cost	278.25	297.93	100	318.80	340.77	363.74

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies, sludge are not included
3. Cost of water is the total cost, to Gear Island Pumping Station junction.

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Table 10.

Wainuiomata Water Treatment Plant Value Analysis
Gear Island Pumping Station
Table of Capital Costs

	Year of Construction	Cost in 1976	Cost in 1990	Cost in 1991 $'000	Life years	Depreciated Value 1991 $'000	year	Replacement Value $'000
index		4.2	1.03					
Capital costs ($000's)								
Wells	1976			114	50	80	2,026	114
Well Upper Casings	1976			27	30	14	2,006	27
Well screens	1976			27	20	7	1,996	27
Subtotal, Wells				168		100		168
Well pumps	1976			67	30	34	2,006	67
Pipeline fittings	1976	2		8	100	7	2,076	8
Controls	1976	11		46	10		1,986	46
Pipelines	1976		45	46	100	39	2,076	46
Pumps, Chemical & Control	1976		1,150	1,185	20	296	1,996	1,185
Building	1976		700	721	60	541	2,036	721
Site			200	200	infinite	200		200
Total capital costs ($000's)				2,441		1,217		2,441

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Table 11.

Wainuiomata Water Treatment Plant Value Analysis
Gear Island Pumping Station
Table of Costs and Discounted Cashflow

year beginning		1-Jul-90	1991	1992	1993	1994	1995	1999	2000	2004	2005	2009	2010	2014	2015
year		1	2	3	4	5	6to9	10	11to14	15	16to19	20	21to24	25	26to29
output (Ml/day)	days/year	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
output (Ml/year)	360	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188
capital costs(depreciated value) ($000's)															
Wells		80													
Well Upper Casings		14													
Well screens		7													
Subtotal, Wells		100													
Well pumps		34													
Pipeline fittings		7													
Controls															
Pipelines		39													
Pumps, Chemical & Control		296													
Building		541													
Site		200													
Total capital costs ($000's)		1,217													
replacement costs ($000's)															
Wells (50 yrs)										114					
Well Upper Casings(30 yrs)															
Well screens (20 yrs)						27								27	
Well pumps (20 yrs)						67								67	
Pipeline fittings (100 yrs)															
Controls (10 yrs)		46						46				46			
Pipelines (100 yrs)															
Pumps, Chemical & Control (20 yrs)						1,185								1,185	
Building (60 yrs)															
Total replacement costs		46				1,279		46		114		46		1,279	
decommisioning costs															
operating costs	$/Ml														
chemical, power & maintenance	45	53	53	53	53	53	53	53	53	53	53	53	53	53	53
insurance		6	6	6	6	6	6	6	6	6	6	6	6	6	6
Total operating costs		59	59	59	59	59	59	59	59	59	59	59	59	59	59
total cost		1322	59	59	59	1338	59	105	59	173	59	105	59	1338	59

Table 11. (continued)
Gear Island Pumping Station
Table of Costs and Discounted Cash

year beginning	2019	2020	2024	2025	2029	2030	2034	2035	2039	2040	2049	2050	2053
year	30	31to34	35	36to39	40	41to44	45	46to49	50	51to59	60	61to63	64
output (Ml/day)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
output (Ml/year)	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	1188	
capital costs(depreciated value) ($000's)													
Wells													
Well Upper Casings													
Well screens													
Subtotal, Wells													
Well pumps													
Pipeline fittings													
Controls													
Pipelines													
Pumps, Chemical & Control													
Building													
Site													
Total capital costs ($000's)													
replacement costs ($000's)													
Wells (50 yrs)			114										
Well Upper Casings(30 yrs)							27						
Well screens (20 yrs)							27						
Well pumps (20 yrs)							67						
Pipeline fittings (100 yrs)													
Controls (10 yrs)	46				46				46		46		
Pipelines (100 yrs)													
Pumps, Chemical & Control (20 yrs)							1,185						
Building (60 yrs)							721						
Total replacement costs	46		114		46		2,027		46		46		
decommisioning costs													50
operating costs													
chemical, power & maintenance	53	53	53	53	53	53	53	53	53	53	53	53	
insurance	6	6	6	6	6	6	6	6	6	6	6	6	
Total operating costs	59	59	59	59	59	59	59	59	59	59	59	59	
total cost	105	59	173	59	105	59	2086	59	105	59	105	59	50

Table 11. (continued)

Wainuiomata Water Treatment Plant Value Analysis
Gear Island Pumping Station
Table of Costs and Discounted Cashflow

discount rate (%)	6	7	8	9	10
net pres. value total costs ($000)	3671	3355	3106	2904	2737
net present value output (Ml)	19296	16732	14734	13142	11851
Cost of Water ($/Ml) 3/	190	201	211	221	231

Components of costs ($/Ml)

discount rate (%)	6	7	% (@7%)	8	9	10
capital costs	59.50	67.97	34	76.48	84.95	93.36
replacement costs ($000's)	81.01	82.82	41	84.58	86.29	87.92
decommisioning costs	0.06	0.04	0	0.02	0.02	0.01
chemical, power & maintenance	45.00	45.00	22	45.00	45.00	45.00
insurance	4.70	4.70	2	4.70	4.70	4.70
total cost	190.27	200.53	100	210.79	220.96	230.98

Note: 1.Refer separate document for plant limits and assumptions
2.Items within plant limits but common to all options (e.g. office supplies) are not included
3. Cost of water is to junction of GIPS with the Orongrongo-Karori main.

MORRISON COOPER LIMITED
19-Jul-91

B42/1/13

Hutt News
23/11/93

The Wainuiomata Chroni

Water plant finished within timetable and under budget

Wainuiomata's new water treatment plant, which cost $13.9 million to build, is delivering water of a markedly higher standard for the region.

The plant, off Moores Valley Road, was officially opened by the Chairman of the Wellington Regional Council, Stuart Macaskill, last Thursday. Design to finished construction took under two years.

The plant is able to supply 60 million litres of water per day. It uses the latest technology to treat water from the Orongorongo and Wainuiomata Rivers.

As well as supplying Wainuiomata and a significant part of Wellington City, the regional council wants this water supply to eventually fill Petone's pipes - an aim sections of the old borough is resisting.

The first stage of treatment is the removal of micro-organisms and dirt by a process called flocculation. A liquid coagulant chemical is added to the water. This binds the dirt and bacteria into small congealed blobs, which have the appearance of brown cotton wool, known as "flocs".

The water then enters flocculation chambers where the flocs are forced to the top by pressurised water being pumped through the chambers. The floating material is then removed. In order to get rid of any of floc left over, the water is filtered through a deep bed of sand.

After filtration, lime is added to reduce the water's acidity.

Less chlorine

A small quantity of chlorine is added to disinfect the water. (Chlorine is the chemical that tends to affect most the taste of drinking water).

The manager of technical services for the regional council, John Morrison, said the new system results in chlorine levels being two or three times less than under the previous system.

Fluoride levels, he said, remain unchanged.

" The fluoride is still being added by the same plant that has been operating since 1964."

The green and brown plant was designed by John McDougall of Kingston Morrison.

■ Cont. next page...

CLEARLY SUPERIOR: Wellington Regional Counci beaker of clear, clean water produced by the nev (background). The chairman, Stuart Macaskill, holds has stuck to dirt particles floating in itake water. On

Water plant

■ From p9

A spokesperson for the firm, Arthur O'Leary, said the architectural features which made the building attractive had added little to the overall cost of the project. The additional architectural costs were minimal. The architecture cost a fifth of the total cost. The additional architecture would be about five per cent of that cost."

He said their brief had been to blend the building in with the local environment. In the future it was planned to make it part of a Regional Park, he said.

Wainuiomata Chronicle

Hutt News
23/11/93

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The manager of technical services for the regional council, John Morrison, said the new system results in chlorine levels being two or three times less than under the previous system.

Fluoride levels, he said, remain unchanged.

" The fluoride is still being added by the same plant that has been operating since 1964."

The green and brown plant was designed by John McDougall of Kingston Morrison.

■ Cont. next page...

CLEARLY SUPERIOR: Wellington Regional Council deputy chairman Allison Lawson holds a beaker of clear, clean water produced by the new Wainuiomata Water Treatment Plant (background). The chairman, Stuart Macaskill, holds murky water where the flocculant agent has stuck to dirt particles floating in itake water. Once filtered, all trace of dirt is removed.

Water plant

■ From p9

A spokesperson for the firm, Arthur O'Leary, said the architectural features which made the building attractive had added little to the overall cost of the project. The additional architectural costs were minimal. The architecture cost a fifth

July 1994
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ceh\masters\strategy\strategym005-wwtp project statistics

Wainuiomata Water Treatment Plant
Project Statistics

1. General

The Wainuiomata Water Treatment Plant has a design capacity of 60 ML per day, supplying approximately 25 percent of the water provided by the Wellington Regional Council. The water is distributed to Wainuiomata, Ngaio, Central Wellington and the eastern and southern suburbs of Wellington City.

The treatment process involves Dissolved Air Floatation (DAF) over filters. It replaces the earlier system of straining, chlorination and fluoridation of surface water taken from run of the river intakes.

2. Principal Parties Involved

Owner/Operator:	Wellington Regional Council
Project Management/Value	Analysis:Kingston Morrison Ltd
Process Design and Installation:	PWT New Zealand Ltd
Structural Design:	Kingston Morrison Ltd
Treated Water Reservoir Construction:	G K Shaw Ltd
Treatment Plant Building Construction:	McKee Fehl Constructors Ltd
Washwater Recovery Plant Civil Construction:	Downer and Company Ltd

3. Project Programme

Project Start:	1990

F.

Design Report for DAF Treatment Plant:	1990-91
Value Analysis of Treatment Process:	1990-91
Process Design and Installation:	1991-93
Treated Water Reservoir Construction:	1991
Treatment Plant Building Construction:	1992
Washwater Recovery Plant Construction:	1992-93
Process Equipment Installation:	1993
Commissioning:	Mid-1993

4. Project Costs (Approximate)

	$ (m)
Site Works	0.6
Treated Water Reservoir	0.8
Buildings	4.0
Process Design and Equipment	5.8
External Pipework	1.0
Administration and Engineering Costs	1.4

Total	13.6

5. Water Source

Source: Wainuiomata and Orongorongo Rivers

Catchment: Native forest, restricted entry

Raw Water Quality: Generally coloured with low turbidity, low alkalinity and neutral pH

Turbidity Range:	0-150 NTU
Colour:	0-200 TCU
Alkalinity:	5-30 mg/L
Temperature:	4-18°C

6. Water Treatment Process

Process Train:

- Stabilisation with CO_2 and lime

- Coagulation with alum, poly-aluminium chloride (PAC) or ferric sulphate
- Hydraulic rapid mix
- Five flocculation/filter modules, each with a design capacity of 12 ML per day
- Polyelectrolyte dosed at inlet to flocculation basins
- Two stage flocculation with a retention of 20 minutes at full flow
- Dissolved Air Flotation (DAF) over filters with up to 10 percent recycled water.
- Deep bed rapid rate single media sand filters:

  Area - 43.5 m²
  Depth - 1.6 m
  Sand size - 1.2 to 2.4 mm
  Maximum filter rate - 3.6 mm per second

- Filter backwash, combined air and water with water upflow rate of 6.5 mm per second
- Final pH correction with lime
- Disinfection with chlorine gas
- Fluoridation with sodium silicofluoride powder

7. Washwater Recovery Plant

Process Train:

- Washwater settling with approximately two-thirds returned to the water treatment plant inlet and one-third to the sludge thickener
- Float (floc material removed by DAF) discharged into a balancing tank and fed to the sludge thickener
- Sludge thickener with maximum upflow rate of 1.45 m per hour
- Sludge dewatered in a centrifuge and disposed of at the municipal landfill

- All water is returned to the water treatment plant inlet

8. Process Control

Control Equipment: The water treatment plant is fully automated with Programmable Logic Controller control equipment (PLCs) for up to five day unattended operation. Two PLCs are arranged in hot standby mode to achieve a "bumpless" transfer in the event of a single PLC failure. The plant control system is provided by Horizon Technology Ltd.

9. Plant Operation

Attendants: The treatment plant is attended only during normal working hours with a workforce of six people.

Operating Costs: An annual operating cost of approximately $1 million is expected for chemical and power usage.

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TECHNICAL INFORMATION

Wainuiomata Water Treatment Plant

Key statistics

Plant flow: 16 ML/d to 60 ML/d, daily average flow 30 ML/d

Main treatment processes:

- Coarse Screening
- Coagulation/Flocculation
- Dissolved Air Flotation over Filters
- Chlorination
- pH adjustment
- Fluoridation

Treatment chemicals:

- Raw Water Dosing
  - Carbon Dioxide (CO_2)
  - Lime ($Ca(OH)_2$)
  - Polyaluminium Chloride (PACL)
  - Polyelectrolyte
- Treated Water Dosing
  - Lime ($Ca(OH)_2$)
  - Chlorine (Cl_2)
  - Fluoride (Na_2SiF_6)

Typical operating costs:

- Power: 0.8 cents/cubic metre
- Chemical: 3.5 cents/cubic metre
- Sludge disposal: 0.6 cents/cubic metre

20% of the Wellington urban region's treated water supply comes from Wainuiomata Water Treatment Plant

Raw water sources

Water for the treatment plant comes from the 7,600 ha Wainuiomata/Orongorongo Water Collection Area in the Rimutaka Ranges. The water is taken from five different rivers or streams. These are the:

- Wainuiomata River
- George Creek
- Orongorongo River
- Big Huia Creek
- Little Huia Creek

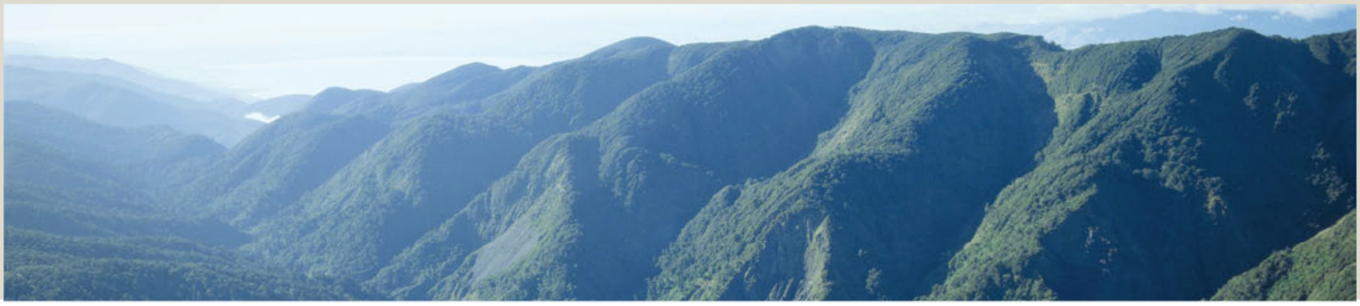
At each site the water flows over a weir, through bar screens measuring 15-20 mm (to remove large objects such as leaves and twigs), and into an intake pipe. From the Orongorongo catchment the water flows by gravity through a 5.6 km long pipeline to the treatment plant, and through a 1.4 km pipeline from the Wainuiomata River.

The Wainuiomata River and George Creek provide about 15% of the annual water supply for Wellington. The Orongorongo River, Big Huia Creek, and Little Huia Creek provide about another 5% of the supply.

As there is no means of storing raw river water at Wainuiomata, the treatment plant must be switched off temporarily if the water quality at the intakes deteriorates. Extra water is sourced from the artesian supply in the Hutt Valley to make up the shortfall.

Typical raw water quality

Colour:	5-50°Hazen, average 12°Hazen
DOC:	0.5-10 mg/L, average 2.5 mg/L
Turbidity:	0.1-5.0 NTU, average 1.0 NTU
pH:	7.2-7.6, average 7.3
E.coli:	0-250 cfu/100 mL, average 19 cfu/100 mL
Cryptosporidium:	0.7-5.9 oocysts/100 L, average 1.2 oocysts/100L
Giardia:	0.6-5.9 cysts/100 L, average 1.2 cysts/100L
Alkalinity:	10-30 mg/L as $CaCO_3$, average 16 mg/L as $CaCO_3$
Temperature:	3-18°C, average 9°C



Plant inlet

As water enters the plant, carbon dioxide (CO_2) and lime ($Ca(OH)_2$) are added to the raw water to achieve optimum pH and alkalinity for coagulation and flocculation. They also reduce the corrosiveness of the water.

Carbon dioxide gas is added at a rate proportional to the flow to give an optimum concentration set by the plant operators. The amount of lime added is also proportional to the flow. The lime is used to achieve a water pH of 6.7, with the pH being measured three times to ensure an accurate reading.

Typical dose:

CO_2:	5-30 mg/L, average 15 mg/L
($Ca(OH)_2$):	5-30 mg/L, average 15 mg/L

Inlet mixing chamber

The water then flows into the inlet mixing chamber where polyaluminium chloride (PACL) is added at the tip of the mixing blades inside the chamber. The PACL acts as a coagulant, causing small particles in the water to clump together forming flocs. Polyelectrolyte, which increases the strength of the flocs, is added after a delay of at least 13 minutes in a second mixing chamber.

Both the PACL and the polyelectrolyte are dispersed using mechanical mixers.

Polyaluminium chloride

The amount of PACL coagulant needed to treat the water depends on the raw water organic content and turbidity.

The pH and alkalinity of the raw water is adjusted prior to the addition of PACL so that the predominant mechanism of coagulation is charge neutralisation.

Typical dose:

Polyaluminium chloride (as PACL):
8-40 mg/L, average 12 mg/L

Polyaluminium chloride (as Al^{3+}):
1.3-6.0 mg/L, average 1.9 mg/L

Polyelectrolyte

The polyelectrolyte used is a cationic polymer which increases the strength of the flocs created during coagulation and flocculation. This increased strength prevents the flocs from breaking up during the flotation process and within the filter bed.

The amount of polyelectrolyte needed depends on the flow rate of raw water and the amount of PACL that has been added. The exact amount added is managed by the plant computer control system.

Typical dose:

Polyelectrolyte (as product):
0.05-0.15 mg/L, average 0.10 mg/L

Flocculation tanks

From the inlet mixing chamber the water is split into (up to) five different process streams via weirs in the inlet channel. There are two flocculation tanks in each process stream. Energy for flocculation is applied using paddle flocculators. The flocculation tank operating parameters are:

- Flocculator 1 Gt*: 22,000/s
- Flocculator 2 Gt*: 18,000/s
- Total Gt* for flocculation: 40,000/s

* The intensity of mixing required for optimal flocculation is measured by the "G" value. Combining the G value with flocculation time provides a Gt value.

Flocculation tanks

Float layer over filter

Dissolved Air Flotation over Filters (DAFF)

No. DAFF modules:	5
No. of saturators:	2
Recycle:	10-12%
Float-off mechanism:	Hydraulic or mechanical
Flotation area:	54.3 m^2
Hydraulic loading on flotation area:	10.1 m/hr at max plant flow (including recycle)
Typical float sludge solids concentration:	0.05% Hydraulic 0.3% Mechanical
Filter Area:	44 m^2
Media Type:	Mono media sand Sand depth: 1.6 m, 1.2-2.4 mm media size
Hydraulic loading of filter area:	12.5 m/hr max plant flow (including recycle)
Typical filter run time:	8-12 hours
Backwash regime:	Combined air and water backwash
▪ Air scour rate:	30 m/hr
▪ Backwash water rate:	950 m^3/hr, 34 m/hr
▪ Backwash duration:	18 minutes
▪ Backwash water volume:	3.6 bed volumes, 250 m^3

There are five Dissolved Air Flotation filters at the Wainuiomata Water Treatment Plant. Flotation and filtration occur in the same vessel.

Around 10-12% of the filtered water is recycled to the two saturators, where air is dissolved into the water at a pressure of around 550 kPa.

Water, now containing the flocs created from particles in the water reacting to the chemicals which have been added, enters the first section of the filter. The recycled water, saturated with air, is released through a manifold across the width of the tank. At this point, the air comes out of solution in the form of microbubbles, which attach to the flocs. The water-floc-microbubble mixture floats to the surface, guided by an inclined baffle, and into the second section of the filter. This DAFF process removes approx 90% of the floc particles.

The float layer (flocculated particles brought to the surface by the air bubbles) which forms on top of the filters is removed either hydraulically, by flooding the filter with discharge over a weir; or mechanically, by a tilting tray. The operator can choose which mechanism to use.

When either method is used, the interval between each float-off decreases as the amount of coagulant used increases. This is because more flocs are formed. During a hydraulic float-off operation the whole float is removed. The float-off interval can range between 2 and 4 hours. When the mechanical mechanism is used, the float removal is a more continuous process ranging from 1 to 4 minutes. Float from all of the filters is sent to the float balance tank.

Filter gallery

The subnatant (clean) water from the DAFF process flows downwards through the 1.6 m deep filter of mono media coarse sand (1.2-2.4 mm) into the underdrains.

The turbidity of each individual filter is monitored continuously and maintained below 0.1NTU to ensure they are operating effectively to remove protozoa. If the turbidity of an individual filter exceeds the limits which have been set, the filter becomes 'out of service' until it can be backwashed.

Backwashing

Because the filters remove flocculated particles, over time they become clogged and less effective. At this stage they must be backwashed to remove the flocs and 'clean' the sand.

Backwashing of the filters starts automatically if any of the following three events occurs:

- Turbidity spikes in the treated water
- Excessive run time or
- High bed headloss

The operators can also manually start a backwash of the filters.

When a filter backwash is required, the filter is taken offline until there is sufficient water in the washwater reservoir (backwash tank) and there is capacity in the washwater recovery plant for the dirty backwash water. Filters are washed on a first in/first out basis, however the operators can change the order in the queue.

The backwash involves both a combined air scour and water wash. Once the backwash is completed, the filter is half-filled with washwater and ready for operation again.

Clean wash water is pumped to the filters from the washwater reservoir.

Washwater Recovery

Washwater settling tank:	1 x 250 m^3
Float balance tank:	1 x 21 m^3
Thickener:	1 x 420 m^3
Supernatant tank:	1 x 250 m^3
Centrifuge:	1

Typical dried solids concentration:

Float:	Hydraulic 0.05% dried solids Mechanical 0.3% dried solids
Unsettled washwater:	0.05% dried solids
Settled washwater:	0.5% dried solids
Thickened sludge:	2.5% dried solids
Centrifuge sludge:	18% dried solids

Backwash water from the filters flows by gravity to the washwater settling tank where it is left to settle for an hour. Settled washwater sludge together with float from the float balance tank are transferred to the thickener where polymer is added to speed up the sedimentation process.

Settled sludge from the thickener is pumped to the centrifuge. More polymer is added to the sludge to strengthen the flocs so that they do not break apart in the centrifuge.

Centrifuge sludge is taken to the landfill, while the centrate is discharged into a dedicated sewer.

Supernatant from the washwater settling tank and the thickener, is stored in the supernatant tank before either being pumped back to the head of the plant or discharged to the river (under controlled conditions).

Treated water

Lime and chlorine are added to the filtered water in the outlet mixing chamber.

Lime

Lime is added to raise the water's pH and to reduce its corrosiveness. The water leaving the treatment plant generally has a slight tendency to dissolve calcium carbonate.

The amount of lime added is controlled by the flow and desired pH of the treated water. This is set by the operators but is usually around 7.8.

Typical Dose:
Lime: 2-10 mg/L, average 5.0 mg/L

The lime used at the plant contains some impurities which do not dissolve in the water. These could accumulate in the treatment plant and the water reticulation system. Therefore a grit chamber is provided after the outlet mixing chamber to collect the majority of these impurities before the water is sent to the treated water reservoir.

Chlorine

Chlorine gas is used to disinfect the filtered water.

The flow of chlorine is adjusted in proportion to the flow of treated water to achieve the required chlorine concentration when the water leaves the treated water reservoir. The chlorine dose is adjusted to produce a final concentration of approximately 0.6 mg/L.

The amount of chlorine in the water is monitored continuously. If the concentration exceeds predetermined limits the plant is 'slam shut' to protect the treated water supply.

Typical Dose:
Chlorine: 0.5-2.0 mg/L, average 0.8 mg/L

Fluoride

Fluoride is dosed after water leaves the treated water reservoir.

Fluoride is added to the water to provide dental health benefits to the consumer. The natural level of fluoride in the river water around Wellington is 0.1 mg/L. Following treatment this is increased to 0.7-1.0 mg/L as recommended by the Ministry of Health.

Sodium silicofluoride (Na_2SiF_6) is made into a slurry and added to the treated water. The fluoride is added at a rate proportional to the flow of treated water.

The concentration of fluoride is monitored to ensure that the required dosing range is maintained.

From the treated water reservoir, water flows by gravity to the water supply system.

Typical treated water quality

The quality of treated water from the Wainuiomata water treatment plant is very high, and exceeds all the standards set out by the Ministry of Health in the Drinking Water Standards for New Zealand 2005. This is reflected in the plant's attainment of the Ministry's A1 grading for the source and treatment management. The quality management system is certified to ISO 9001: 2000 while the environmental management system holds ISO 14001:2004 certification.

Treated water is monitored for turbidity, pH, and residual chlorine to ensure the standards are met. In addition, treated water is monitored continuously for organics, aluminium and alkalinity.

Typical characteristics:

Colour:	0.5-5°Hazen, average 2°Hazen
DOC:	0.1-1.0 mg/L, average 0.4 mg/L
Turbidity:	0.02-0.5 NTU, average 0.06 NTU
pH:	7.0-8.5, average 7.7
Chlorine Residual	0.5-1.0 mg/L, average 0.6 mg/L

Comparing typical mean values with popular brands of bottled water

Parameter	**Pump***	**Kiwi Blue***	**Wainuiomata**
Calcium (total), mg/L	2.7	2.2	**20**
Chloride, mg/L	5.0	6.4	**21**
Magnesium (total), mg/L	1.0	1.3	**2.0**
pH	6.5	5-7	**7.7**
Sodium (total), mg/L	7.8	8.3	**12**
Solids (total dissolved), mg/L	110	110	**115**

* Mean values derived from Nutritional Information supplied on product

Wainuiomata Water Treatment Plant

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Greater Wellington Water

Water Supply Asset Management Plan

November 2012

Quality for Life

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

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1. Executive summary

1.1 Overview

Greater Wellington Water (GWW), the name given to the water supply group within the Greater Wellington Regional Council (Greater Wellington), is the wholesale supplier of drinking water to four metropolitan city customers: Porirua city, Hutt city, Upper Hutt city and Wellington city.

The purpose of this Asset Management Plan is to ensure that water supply funding commitments are based on the best information available, so that the necessary assets are in place and maintained to provide a water supply to customers at the promised levels of service over the long term, at reasonable cost and in a sustainable and environmentally responsible way.

Asset management is important to Greater Wellington for a number of reasons. First, many of the services delivered by Greater Wellington rely on assets to support their delivery. Secondly, assets represent a significant investment by the community and that investment needs to be protected. Thirdly, asset failure can have significant social and economic effects on the community.

The stated purpose of GWW is to:

> *"Provide enough high-quality water each day to meet the reasonable needs of the people of greater Wellington, in a cost effective and environmentally responsible way"*

High-quality refers to both water quality and water quantity. The targeted supply is one which:

> *"Is sufficient to meet any drought condition except one that is equalled or exceeded once every 50 years on average, and meets all aspects of the Drinking Water Standards of NZ, including aesthetic requirements"*

GWW is the owner and manager of the wholesale water supply system under the Wellington Regional Water Board Act 1972. This Act, which is now administered by Greater Wellington Regional Council (Greater Wellington), brought together the wholesale water collection, treatment and distribution functions of the cities within the metropolitan Wellington area. It recognised that the critical wholesale water sources for the area are located within the boundaries of the cities of Hutt and Upper Hutt and allowed the available surface water catchments and aquifers to be utilised in the best way for the common good of all four cities. This Act also precludes any of the cities undertaking a wholesale water supply function without the approval of Greater Wellington. Generally the Act empowers Greater Wellington to provide wholesale drinking water for the community, to meet the community's public health needs.

1.2 Asset valuation

GWW owns and manages water supply assets with a replacement value of over $550 million. A breakdown of this valuation is provided in Table 1. More detailed asset valuation information is supplied in the section 9. A breakdown by location and asset type is given in Appendix 5.

1.3 Levels of service

GWW consistently meets its Level of Service (LOS) targets. The targets are the subject of consultation and are published in the Long Term Plan and Annual Plan. They are discussed in detail in Section 4.

1.4 Future demand

GWW utilises an advanced mathematical model to analyse growth in demand and the impact on the ability of the water supply system to continue to meet service levels.

The Sustainable Yield Model (SYM) is the strategic planning tool used to assess the capability of the wholesale water infrastructure to meet predicted demands. The modelling approach, including use of a 2% annual shortfall probability (ASP) reliability standard, was reviewed by MWH in 2010 through an international survey of water suppliers (refer

Table 1 High level asset valuation summary as at 30 June 2012

Asset type	Description	Book value ($) 2012	Replacement value ($) 2012
Water treatment plants	3 active water treatment plants and 1 standby water treatment plant (including associated buildings and fixtures)	$133,627,752	$234,440,436
Distribution pipelines	183km	$119,062,521	$249,570,406
Pump stations	18 pump stations	$8,840,561	$16,727,207
Water storage	Includes 2 raw water storage lakes, 4 treated water reservoirs and 2 distribution balancing storages	$47,450,901	$59,003,761
New Sources	Upper Hutt Aquifer	$91,660	$100,000
Total		$309,073,396	$559,841,811

#814200). It was found that the SYM modelling tool is a best practice methodology, and the 2% ASP standard (50-year return period) is a reasonable planning target.

The SYM indicates that a 2% ASP can be achieved for a Wellington urban population of approximately 414,000 (following completion of the Stuart Macaskill Lakes upgrade). Note that a shortfall is defined as the occurrence in any one year of at least one day when insufficient water is available to meet the modelled demand.

Based on the latest Statistics New Zealand population estimates, the urban population of the four cities is around 395,000 as at 30 June 2012.

Demand for water has been showing a downward trend since 2005/06. In 2011/12, GWW supplied 50,722 million litres (ML) of water, which is a 12% reduction in absolute terms compared with 57,911 ML supplied in 2005/6. The resident population has increased by around 5% during this period. The average daily water supply per person has shown an overall decrease of around 1% p.a. since around 1990. Per capita demand reduction has offset the effect of increasing population to date, however there are many contributing factors and there is no guarantee this trend will continue.

Demand will eventually outstrip supply capacity, and GWW is currently looking at various new water source options in preparation. These are explained in detail in the body of this plan.

1.5 Financial forecast

GWW recovers costs associated with provision of wholesale water services through a levy applied to the customer city councils. Capital expenditure is loan funded through application of new loans. The operating surplus/deficit each year is used to make additional debt repayments/withdrawals. Figure 1 shows the 10-year financial projection, giving operating and capital expenditure, total revenue and total debt.

1.6 Lifecycle management considerations

GWW assets are managed to meet required levels of service and minimise long term costs. Key considerations are a strong community expectation for a continuous supply of water, and the fact that many of our assets have 5-10 year development lead times and very long lives, of up to 100 years. For GWW, minimising lifecycle costs means:

- Maintaining a high level of competence with our planning and development work to ensure the right infrastructure is in place at the right time. This includes designs that provide the necessary backup and redundancy, and procurement practices that result in a high level of reliability
- Keeping operations and maintenance costs down by investing in new technologies, automation and maintenance planning
- Monitoring asset condition and performance and continually reviewing the need for renewal, replacement or upgrade
- Disposing of assets that are obsolete, under-utilised or uneconomic to operate

1.7 Asset management practises

GWW asset management practices are based on the guidelines contained in the International Infrastructure Management Manual (IIMM). Wholesale water supply is a high value, critical activity, and GWW seeks to achieve high intermediate to advanced scores across all functions (using the Treasury spreadsheet tool).

The quality of asset management practices implemented by GWW has consistently improved over time, with particular strengths in quality management (ISO 9001 and 14001 certification), demand forecasting and operational planning (assessed by independent review).

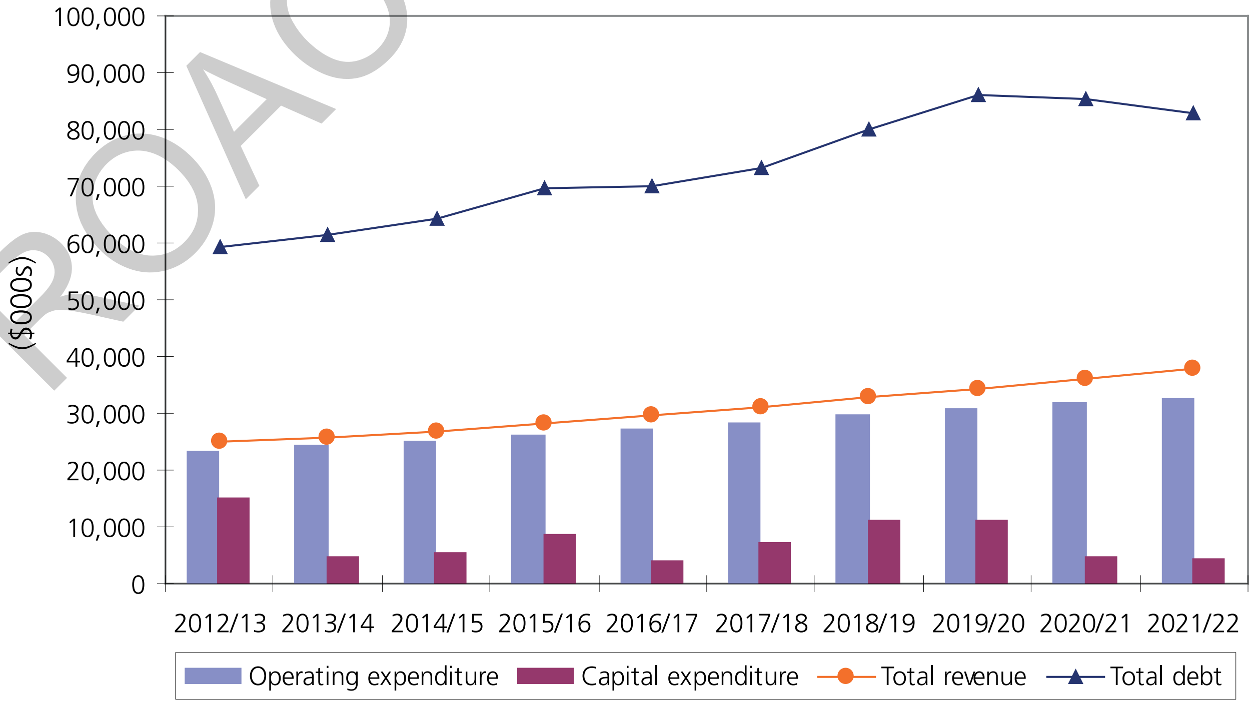


Figure 1: 10-year financial projections (#1063554)

The priority asset management improvements for the next three years are:

- Develop and implement an asset management policy
- Expand the capex programme to include detailed scope/estimates for 3 years plus major projects out to 10 years
- Implement continuous review of this asset management plan to support LTP and annual plan preparation
- Develop risk framework and strategy and establish an asset risk register, subject to regular monitoring and review
- Integrate SAP/GIS data and improve the accuracy of spatial data
- Improve customer engagement over level of service options and confirm service level agreement
- Review asset lives with updated condition/performance data and align SAP/AMP lives
- Continue development and implementation of condition assessment strategy and technical guidelines, tailored to asset criticality
- Establish asset criticality rating in asset register, and strategy for managing critical assets
- Develop renewal programme from condition assessment and asset lives review
- Develop standardised asset reports that support AM analysis
- Confirm the preferred next water source for development

2. Introduction

Asset management is important to Greater Wellington Regional Council (Greater Wellington) for a number of reasons. Firstly, many of the services delivered by Greater Wellington rely on assets to support their delivery. Secondly, assets represent a significant investment by the community that need to be carefully managed and adequately protected. Thirdly, asset failure can have significant social and economic effects on the community.

In light of the above, GWW implemented it's first asset management information system in 1997, and has been formally undertaking asset management planning since 1998.

The objective of asset management is:

> *"To meet an agreed level of service in the most cost-effective way (through the creation, operation, maintenance, renewal and disposal of assets) to provide for the reasonable needs of existing and future customers"*

The Asset Management Plan is a tool for combining management, financial, engineering and technical practices to ensure that the level of service required by customers is provided at the lowest long-term cost to the community. The plan is intended to demonstrate that Greater Wellington is managing the assets responsibly, provide the necessary information to allow funding commitments to be made on an informed basis with, and ensure that customers will be regularly consulted over the price/quality trade-offs resulting from alternative levels of service.

2.1 Asset management plan development and review process

Greater Wellington developed its first Water Supply asset management plan in 1998. It incorporated population projections published by Statistics NZ. In 2004, a revised Water Supply asset management plan was published.

The asset management plan was updated in 2008 to reflect the population projections and changes in asset renewals and new works forecasts, and the requirements of the Health (Drinking Water) Amendment Act 2007.

The process of developing the 2012 Asset Management Plan began in 2011. The main drivers for the update were:

- Changes in customer demand (ie, reduction in per capita demand)
- Improvements in modelling capability (eg, disaggregated demand model)
- The Health (Drinking Water) Amendment Act 2007
- The Local Government Amendment Act (2010)

A fundamental objective throughout the preparation (and future review) of this asset management plan will be to identify potential opportunities for reductions in asset lifecycle costs while meeting levels of service objectives.

2.2 Objectives of plan

The purpose of this Asset Management (AM) Plan is to provide information to support funding decisions that will put the necessary assets in place to provide the agreed levels of service to GWW customer authorities over the long term, at a reasonable cost and in an environmentally responsible way.

The plan sets out expectations for future growth, analyses legal and regulatory requirements and describes the environmental context. The plan also examines the current assets, explains their maintenance needs, and how they will provide the promised levels of service now and in the future.

The plan outlines proposed future capital works, and the reasons these works are considered necessary. These reasons include growth, potential failure to meet agreed levels of service, obsolescence, environmental considerations, security of supply or risk reduction.

The AM Plan provides input into the Long Term Plan (LTP) which, following consultation with the community, forms the basis of all GWW activity.

The Asset Management Plan provides clear linkages to the Annual Plan, LTP, and all other key planning documents.

Specifically, this plan does that by:

- Demonstrating responsible stewardship of water assets
- Identifying minimum lifecycle costs to provide an agreed level of service
- Improving understanding of service level standards and options
- Assisting with an integrated approach to asset management throughout the organisation
- Improving customer satisfaction and organisational image
- Managing the risk of failure to deliver the required level of service
- Supporting long term financial planning of the Council
- Clearly justifying forward works programmes
- Improving decision making based on costs and benefits of alternatives

The AM Plan has a planning horizon of approximately 40 years through to 2052, but with a closer focus on the first 10 years ending 2022.

2.3 Relationship with other plans and regulations

The 2012 GWW Water Supply Asset Management Plan is closely linked with the many of Greater Wellington's other plans as well as several of the other regulations. These are briefly explained below.

2.3.1 Long term plan

As required by the Local Government Amendment Act 2010, Greater Wellington produces a long-term plan (LTP) every three years. The plan contains information about our planned activities by service groups for the next 10 years and shows how these contribute to Greater Wellington's community outcomes. The process of defining these planned activities is firstly agreed through community consultation, then implementation is driven from the asset management plan, which details how we are going to manage our assets and water resources wisely to ensure we achieve service levels and allow for growth in population and demand. The asset management plan provides the data required to enable future planning for the management of our assets, eg, asset ages, conditions, replacement costs etc. This data is used for our forward planning in the LTP.

The regional wholesale water supply network, including storage lakes, treatment plants, pipelines and reservoirs is considered by GWW to be strategic assets as defined in the Local Government Act 2002. All Greater Wellington decisions relating to the transfer of ownership, control, construction, replacement or abandonment of strategic assets must be first included in the draft LTP for public consultation.

2.3.2 Legal framework

Statutory requirements have an impact on the manner in which GWW operates to meet its obligations to its stakeholders. GWW's operation is governed specifically by the requirements of the following legislations.

- Wellington Regional Water Board Act (WRWB) 1972
- Health and Safety in Employment Act 1992
- Health Act 1956 (and Water Supply Protection Regulations)
- Health (Drinking Water) Amendment Act 2007
- Resource Management Act 1991
- Local Government Acts 1974 and 2002
- Local Government Act 2002 Amendment Act 2010
- Council bylaws (Hutt city, Porirua city, Upper Hutt city, Wellington city and Wellington Regional Water Board)
- Various other laws, regulations and guidelines

The asset management plan must follow published guidelines and provide the means for meeting legislative requirements.

2.3.3 Compliance with resource consents

GWW currently has 87 resource consents covering abstraction of water from surface and underground sources, discharges to water, land and air and other aspects of the water supply operation. Compliance with the consent conditions is a requirement of the Resource Manaagement Act. GWW is certified under ISO 14001 Environmental Management Standard which assists in meeting and exceeding environmental compliance requirements.

2.3.4 Quality and environmental policies

GWW's quality policy is a statement of its commitment to meeting customer requirements with respect to the supply of water, providing a framework for the setting of objectives relating to the achievement of policy aims and for the continual improvement of our staff, infrastructure and systems.

The quality policy states:

Greater Wellington Water is committed to providing an adequate supply of high quality water to the customer territorial authorities at a cost comparable to that of other similar suppliers. Water treatment plants will achieve a grading of "A1" and distribution zones "a1", unless customer preferences preclude this. Environmental impacts will be kept to the minimum practicable level.

All water will be fluoridated unless a territorial authority specifically requests otherwise, the supply of unfluoridated water is practicable and all territorial authorities agree to the non-fluoridated supply.

The quality management system objectives are detailed in the GWW System Manual and progress is reported on an annual basis.

The environmental policy takes account of the environmental impacts of GWW activities and the environmental results the community and Greater Wellington have agreed on.

The environmental policy states:

GWW is committed to sustainable environmental management, consistent with the production of water at competitive rates. In demonstrating this commitment Greater Wellington Water undertakes to:

- *Comply with all relevant laws and any Standards to which Greater Wellington subscribes*
- *Evaluate the environmental effects and risks of all activities, and adopt all reasonable means, including consideration of alternatives, to avoid, remedy or mitigate these effects*
- *Prevent pollution of the environment. Wastes will be treated and disposed of in an environmentally safe manner. Where practicable, waste will be reduced through the use of alternative processes, reuse, recycling or conversion to by-products*
- *Recognise and operate within the natural limits of renewable resources, particularly water, and conserve non-renewable resources such as fuels, energy and materials*
- *Aim for no net loss of significant habitats or ecosystems*
- *Consider the environmental implications of business decisions*
- *Ensure that all staff members are aware of the importance of the environmental performance of GWW and of the environmental implications of the activities they undertake*
- *Specify the environmental requirements to be met by third parties engaged by GWW*
- *Where practicable, include consideration of environmental performance in the selection of contractors and suppliers*
- *Strive to continuously improve the environmental performance of GWW*
- *Make this environmental policy available to the public*
- *Review this policy and the supporting system regularly*
- *Report annually on the environmental performance of GWW*

All staff members have received a copy of the quality and environmental policies and it is the responsibility of managers and supervisors to ensure all staff understand and maintain the policy.

3. Business overview and activities

This section sets out the services provided by the water activity and an;

- Overview of the wholesale water supply network
- Organisational structure
- The rationale for Greater Wellington's involvement and ownership of assets
- The significant negative effects of the activity, and
- The significant changes in the activity since the last asset management plan

3.1 Overview of the wholesale water supply network

GWW is required by the WRWB Act to supply water to the constituent authorities as defined in the Act. Currently these constituent authorities are the cities of Wellington, Lower Hutt, Upper Hutt (all represented by Capacity Infrastructure Services Ltd), and Porirua. These four cities share the cost of GWW's operations in proportion to the amount of water they use, so they have a significant and vested interest in GWW activities. To date, the conditions under which water is supplied to these cities have been those broadly described in the WRWB Act. Regular consultation and liaison is undertaken with the constituent authorities and Capacity Infrastructure Services, and a good working relationship exists. The percentage of water supplied to each constituent authority in 2011/12 is shown in Figure 2.

In order to meet the water demand for the population living in the urban areas of the four territorial authorities; GWW sources water from six river intakes (surface water sources) and one ground water source (Waiwhetu aquifer). In addition, water abstracted from the Hutt River at Kaitoke intake and not required for treatment and distribution immediately is stored in the twin Stuart Macaskill Lakes at Te Marua. The lakes have a combined usable storage capacity of 2990 million litres (ML), which will increase to 3390 ML on completion of a project to seismically upgrade the lakes and increase their usable storage capacity.

There are three duty water treatment plants (WTPs) and one standby WTP processing water from these sources. Total water treatment capacity is 280 ML per day (ML/d). The distribution network consists of more than 180km of pipelines and 18 pump stations. A more detailed description of the water supply network is given below.

a. **Water sources:** GWW takes water from both surface water and groundwater sources.

- **Surface water sources** - There are six river intake points from three water collection areas for supply to the Te Marua and Wainuiomata Water Treatment Plants. The flow from the intakes to the treatment plants is by gravity. The three sources are:
  - The Hutt River at Kaitoke
  - The Wainuiomata River and its tributary George Creek
  - The Orongorongo River and its tributaries Big Huia Creek and Little Hui Creek

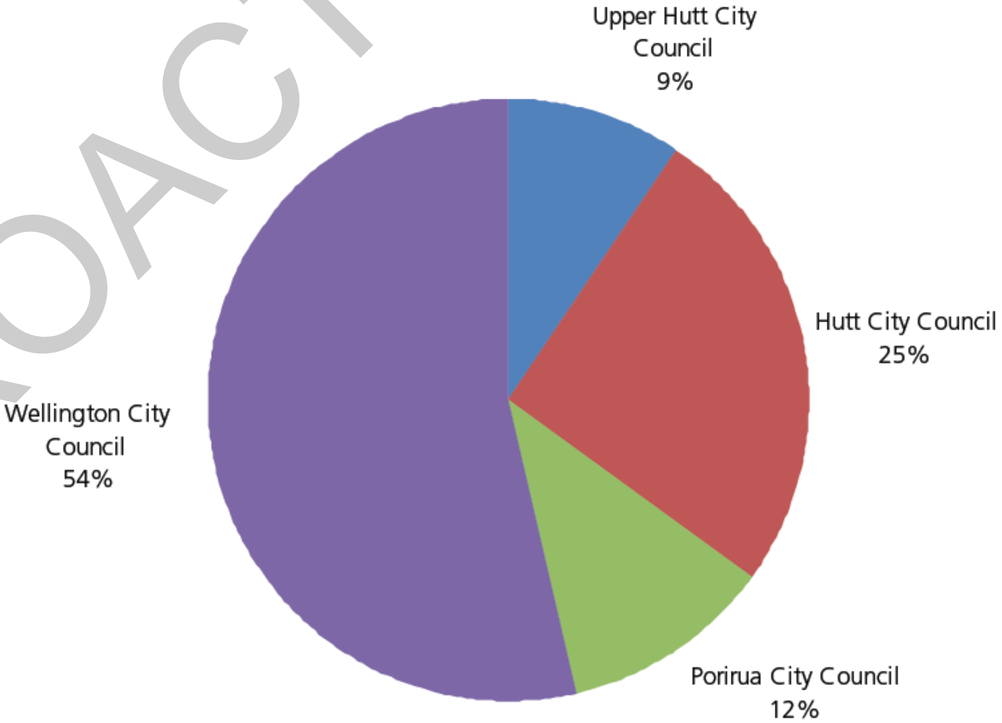


Figure 2: Water supplied by territorial authority for year ending 30 June 2012 (source #1015277)

All land upstream of the abstraction points is owned and managed by Greater Wellington. These forested catchment lands have been under the control of Greater Wellington or its predecessor authorities for many years, with active control of pest plants and animals strictly controlled public access. As a result, the quality of the water coming from these catchments is very high and the contamination risks are low.

- **Groundwater sources** - The Waiwhetu aquifer, which lies beneath the lower reaches of the Hutt Valley, is an extremely productive and very safe aquifer, which has been used for water supply for many years. Water is abstracted from it at two locations, Waterloo and Gear Island. Wells at these locations contain submersible pumps, screened casings, delivery pipework and valves. The Waiwhetu aquifer is monitored and actively managed by the Environmental Management group of Greater Wellington

b. Raw water storage lakes: Water from the Hutt River at Kaitoke is stored in the Stuart Macaskill (SM) Lakes at Te Marua. When water cannot be abstracted at the Hutt River due to its poor quality, or there is insufficient water to meet demand, water is taken from the Stuart Macaskill Lakes and pumped to the Te Marua Water Treatment Plant.

c. Water treatment plants: Water treatment plants at Wainuiomata and Te Marua treat river-sourced water. The treatment plants at Waterloo and Gear Island receive artesian aquifer water and rely on the secure groundwater status of the aquifer to provide a supply free of microbiological contamination. Wainuiomata, Te Marua and Waterloo are used as duty treatment plants and Gear Island is used as a standby treatment plant.

d. Distribution pipelines: Pipeline assets serve two functions, these being to deliver:

- Untreated raw water from the intakes and wellfields to the treatment plants
- Treated water from the treatment plants to the customer supply points

Pipeline assets include isolation valves, air valves, scour valves and bypass valves. Chamber structures of varying sizes house these valves. Branch pipelines of smaller diameter than the main trunk pipelines are used to deliver water from the trunk mains to supply points that are in most cases at the inlet of customers' reservoirs.

e. Tunnels: Topographical constraints and the need to avoid negative pressure in the pipelines has required pipelines to be installed in tunnels at several locations,, eg,, through the Wainuiomata Hill. There are two tunnels at Kaitoke that transport water directly (without the use of internal pipelines).

f. Pump stations: Pump stations serve several purposes:

- Deliver treated water from the treatment plants through trunk mains to reservoirs
- Boost flows or pressures on trunk mains
- Lift water from trunk mains to service reservoirs that are higher than the trunk line pressure
- Deliver raw water from the Stuart Macaskill Lakes to the Te Marua treatment plant
- Transfer water from one part of the distribution system to another (eg, between the Kaitoke and Wainuiomata trunk mains at Ngauranga)

g. Treated water reservoirs: Treated water is usually delivered to service reservoirs that are owned by the city council customers. The reservoirs that are owned by Greater Wellington have been constructed at treatment plants for process reasons, or connected to trunk mains as emergency storage or for balancing water demand. Treatment plant reservoirs at Te Marua, Wainuiomata, Gear Island and Waterloo are included with treatment plant assets.

h. Control systems, telemetry and flow meters: Treatment plants, pump stations, intakes and well fields all contain instrumentation and control equipment. These assets are included on the asset lists associated with the particular facilities. In addition, there is instrumentation for flow and level measurement and electrical control equipment at numerous locations on the distribution system. Usually the equipment will be associated with individual supply points and will be required to control the flow rate into, or level of customers' service reservoirs. Flow meters at supply points are used to measure water quantities delivered for calculation of the water levy to be charged to each city. Communication between supply points, treatment plants and pump stations is achieved using telemetry equipment.

i. Access-way assets: The principal roads that are owned by Greater Wellington have been constructed and maintained to allow access to treatment plants and into the catchment areas beyond the treatment plants. Access roads to treatment plants are sealed, while roads into the catchment areas are generally unsealed. Good drainage is recognised as important to protect these road assets. The treatment plants incorporate car parking facilities and truck manoeuvring areas for chemical delivery trucks.

A schematic plan of the GWW's wholesale water supply network is shown in Figure 3.

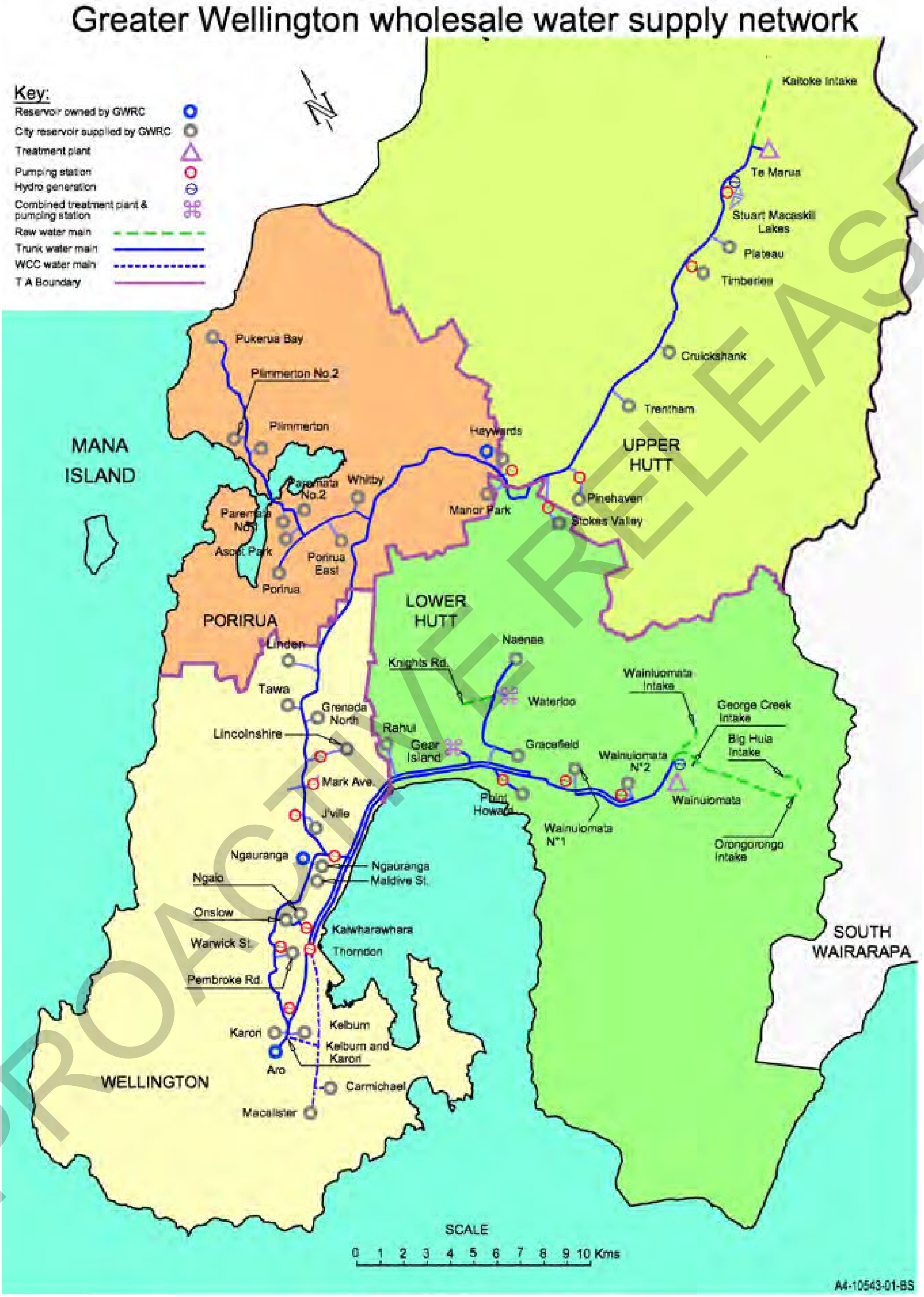


Figure 3: Greater Wellington wholesale water supply network (source #1001990)

3.2 Organisational structure

The management structure for GWW is shown in Figure 4.

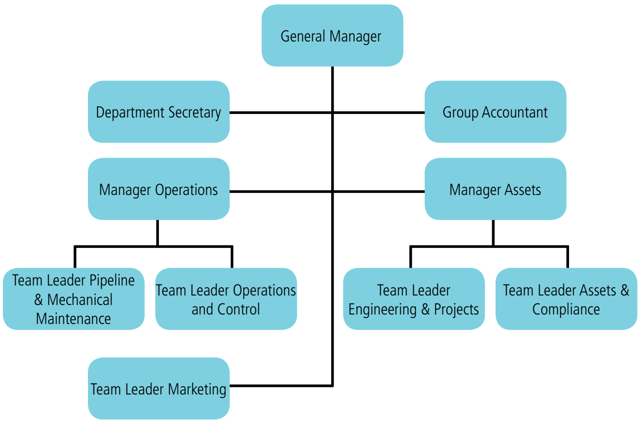


Figure 4: GWW management structure

There are around 55 staff working for GWW across five Teams. Their duties are briefly explained below.

- Assets and Compliance team - Looks after asset management, quality & environmental management, resource consent compliance and health and safety management
- Engineering and Projects team – Carries out capital works projects and provides engineering services
- Operations and Controls team - Operates treatment plants, the distribution system, the Water Supply ICT network, system automation, telemetry and instrumentation
- Pipeline and Mechanical Maintenance team – Manages pipeline and plant/equipment maintenance, repairs and installations
- Marketing Team – Manages public information and reporting events and water conservation promotions

3.3 Rationale for Greater Wellington involvement

Greater Wellington's role in providing wholesale drinking water services is governed by the Wellington Regional Water Board act 1972. The Wellington Regional Water Board was formed in 1972 from the amalgamation of the Hutt River Board, Hutt Valley Underground Water Authority, and Wellington City and Suburban Water-supply Board. The role of the Wellington Regional Water Board was transferred to the Wellington Regional Council (now known as Greater Wellington) when it was established in 1980.

3.4 Significant effects of the water supply activity

Significant effects of the water supply activity are summarised in Table 2.

3.5 Key issues for activity

There are several key issues that GWW is facing when trying to carry out its activities. These issues can be summarised as below:

3.5.1 Security of supply

Currently, GWW is able to meet a its target for annual probability of water shortfall, being less than 2%. Planning for new infrastructure started around 2005, when population projections were revised upwards by Statistics New Zealand.

Unless more water sources are developed or demand reduced, GWW will eventually be unable to meet the 2% security of supply standard. A number of supply side capital projects are proposed to maintain the 2% probability of shortfall and provide for future growth.

3.5.2 Water conservation

Water use efficiency and conservation initiatives contribute towards achieving two of the three strategic community outcomes identified by Greater Wellington for its Water Supply operation: **a strong**

Table 2: Summary of significant effects of the Water Supply activity

Wellbeing	Positive effects	Negative effects	Mitigation measures adopted by GWW
Environmental	Reduced net power consumption through hydro generation	River and aquifer abstraction results in reduced flows in Hutt, Orongorongo and Wainuiomata rivers Associated impacts of energy and chemicals used in water treatment and distribution Discharge of water treatment waste products	By complying with resource consent conditions and maintaining ISO 14001 accreditation; GWW is making sure that the Environmental impacts are kept to a minimum GWW has adapted various measures on energy and chemical use optimisation Environmentally friendly disposal of waste products
Social	Provide safe, clean drinking water to nearly 400,000 people	Contribution to consumer attitude that water supply is abundant and should come at negligible cost	GWW maintains an active marketing campaign during the summer months to promote the benefits of minimising water consumption, and provide relevant and timely information about potential water shortages
Financial	Enhance economic activity through provision of water supply to large industrial customers	Cost of wholesale water supply activity of the order $25m p.a.	GWW seeks to minimise operational costs by continually improving processes and productivity through a ISO9001 accredited quality system
Cultural		Impact of water abstraction on cultural values	Consultation with relevant stakeholders prior to application for resource consents

regional economy supported by a secure and reliable water supply; and a **healthy environment** supported by wise use of water to reduce related environmental impacts.

The water supply system for the region's four cities is primarily 'run of river': it relies on river flows, backed up by an aquifer source and some lake storage. Available water and production and distribution capacities easily exceed water use for most of each year. However, dry spring and summer conditions can raise potentially serious water shortage concerns. In such years, storage can be depleted rapidly, as demand for water tends to reach more extreme peaks due to the same set of climate conditions that restrict supply. This extra demand during spring and summer – as much as 65 ML/day on 'peak' days – arises mainly from discretionary outdoor water use, particularly for garden watering, on top of indoor water use.

Greater Wellington plans its Water Supply infrastructure needs to meet the maximum anticipated peaks in demand. GWW's water use efficiency and conservation activity can provide a significant benefit to the community by meeting all reasonable demand for water while deferring the need for capital investment. Encouraging consumers to use water efficiently helps maximise the use of our existing wholesale water supply infrastructure and water-take consents.

GWW uses a variety of methods and tools to promote water use efficiency and conservation, including analysis of system flow data, educational resources, proactive communications and a drought response plan (see Section 5.6). We promote the responsible use of water, particularly during late spring and summer, with activities coordinated with our customers.

In 2000, population projections indicated that the wholesale water supply system would meet our 'security of supply' standard until 2020. However, relatively high population projections in 2005 resulted in the modelled timing for reaching our maximum acceptable shortfall probability shortening considerably, to as early as 2007. Subsequent discussions with our customers, about long-term supply-side solutions and their related costs, have seen representations from all customers endorsing greater emphasis on cost-effective demand-side measures as a priority, to defer system expansion. Significant progress has been made by the customers, especially in the area of leak detection and repair. GWW is working with its customers to explore and develop a coordinated response to this position.

In the late 1980s, gross water use 'per resident' averaged over 500 litres per day (L/d). Ten years ago (2003), that figure had reduced to 450 L/d. For the year to June 2012, the equivalent figure was 351 L/d. Importantly, average summer and peak week water use each show a steadily declining trend over the last decade.

In 2009, Greater Wellington adopted a target to reduce water supply per resident by a minimum of 10% over 10 years, from a base of 400 litres per head per day. To date, this target has been exceeded comfortably, although it should be noted that the figure of 351 L/d for 2011/12 was affected by poor summer weather conditions and an abnormally high conservation campaign associated with upgrade work on the Stuart Macaskill lakes.

3.5.3 Water quality standards

The availability of safe drinking water is a fundamental requirement for public health and sustainable communities. We aim to provide water that is safe, pleasant to drink, does not degrade household plumbing or water distribution pipelines and is acceptable for general use by industry.

We are governed by the Health (Drinking Water) Amendment Act 2007. Water quality requirements are set out in *Drinking Water Standards for NZ 2005 (Revised 2008)*. In addition, the Ministry of Health's *Grading systems for community drinking water supplies* is used as a tool for assessing the quality and risk profile of the water supply – how safe it is to drink and the risk of contamination. We target an A1-grade quality standard for our water treatment plants and distribution system, where this is compatible with customer requirements.

The Te Marua, Wainuiomata and Gear Island water treatment plants are currently graded A1 and the wholesale water distribution system is graded a1. These are the highest gradings achievable from the Ministry of Health. Waterloo water treatment plant is graded B because of Hutt City's requirement for non-chlorinated water. A secure groundwater source supplies water to the Waterloo plant, so disinfection is not required to comply with the drinking-water standards.

3.5.4 Energy management

Approximately 75% of Greater Wellington's carbon footprint is from energy uses in water treatment and distribution, and electrical energy is an ever-increasing proportion of the operating costs for water supply.

Both the cost and environmental issues need to be addressed. For this reason, a number of mini hydrogenation projects, that were previously uneconomic, are now being reviewed and, in some cases, implemented. Hydrogenation schemes have already been installed at Wainuiomata and Te Marua. Other renewable sources will be investigated for part of the remaining power needs.

The cost of pumping is the single largest component of our power bill. We have an active pump performance testing programme using the most accurate thermodynamic testing equipment available. The results of the testing drives refurbishment work that is justified on a payback basis.

Efficient power management and power purchasing is also implemented with the aid of the latest technology. Software packages such as Energy Pro help GWW to understand power use trends and to manage the energy cost in the most efficient way. All sites consuming significant quantities of power are on a spot market supply contract with a hedge agreement in place for risk mitigation. GWW is also aided by the state of the art Aquadapt optimiser software package, which determines the optimal supply balance from our different sources and schedules pumping to make best use of off-peak power.

3.5.5 Controlling costs and the wholesale water levy

The cost of purchasing materials and supplies is constantly rising, so continuing to find ways to reduce costs and prevent a rise in the wholesale water levy is a challenge. The levy has decreased twice and increased once in the past 10 years. Overall efficiency gains and reduced debt servicing have contributed to keeping the levy down.

3.5.6 Sustainability

Greater Wellington owns and manages a significant base of water supply assets. We have a responsibility to manage these assets so that we can sustainably provide our services to current and future generations. We do this by:

- Being cost effective, including managing assets to optimise the return on the public's investment
- Meeting all relevant environmental and health and safety standards
- Managing water catchment areas to ensure that they are not compromised by pests, disease or inappropriate use
- Managing the Waiwhetu aquifer to ensure it remains a viable source of safe water in the long term by ensuring it is not contaminated by salt water intrusion or the infiltration of surface contaminants

4. Levels of service

This section defines the levels of service that GWW intends to deliver and the measures used to monitor this. The levels of service support Greater Wellington's strategic goals and are based on user expectations and statutory requirements.

The term 'Level of Service' refers to the standard to which a service is delivered to the customer. This may include targets for availability, quality, quantity, responsiveness and customer satisfaction. Greater Wellington ensures that levels of service are customer-focused, technically meaningful and address the issues that are important to the community.

The adopted levels of service for the delivery of wholesale water reflect current industry standards and are based on:

Customer expectations – Information gained from customers on expected quality and price of services.

Community outcomes – Guidelines for the scope of current and future services offered, the manner of service delivery and specific levels of service which the organisation wishes to achieve.

Statutory requirements – Environmental standards, regulations, Acts of Parliament and council by-laws that impact on the way assets are managed (ie,: resource consents, building regulations, health and safety legislation). These requirements set the minimum level of service that must be provided.

The level of service for water supply activity is the agreed quality of service that Greater Wellington has established through community consultation. The process for the development and monitoring of levels of service can be summarised as follows:

- Identifying key stakeholders and their requirements
- Designing and carrying out consultation to define the desired service level
- Defining the current levels of service the organisation delivers
- Establish service targets and review service achieved over a long period
- Measure and report to community on level of service achieved

GWW carries out reviews of the levels of service with stakeholders at regular intervals to check desirability and affordability of level of service provided.

The asset management plan aims to document each of these steps for the activity, identify any issues such as adequacy of consultation, suitability of standards, or service gaps, and describe plans to address or improve them.

It is common for customers and stakeholders to demand a continual improvement in service, and while Greater Wellington will strive to deliver improvements, the level of service is constrained by cost considerations. It is therefore important that when Greater Wellington consults with the community over levels of service, cost information is provided in order for the price/quality trade-off to be established. The main mechanism for consultation on levels of service is via statutory long term plans.

4.1 Identifying key stakeholders and their requirements

Stakeholders have an interest in the services provided by GWW. The LGA 2010 provides that in its decision-making GWW will consider the views of not only those affected by the outcomes of the decision but also who might have an interest in the decision being made. The stakeholder group for GWW can therefore be seen to be a much wider group than its four customers.

At the moment, the key stakeholders and their requirements have been identified as:

- Water consumers
- Greater Wellington's Environment group
- Local network operators
- Central government and central government agencies
- Public health authorities
- Cultural and community groups

4.1.1 Water consumers

Water consumers are those residents living within the urban areas of the Wellington, Porirua, Hutt and Upper Hutt City Councils. These residents receive water from the public water supply and are the end consumers of water supplied by Greater Wellington Water. However, these people are considered by GWW and by the constituent authorities to be the customers of the city councils who operate the local retail networks. GWW does not have a direct relationship with these consumers. The total population supplied by the Territorial Authorities' is approximately 395,000 people.

The customer expectations in the context of GWW are those of the four city councils supplied.

In general these can be summarised as:

- Quality: Water that is fit for drinking and meets the Ministry of Health Standards
- Quantity: Sufficient volume and pressure to meet end user needs now and into the future. This also includes reliability, with supply disruptions kept to a minimum
- Affordability: Price for water is reasonable and levies are kept to a minimum

4.1.2 Greater Wellington's Environment group

Greater Wellington's Environment group acts as the environmental administrator and regulator for the region. As part of this role Greater Wellington monitors the environment, researches natural resources and issues resource consents for the use of these resources, and for discharges into the environment. The primary issue dealt with by Environment group staff is the granting of resource consents to GWW to take water from the various sources, and the monitoring of the conditions imposed in granting those consents. They also issue discharge consents for the various minor discharges from the treatment plants and distribution network. GWW staff work closely with Resource Investigation staff, particularly on issues like establishing safe, sustainable management practices for the Waiwhetu aquifer.

GWW takes its environmental responsibilities very seriously, and works at maintaining a good working relationship with Environment group staff by meeting all conditions imposed by consents, and reporting promptly, fully and honestly.

4.1.3 Local network operators

Capacity Infrastructure Ltd (CIL) is a council-controlled organisation that is responsible for retail water-network management in the areas of Wellington, Lower Hutt and Upper Hutt, on behalf of the Wellington, Hutt and Upper Hutt city councils. The Porirua City Council is responsible for retail water network management within Porirua. GWW considers the four city councils and CIL as key stakeholders, and good working relationships are maintained with them.

4.1.4 Central government and central government agencies

Central government and its agencies is also a key stakeholder in GWW's water supply activities. GWW deals with various government agencies on a regular basis. These include, Statistics New Zealand, Inland Revenue Department, Ministry of Health, Ministry of Local Government, Controller and Auditor General.

4.1.5 Public health authorities

The Regional Public Health section of the Hutt Valley District Health Board (HVDHB) carries out public health monitoring in the region under contract to the government, and on behalf of other district health boards within the region. Part of their responsibility is to monitor public water supplies. This involves assessing annual compliance (with the drinking water standards), grading assessments and involvement in any incidents of public health significance that might arise. A good working relationship is maintained with HVDHB staff, and information is supplied to them promptly and in a form that makes the discharge of their responsibilities as easy as possible.

4.1.6 Cultural and community groups

GWW deals with various cultural and community groups such as local iwi, environmental groups, specific interest groups, etc. These community groups are treated as important stakeholders and their opinions and views are taken onboard by GWW.

The tangata whenua iwi (tribes) which represent the interests within Hutt Valley, Wellington and Porirua are:

- Ngati Toa Rangatira (represented by Te Runanga o Toa Rangatira Inc).
- Te Atiawa/Taranaki ki te Upoko o te Ika a Maui (represented by the Wellington Tenths Trust (Nga Tekau o Poneke) and Te Runanganui o Taranaki Whanui ki te Upoko o te Ika a Maui Inc).

4.2 Design and consultation to define the desired service level

GWW has identified the key areas that define the purpose of the business. These high-level business objectives form the basis of our levels of service (LOS). Public consultation on our proposed levels of service is achieved through development of Greater Wellington's long term plans. We also have more detailed annual performance targets (APTs) that have been developed over many years in consultation with our customers.

The following points are a summary of our high-level business objectives:

1. **Ensuring we have a secure water supply**
   As an essential service, it is important to have a secure water supply system that is resilient to damage from hazards, both natural and man-made, and able to be reinstated quickly should any serious damage occur. This means that we have to build redundancy into the system and be prepared for emergencies, to minimise the impact on levels of service.
2. **Providing safe, high-quality water**
   The provision of safe drinking water is a primary objective of GWW. Acute and long-term health effects can be caused by microbiological organisms or chemical compounds in drinking water and therefore the availability of safe drinking water is a fundamental requirement for public health.
   In addition to being safe, high quality water should be pleasant to drink, not degrade water distribution pipelines or household plumbing, and be acceptable for general use by industry. There are numerous critical activities that must be completed to ensure consistent water quality. These activities need to be systematically controlled and monitored. We use a quality assurance system consistent with the international quality management standard ISO 9001 for this purpose.
3. **Meeting current and future demand**
   GWW is committed to providing sufficient water to meet the daily demand of its customers now and into the future. Our aim is to have a very low risk of water shortage, and so we plan for future needs of the region by projecting population growth, forecasting water demand and providing the infrastructure required to maintain the agreed security of supply standard.
4. **Minimising impact on the environment**
   We are aware that use of natural resources often results in trade-offs between the environment and the needs of the community. GWW aims to minimise impact on the environment wherever possible, and ensure that decisions are made on an informed basis. We maintain the highest standards possible through ISO 14001 certification of our environmental management system.
5. **Being cost effective**
   GWW owns and manages over $300 million dollars worth of public assets that contribute to the community's needs. It is our responsibility to manage these assets so that we can continue to provide our services for current and future generations.
   With limited resources and competing objectives we need to make sure that our resources are applied to where the most value can be gained. Since value can be subjective, we also need to be clear about what we consider to be valuable and how this relates to achieving our objectives. Some of our assets last over a hundred years, so

being cost-effective means we need to optimise our operational performance, as well as design and build infrastructure that minimises lifecycle costs.

6. **Maintaining a safe, healthy and productive workforce**
As a responsible employer, GWW takes all practicable steps to minimise harm to our employees as required by the Health and Safety in Employment Act 1992. We manage risks associated with our operations through our health and safety management system. We also recognise that our service delivery is enhanced through having an engaged and productive workforce.
7. **Meeting the expectations of our stakeholders**
Our reputation as a provider of safe high-quality water and effective asset manager is critical to maintaining credibility with our stakeholders. There are a number of organisations that have a legitimate interest in, can be affected by, or can impact on, the activities of GWW. To achieve sustainable relationships we must understand the varying perspectives and priorities of these stakeholders in order to give due regard to their interests in our decision making processes.

4.3 Define the current levels of service the organisation delivers

GWW's levels of service were last updated during the preparation of Greater Wellington's Long-Term Plan 2012-22 (LTP) and is defined in Table 3. The baseline represents what was achieved during Greater Wellington's 2010/11 financial year and the targeted goals for the future are summarised in the table. GWW is committed to achieve or exceed these goals. The links between LOS performance measures, business objectives and our detailed APTs is shown in Appendix 1.

4.4 Measure and report to community on level of service achieved

Performance against long-term plan performance measures is provided in Greater Wellington's annual report. Performance against our detailed APTs is provided every year in the Water Supply annual report.

Table 3: Levels of service and performance measures

		Performance targets				
Level of service	**Performance measure**	**Baseline**	**2012/13**	**2013/14**	**2014/15**	**2015-22**
Provide water that is safe and pleasant to drink	1. Number of waterborne disease outbreaks	0 (2010/11)	0	0	0	0
	2. Number of taste complaint events related to the bulk water supply	0 (2010/11)	0	0	0	0
	3. Percentage compliance with the Drinking Water Standards of New Zealand	Microbiological and aesthetic compliance – 100% Chemical compliance – 85% (2010/11)	Microbiological and aesthetic compliance – 100% Chemical compliance – 90%	100%	100%	100%
	4. Treatment plant and distribution system grading	Te Marua, Wainuiomata and Gear Island treatment plants – A1 Waterloo treatment plant – B Distribution system – a1 (2010/11)	Maintain current grading	Maintain current grading	Maintain current grading	Maintain current grading
Provide secure & continuous water supply	5. Number of shut-offs of the wholesale water supply network resulting in loss of water or pressure to consumers	0 (2010/11)	0	0	0	0
	6. Improve the resilience of the wholesale water supply to catastrophic events such as earthquakes	Resilience projects completed in 2010/11 included: - Aro Tunnel improvements - Gear Island valve chamber improvements - Emergency supply point in Khandallah - New connection in Ngaio - Changing the management of pipe stock (2010/11)	Establish a methodology for assessing improvements to the resilience of the wholesale water supply	Plan for and implement resilience improvements	Plan for and implement resilience improvements	Continued improvements to the resilience of the wholesale water supply
Ensure that water supply infrastructure is adequate to meet future needs while minimising environmental impacts	7. Modelled probability of annual water supply shortfall	1.5% (2010/11)	No greater than 2%	No greater than 2%	No greater than 2%	No greater than 2%
	8. Compliance with environmental regulations	Full compliance (2010/11)	Full compliance	Full compliance	Full compliance	Full compliance

5. Population and demand

GWW bases lifecycle management on delivering the agreed levels of service for our customers. One of the key levels of service for GWW is "Ensure that water supply infrastructure is adequate to meet future needs while minimising environmental impacts".

Forecasting demand is a key asset management process. It helps GWW ensure that we are able to meet future capacity requirements without over- or under-investing. The forecast demand is used in the lifecycle section of this plan to determine future asset requirements and their associated lifecycle costs.

GWW uses a demand model developed by the National Institute of Water and Atmospheric Research (NIWA). The model incorporates eight demand centres across the four cities and predicts daily demand using a range of climate related factors.

Three models are used to assess the capability of the raw water sources and wholesale distribution system to meet different demand scenarios.

The Sustainable Yield Model (SYM) is a daily supply model that takes into account climatic conditions, demand, population, river flows, aquifer storage, reservoir storage, and system constraints. Scenario modelling is used to assess the impacts of changes to system constraints, source capacity and demand. The model uses a Monte Carlo simulation to assess system reliability, using up to 10,000 two year replicates. System annual shortfall probability, daily demand shortfall, and shortfall quantity estimates can be derived for a given population projection and network configuration.

The Karaka model is used as an operational tool during the summer months to predict the likelihood of storage shortfall at the Stewart Macaskill Lakes. The assessment utilises the SYM in a predictive mode using current lake and aquifer storage volumes and the NIWA three-month seasonal outlook for river flows. A Monte Carlo simulation is completed that shows storage profile probabilities for the coming three-month period.

The hydraulic model of the supply system is used to assess segment capacities for the SYM and aid decision-making on hydraulic (engineering) aspects of the system.

Additional detail about the SYM, Karaka model and hydraulic model is given in Appendix 2.

5.1 Historic demand for wholesale water

GWW monitors the use of water by each of its four customers and has accumulated a wealth of knowledge over time on:

- The volume of water treated at source
- The volume consumed in each part of the network
- The average and peak daily demands

Figure 5 and Figure 6 show the long-term historical daily and annual water consumption statistics for the four cities, and Figure 7 shows per capita demand (PCD) trends.

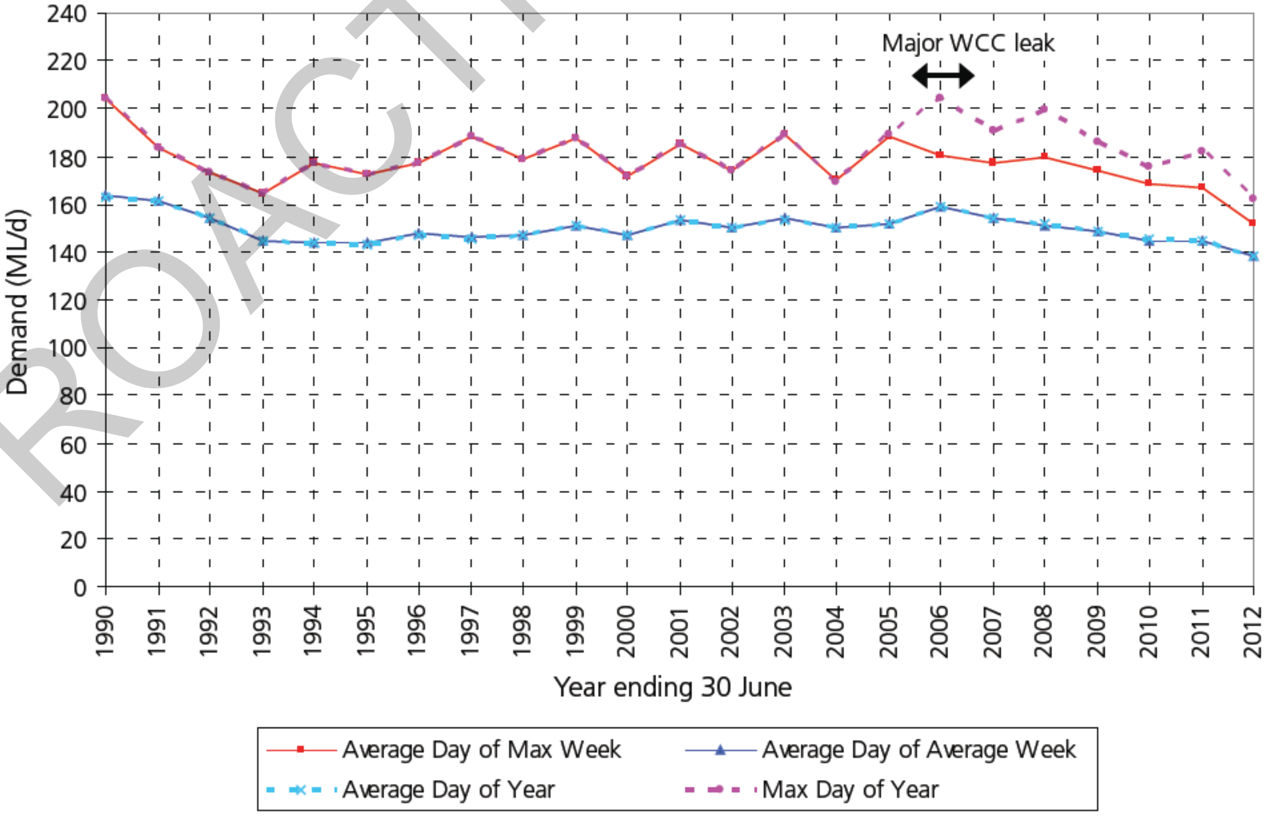


Figure 5: Daily water demand trends (source #987628)

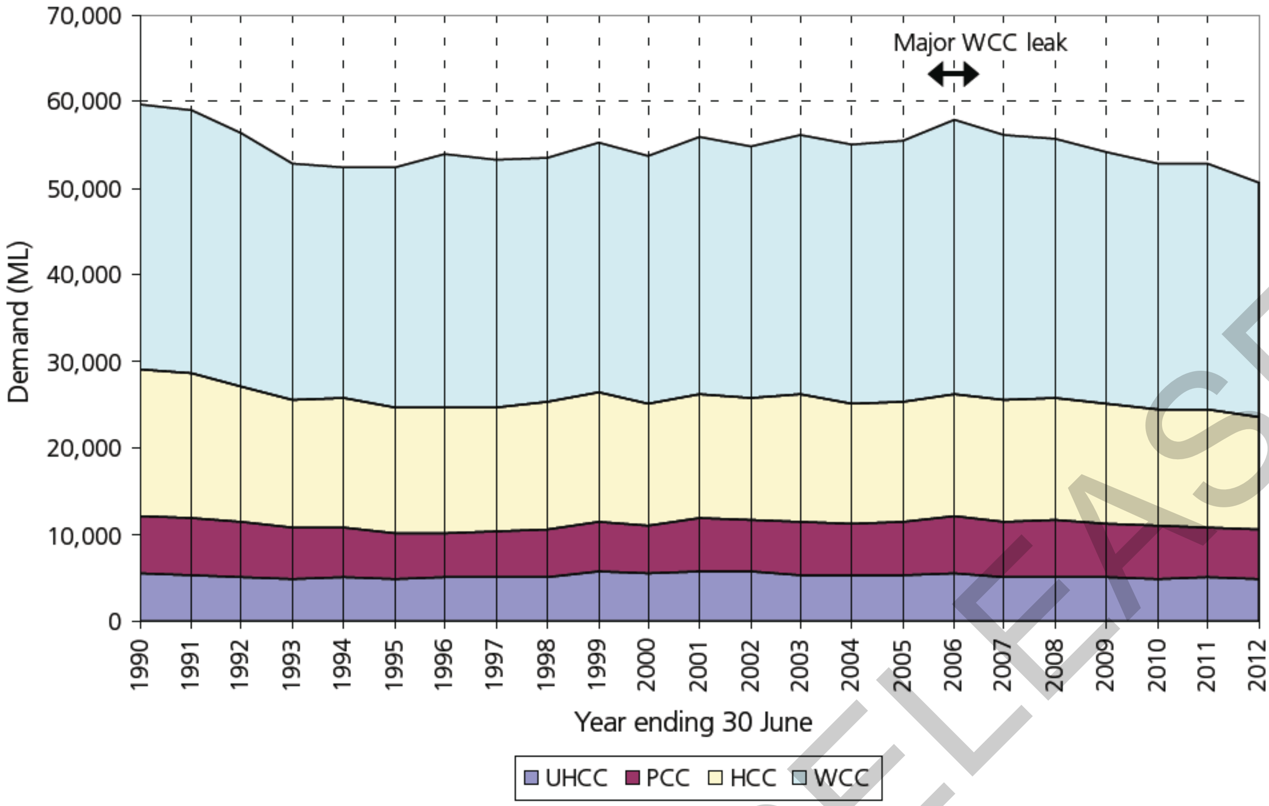


Figure 6: Annual water demand trends (source #987628)

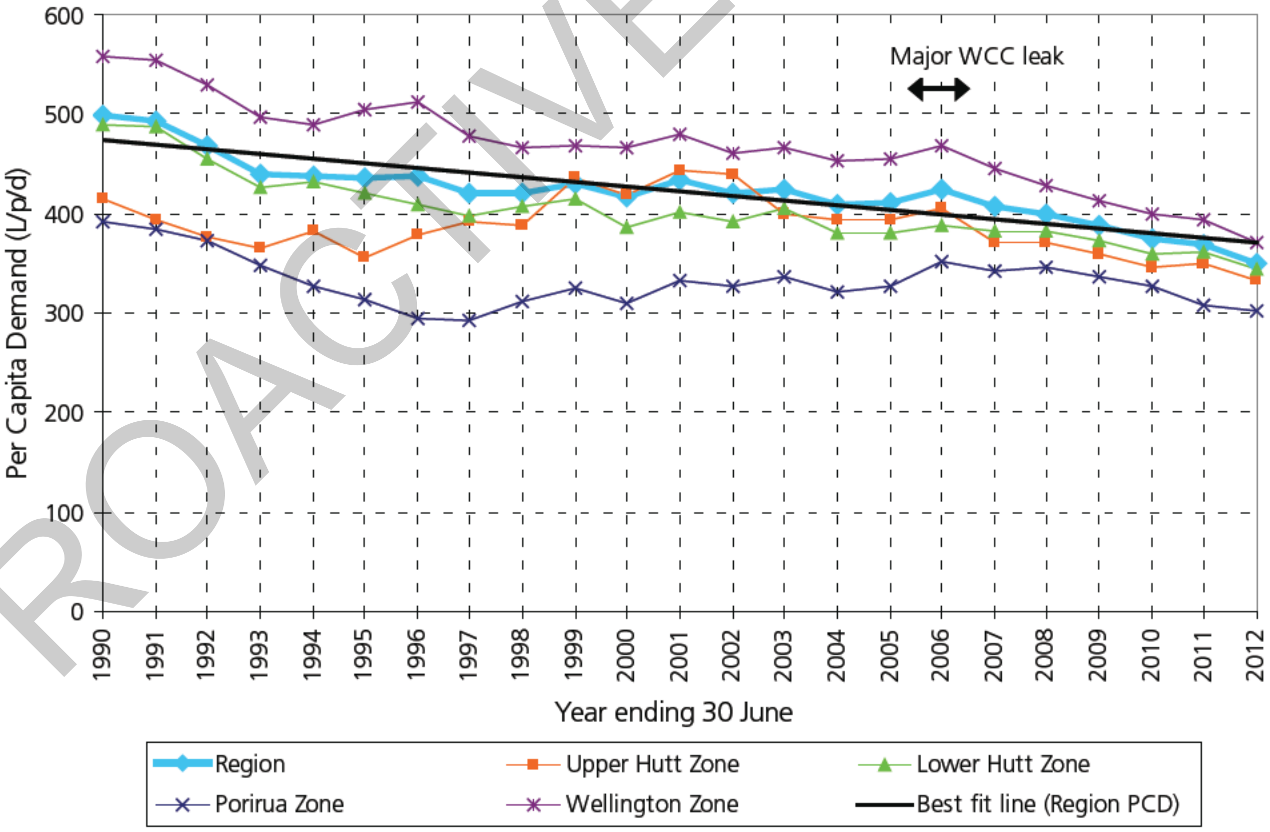


Figure 7: Average day per capita demand trends (source #987628)

Figure 6 shows there has been an overall decrease in water demand since 1990. The annual consumption in 2011/12 was around 8800 ML less than in 1990.

Data from approximately the beginning of February 2006 to the middle of September 2006 were affected by a major leak in Wellington. It has been estimated that the 2006 and 2007 annual consumption figures shown in Figure 7 were inflated by approximately 1300 ML and 700 ML respectively, because of this leak.

When the increase in population is taken into account, a larger decrease in water is revealed on a 'per person' basis. Over the region supplied by the wholesale water supply, the rate of decrease over the period 1990 to 2012 is approximately 1% p.a. on average.

The gradual decline in system-wide per capita demand between 1990 and 2006 is dominated by the Wellington and Lower Hutt reductions. Porirua showed the opposite trend over this period, although its per capita consumption remained the lowest of the four cities. Upper Hutt had an increasing trend between 1995 and 2002, which was reversed in 2002 when active leakage reduction measures were adopted by the city council.

The significant decline in overall PCD since 2006 is likely to be associated with an increase in leak detection work by the territorial authorities following the major Wellington leak. Discussions with the cities indicate there may be limited opportunities for further gains in this area.

Other long-term factors affecting per capita demand include the gradual uptake of conservation measures such as water-efficient household fittings and appliances, improved infrastructure through infrastructure replacement programmes, generally improving community attitudes to water conservation through marketing and education campaigns, better management of reticulation systems, and a reduction in garden sizes through infill housing and apartment developments. The increasing PCD trend for Porirua up until 2006 may be a result of a greater proportion of "greenfield" developments, compared with infill development in the more established Wellington and Lower Hutt suburbs.

5.2 Summer peak demand

Water use in the Region's urban areas is relatively stable for approximately eight (winter) months of the year. Average summer demand is around 10% higher than average winter demand. However, daily demands can be as high as 150 percent of the average day. The primary cause of summer peaks is garden watering. Occasionally, very high daily peaks come close to the capacity of treatment and distribution assets.

Consistently high demand over several weeks, particularly in late summer, requires the use of stored water, depleting reserves and raising the prospect of a water shortage.

5.3 Future demand drivers for wholesale water

The future demands for the wholesale water supply in the greater Wellington urban area are driven by:

- Population – the need to service population growth in the region with drinking water in a manner consistent with urban growth patterns
- Water consumption trends – slowly decreasing consumption per person
- Social – increasing demand for high-quality management of the environment, including the

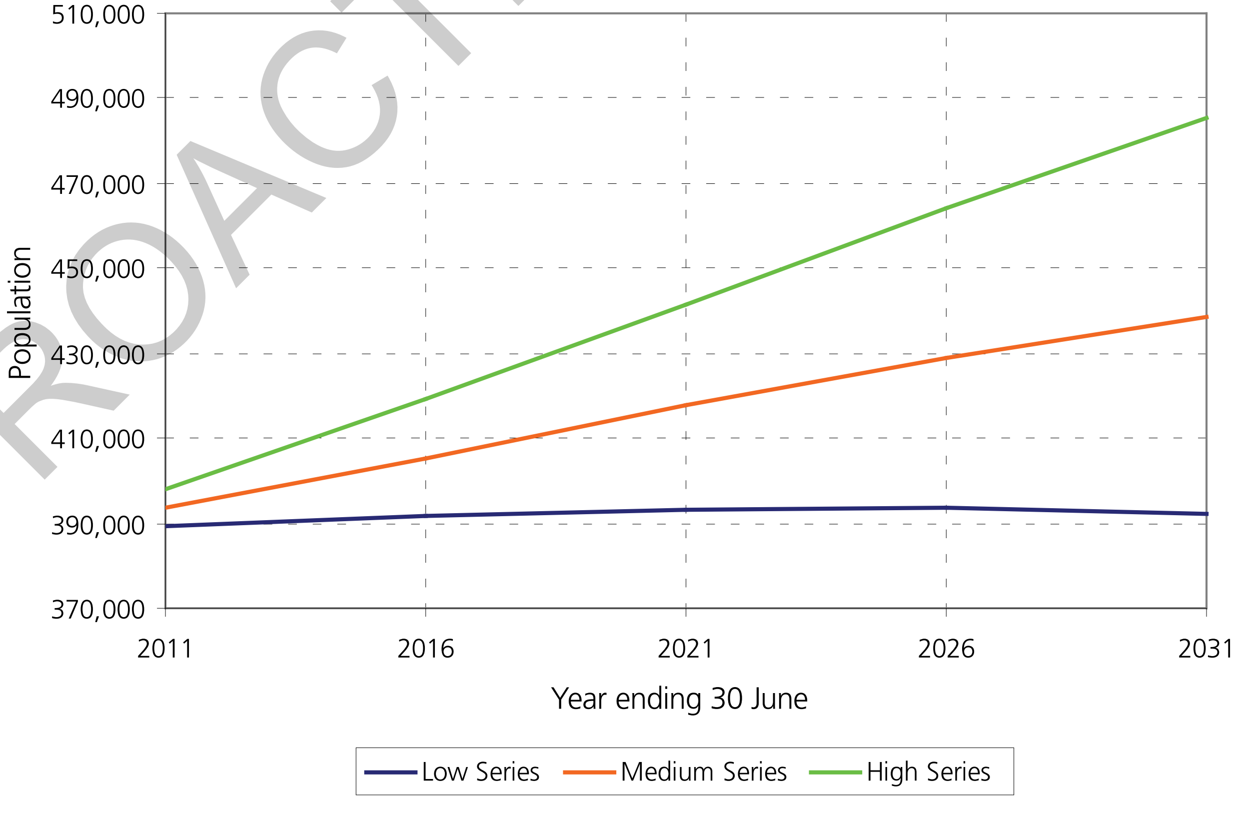


Figure 8: Statistics NZ urban area population projections for the four cities (source #1010538)

use of natural resources such as water and water catchment areas
- Climate change
- The economic strength of the region
- Evolving community needs and desired outcomes (future LTP outcomes)

These future demand issues are discussed below. The implications of changes in demand are addressed in Section 6.2, Meeting future demand.

5.3.1 Population growth

At 30 June each year, Statistics New Zealand produces an estimate of New Zealand's usually-resident population, including Upper Hutt, Lower Hutt, Porirua and Wellington cities. These population estimates are based on Census counts, updated using a post-enumeration survey that evaluates Census undercount, births, deaths and net migration. The latest information is given in Figure 8, for the period 2008 to 2031.

Figure 8 also shows the 2011 low, medium and high population projections. The medium series has been adopted as the basis for future planning. Based on this projection the June 2012 population supplied is approximately 395,000.

The low and high projections reflect more conservative and optimistic demographic scenarios respectively. Projections do not take into account non-demographic factors (eg, war, catastrophes, major government and business decisions) that may invalidate the projections.

There are no confidence intervals put on the population projections, and although the medium variant projections are considered the best at the time of their production, the low and high variant projections should also be considered equally valid. The assumptions adopted with these projections result in a significant difference in the total population between the low and high variants over the next 20 years. GWW has adopted the medium projection for planning purposes.

5.3.2 Household growth

Household growth is not directly incorporated into the GWW demand model, however analysis of the trends contributes to the analysis of population and demand by broadening the context. As population data trends upwards, it is expected that household numbers will grow at a higher rate. The reason for this is that the household occupancy rate over the next 20 years is set to decline from 2.7 to 2.4 per household. The main reasons are an increasing elderly population, an increase in couple-only households without children and a decline in family households. Projected households for Wellington urban areas are shown in Table 4.

Table 4: Household projections for the four cities supplied by the wholesale water supply

Projection	2011	2016	2021	2026	2031
High (%)	152,900	164,100	174,800	185,700	196,700
Medium (%)	150,200	158,400	166,100	173,400	180,200
Low (%)	147,500	152,900	157,600	162,000	164,900

Taking the medium growth projection of an additional 1500 households per year on average, the Region is projected to increase from 150,200 households in 2011 to 180,200 households in 2031.

5.3.3 Economic trends

The key economic trends likely to impact on the long-term provision of water supply are:

- Higher costs will affect the affordability of some traditional maintenance and operations options
- The proportion of residents reliant on fixed and investment incomes will increase over time, due to an aging population. Affordability will become an increasingly important issue
- Water will become an increasingly valuable commodity. A secure supply with adequate capacity will be a key success factor in securing business and residential growth in the region

5.3.4 Climate change

Climate change is expected to progressively affect the seasonal distribution of rainfall in the Wellington region. Over the remainder of this century, drier summers and wetter winters are expected to increase the need for summer balancing storage

In 2008, GWW commissioned NIWA to produce climate change-adjusted input files for the SYM, to allow an assessment of the potential effects. Monthly rainfall and temperature changes were produced by "downscaling" global climate model results. These were then applied to the rainfall-runoff model, to produce river flows. The initial work was based on the third assessment by the Intergovernmental Panel on Climate Change (IPCC). The datasets were updated in 2010 consistent with the IPCC fourth assessment (refer Appendix 2).

GWW uses climate change-adjusted datasets for long-term strategic modelling to assess factors such as optimal volumes for future storage reservoirs.

5.4 Forecast demand

The NIWA demand model predicts daily per capita demand, and this is combined with Statistics NZ population projections to produce daily demand volumes for the eight demand centres in the SYM.

The average per capita demand over the five year period 1 July 2006 to 30 June 2011 was 387 L/p/d, including an adjustment for the major leak in Wellington City in 2006. This five-year average PCD is currently used as the basis for future demand projections. Table 5 shows the demand centres in the demand model and their corresponding PCD statistics. While the system-wide average per capita demand is 387 L/p/d, daily demand can vary considerably depending on demand centre and climate variables.

The volume supplied in 2011/12 was the lowest on record for over 20 years, however this was affected by a significant increase in water conservation efforts due to the upgrade work at Stuart Macaskill lakes and poor weather conditions. The PCD used for future planning has a significant impact on the timing for future source development and therefore must not be overly conservative or optimistic. Care must be taken to ensure any revision to this assumption is valid for the long term and not the result of a limited

Table 5: Demand model PCD statistics in L/p/d (source #1032478)

Demand centre	Mean	Standard deviation	Maximum	Minimum
Upper Hutt	365	49	573	195
Lower Hutt	376	41	554	244
Wellington low level	455	40	630	311
Wellington High Level	368	38	522	222
North Wellington	356	37	523	237
Porirua	340	37	495	224
Petone*	468	66	733	209
Wainuiomata township	300	37	452	157
Total System**	**387**	**39**	**560**	**251**

* Petone has a high maximum value because the demand centre has only one reservoir. This causes anomalies when the supply is off for maintenance, however supply volumes are small so this does not affect the overall performance of the network

** Determined using a total system population of 395,000 people

period of abnormal weather or demand conditions. Our policy is to use a 5 year rolling average, adjusted for any abnormal events, and reviewed at least every 3 years.

5.5 Demand management planning

The traditional organisational response to increasing demand for water has largely been to upgrade or create new assets, with less emphasis placed on modifying demand. This approach tends to raise community expectations that water is abundant and water supply inexpensive, and thus lead to complacency and further demand increases. Since the mid 1990s, a greater focus on strategic planning, fiscal responsibility, user-pays principles, and service level review has created greater awareness of the need to manage demand.

Demand management is a key asset management strategy that involves implementing management techniques to seek to modify demand for the services.

Demand management ensures that:

- The utilisation/ performance of existing assets is optimised
- The need for new assets is reduced or deferred
- Greater Wellington's strategic objectives are met (social, environmental, cultural and financial)
- A more sustainable service is provided
- Greater Wellington is able to respond to the community's needs
- The focus of demand strategies for GWW is to:
- Reduce peak demand – which is a major factor related to the ultimate capacity of the wholesale water supply
- Reduce base demand – which is applicable where there are constraints in resources, financial gains to be made or there is an adverse environmental impact to be addressed, such as a drought

5.6 Demand management strategies

GWW utilises a number of demand management tools to delay the need to develop additional water sources or to fund increases in system capacity. However, as a wholesale supplier of treated water, the options available to GWW for introducing measures that require a specific response from consumers are more limited than those available to city councils, because we have no direct relationship with the end users. The following sections give some of the demand-side measures GWW has been involved with to date.

5.6.1 Market research

Since 1997, GWW's water conservation and efficiency initiatives have reflected a social marketing approach, including education, backed by research.

GWW has commissioned research about attitudes and behaviour regarding water use and conservation in 1997, 2003, 2007 and 2012. Smaller projects to identify recall of specific promotions have occurred between these years. GWW has developed its water conservation tactics from research findings.

What local households pay for water supply is unrelated to how much water they use individually, and historically residents have not experienced a serious water shortage, so key motivators of cost-saving and lifestyle disruption have been absent. While many people view water as important in general, these local circumstances have limited spontaneous engagement with water conservation in its own right.

Most people claim to be engaging in some level of water-saving activity, and most say that they would be willing to do more if they could see a real need to do so. The main barrier to more active water conservation effort is perceived lack of need. This view appears to be supported by a generally low level of awareness that city council watering restrictions are in force every year. The perceived cost, time and effort to implement water-saving actions also limit greater effort.

Our research of 2007 investigated broad preferences between supply augmentation and demand management options. Opposition to water meters is strong when the user-pays aspect is highlighted. Gaining acceptance for meters would be extremely difficult in the short term, given residents' perception that there is a low risk of water shortages.

5.6.2 Water conservation

As noted in Section 3.5.2, the peak demand for water in summer months can be high due to outdoor water use, principally garden watering. It is this peak demand which places the greatest strain on the assets and the supply of stored water. To overcome this situation, GWW has run annual campaigns to promote garden water conservation tips and advice since the early 1990s.

In light of research findings, the main thrust of GWW's water conservation marketing and communications since 1998 has been twofold: to build awareness of the risk of summer water shortages and to increase public awareness and use of a few easy, effective and more conservative garden watering methods, with consumer-orientated benefits. Our research indicated that messages and actions had to be simple and build gradually from pre-existing attitudes and behaviour.

Differing public attitudes and levels of engagement about the importance of water and personal ability to do more to conserve it have been used to segment the population and thus apply more focus to reaching and influencing those who are already more predisposed to change.

A garden-friendly, 'water wise' tips promotion has been the mainstay of GWW water conservation marketing since 1998. We have used various channels over the years to advertise advice from gardening experts, together with a consumer-oriented proposition (reason to pay attention). More recently, advertised advice has been limited to three-to-four key tips, with an incentive used to 'pull' people from the advertising to more detailed information on the Greater Wellington website. GWW has used media statements and Greater Wellington communications channels to extend reach. It has also worked with garden industry suppliers and local city councils to extend reach via their respective communications channels.

Since 2007, GWW has run a separate promotion of the consumer benefits of mulching gardens during spring in preparation for a dry summer. This has included local NGIA-member retailers offering specials mulch to coordinate with GWW advertising and promotional activity. As with the summer 'water-wise' tips promotion, GWW has used Greater Wellington and city council communications channels to support and extend the promotion.

In 2011, as part of communications planning for managing with one of the Stuart Macaskill Lakes being empty for the summers of 2011/12 and 2012/13, common water conservation branding elements were developed for use by our city council customers as well as GWW. This included the 'call to action' "Use a bit less, make a big difference". This branding was widely employed during the spring and summer of 2011/12, including in newspapers, billboards, bus-shelter advertising, rate notice flyers, websites and fridge magnets. Further development of common communications elements is anticipated in coming years

5.6.3 Education

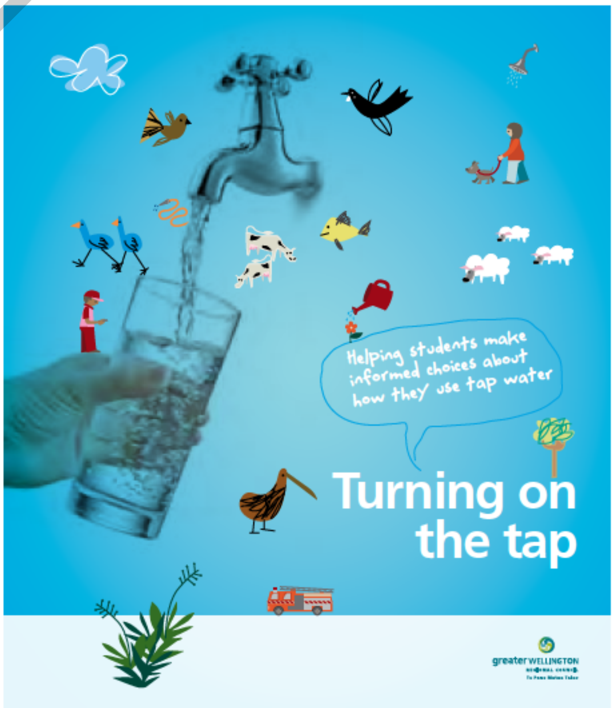
Greater Wellington has for many years sought to raise the level of knowledge in the community about the value of water. This has been done by funding educational resources for schools, providing tours and presentations at our treatment facilities and producing general information about the regional water supply system and water-wise gardening methods.

Beyond its annual spring and summer water-conservation promotions, GWW has a range of related advice and information on the Greater Wellington website, including several printable brochures in PDF file format (www.gw.govt.nz/water-conservation).

GWW helped to fund an update and reprint of the Regional Native Plant Guide in 2010 (www.gw.govt.nz/wellington-regional-native-plant-guide).

GWW provided significant funding to develop Greater Wellington's Take Action for Water environmental education programme for schools (2001-2003). In 2011, we completed a complementary teaching resource with a focus on potable water supply and conservation – Turning on the Tap (www.gw.govt.nz/turning-on-the-tap)

This package is aimed at encouraging primary and intermediate school teachers to study water supply and conservation issues with their pupils, and undertake class visits to a GWW water treatment plant. The intention is to help students to understand where their tap water comes from, and make informed decisions about how they use it.



5.6.4 Water use restrictions

While GWW has a customer-endorsed security of supply standard for system modelling purposes[3], it is not practical to manage a worsening drought in real time to the limit of the standard without restrictions. The severity of a drought is unknown until it has

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[3] An annual shortfall probability of <2% given unrestricted demand (one in 50-years on average)

broken. The consequences of taking no mitigating action until a drought is proven to be at least of 'once in 50 years' severity would be the need for more extreme water use reduction and resulting hardship, which would not serve the interests of our customers or the wider community well.

A stepped water restriction strategy has been in place since October 1996. Since 2004 and the development of the Karaka model we have taken source-water availability into account when considering the need for demand restrictions.

The summer of 2007/08 saw the first use of a sprinkler and fixed irrigation ban since 1985. In 2008, GWW developed and adopted, together with its customers, the Summer Water Demand Management Plan (SWDMP), a new multi-stage drought management plan that refers to several indicators of potential water shortage, primarily output from the Karaka Model. The Plan includes communications and increasingly restrictive, bylaw-supported, water-use rules for successive stages of drought alert. GWW consulted and gained agreement from its four customers for the original SWDMP. In 2011, we developed a second version of the Plan, which responds to the reduced maximum storage available during the Stuart Macaskill Lakes upgrade project, links with the Hutt River Low Flow Management Plan (HRLFMP), and includes extra precautionary demand reduction interventions.

5.6.5 Measurement for management

Maximum utilisation of assets can be achieved if wastage and loss of water can be minimised. GWW upgraded to more accurate magnetic flow (magflow) meters for the recording of supply volumes in the late 1990s. Water take, treated volumes and supply volumes are monitored on a continuous basis, and these figures are used to track non-revenue water.

Data is assessed for inconsistencies that may indicate water losses from the system. GWW supplies water use data for each city on a weekly basis, so each TA can assess our supply volume data in comparison to its own. The installed operational tolerance margin for our water meters is +/- 2%. The annual difference between metered flows leaving our treatment plants and reaching customer points of supply is consistently within this error margin. We investigate any discrepancies immediately.

In 2012, GWW invested in a portable insertion magflow meter to allow validation checks of existing flow meters to be completed.

6. System capacity

6.1 Existing system capacity

The modelled Annual Shortfall Probability (ASP) assessed by the SYM for various populations is given in Figure 9. Also shown is the effect of the current Stuart Macaskill lake upgrade.

The SYM indicates that a 2% annual shortfall probability security of supply standard can be met for an urban population of approximately 414,000 after the lake upgrade work is completed. This means that at a population of 414,000 the chance of supply being unable to meet normal unrestricted demand in any given year will be 2%. Using current population projections this is predicted to occur around 2019. As population increases the chance of supply shortfall will increase if source capacity improvements are not implemented.

The implication of the capacity assessment is that GWW is currently able to provide sufficient water on a daily basis to meet the service level target. The current annual shortfall probability for a population of 395,000 is 1.5%. Based on current projections, a supply side or demand side improvement will be required by around 2019 to maintain the 2% security of supply design standard.

6.2 Meeting future demand

Considerable work has gone into investigating possible options for development of new water sources as well as the upgrading of existing assets. This work has been grouped into long-term and short-term improvements and is summarised below.

6.2.1 Long-term improvements

Studies for development of three storage dams sites, indicated by preliminary studies to be the most suitable, have been completed. The sites were:

- The Pakuratahi River valley
- Skull Gully in the Wainuiomata River water collection area, and
- The Whakatikei River valley

Comprehensive studies covering hydrology, geology, seismic risk, engineering, terrestrial ecology, aquatic ecology, cultural, recreational and heritage aspects and cost have been completed. Multi-criteria analyses workshops based on the results of these studies were carried out with three groups:

- Senior Greater Wellington staff
- Senior water supply staff from the TAs
- Greater Wellington Councillors

Each of these groups independently reached the conclusion that the Whakatikei site was the preferred option.

A third storage lake at Te Marua has recently been proposed as an alternative to the on-river storage dam option. The multi-criteria analysis workshops were re-run in 2011, but agreement was not reached between the three groups. As a result, Councillors have requested additional investigation work be completed before a decision is made. Greater Wellington has a Memorandum of Understanding (MoU) with the owner of the land required for Lake 3 which includes an option to purchase the land. The MoU has been extended to December 2012, and a provisional sum of $4m is included in the capex programme to allow for the purchase.

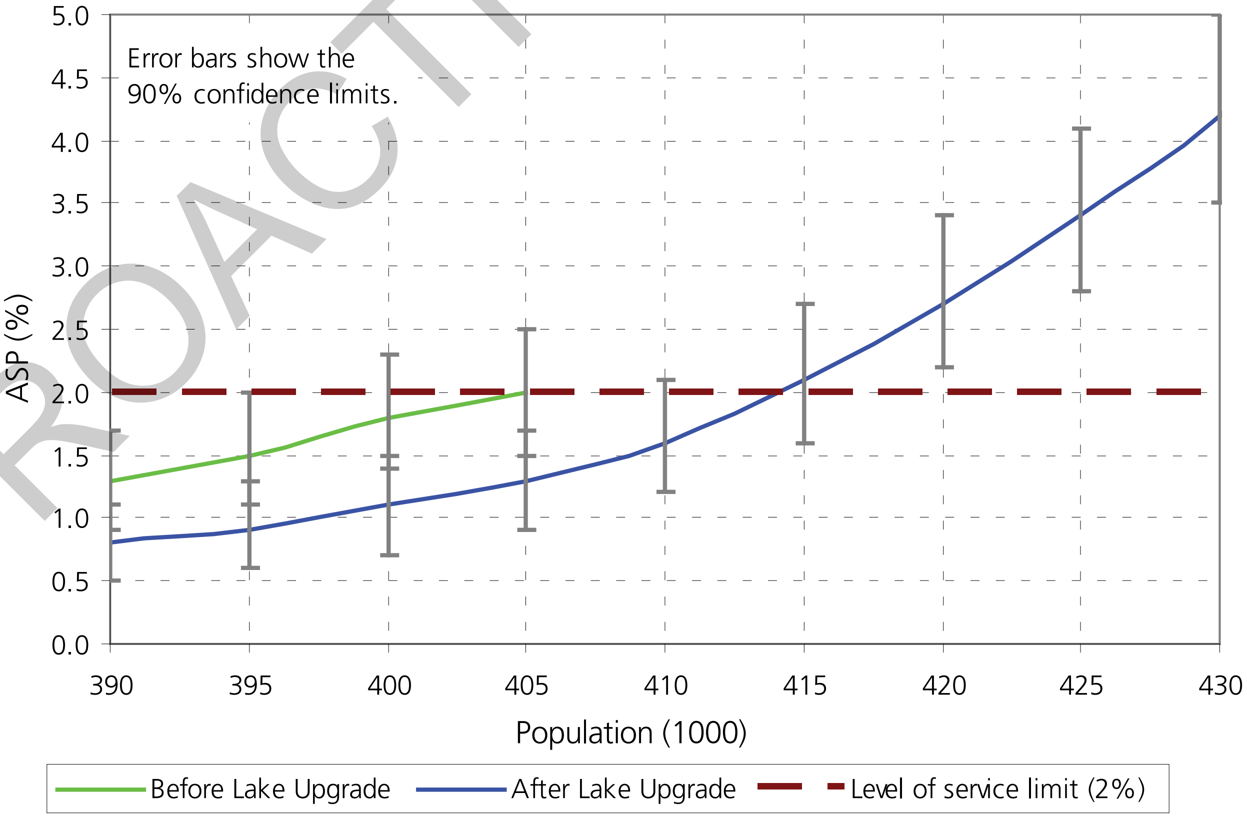

Figure 9: Annual shortfall probability verses population (source #1010154)

A further storage option on the land required for the Kaitoke Lake has also been investigated. This scheme involves the construction of two smaller lakes near the Pakuratahi River. These lakes could be filled either from the Pakuratahi River or from Kaitoke via a pipeline from the Strainer building at Kaitoke. During summer water could be released into the Pakuratahi River to compensate for additional water taken from Kaitoke, or it could be returned to the Kaitoke to Te Marua pipeline and taken to the plant for treatment.

Preliminary investigation work is also in progress for a possible small (10 ML/d) seawater desalination plant and/or treated water storage ponds in or around Wellington city. The desalination option would have seismic resilience benefits and could also be used to supplement supply in dry years.

A Greater Wellington committee workshop and meeting will be held in 2012/13 to review the results of current investigation work and confirm the preferred development options.

6.2.2 Short-term improvements

Short term improvements to optimise the service potential of the existing infrastructure can be highly attractive from a financial perspective. As an example, deferral of the Whakatikei dam option by 5 years has a benefit to GWW in net present value terms of around $25m. This section gives a summary of projects currently underway and options being investigated.

A project is currently underway to seismically upgrade the lakes and increase their usable storage capacity to 3390 ML from an original capacity of 2990 ML. A change to the Hutt River abstraction resource consent was approved to reduce the minimum residual flow at Kaitoke Weir from 600 L/s to 400 L/s during the construction period. This is to reduce the likelihood of a supply shortage during construction.

Construction of a large treated water reservoir in Prince of Wales Park, Mt Cook, jointly funded by Wellington City and Greater Wellington is being considered. This would provide some strategic benefits by providing additional water for very short term demand peaks. However confirming the funding split and coordinating funding priorities between the partners has been very difficult. The current position is that the project is due for construction in 2015.

An option to re-configure usage of the two existing Stuart Macaskill lakes is also currently being considered. A provisional sum of $10m is included in the capex programme for this work.

It is expected that short term improvements will achieve deferral of the next major source upgrade by 5 10 years. This is the reason for the capex programme not reflecting the $160m required for construction of a storage dam by 2019 (refer Figure 10 in the following section).

6.2.3 Meeting future demand summary

Planning work for the next major source upgrade has been well progressed and a decision is expected in late 2012 on the preferred option if and when storage augmentation is required. GWW is also investigating options to improve the service potential of existing infrastructure with a view to deferring major capital investment as much as possible while meeting agreed service levels.

Figure 10: shows the current development plan excluding the effect of likely short-term enhancements and associated deferral discussed above.

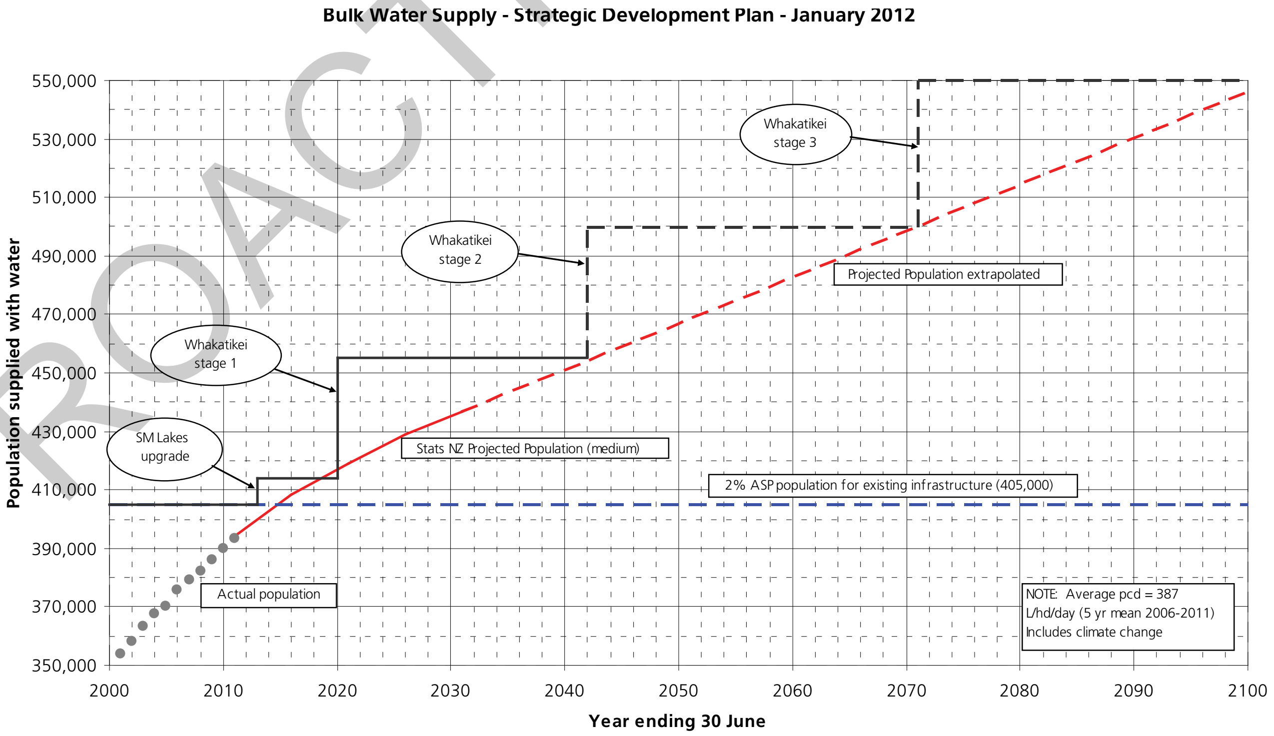

Figure 10: Strategic development plan excluding short term improvements (refer #1012278)

Per capita demand has been reducing for some time, and in recent years this has resulted in a drop in overall demand. This is a key factor when assessing the timing for source development. In broad terms, a PCD reduction of around 3 L/p/d results in a deferral of the next major source by one year.

It is uncertain how long this downward trend in PCD will continue and therefore particular attention will be needed to ensure long term demand forecasts remain at an appropriate level.

7. Risk management

Greater Wellington Regional Council has recently approved a corporate level Risk Management Policy and Procedure. GWW has a number of key systems in place for managing risks including:

Corporate risks

- Greater Wellington Risk Management Policy and Procedure
- Quantate Risk software

Operational risks

- Quality Manual
- Environmental Management Manual
- Public Health Risk Management Plans
- Automation software

Health and Safety risks

- Health & Safety Manual
- Orongorongo Railway Safety System

Project risks

- Project Management Procedure
- Enterprise project management software

Infrastructure risks

- Risk assessment procedure

Work is required to align and/or combine our risk management systems. The intention is for the AM Plan to primarily focus on risk management of physical infrastructure.

7.1 Risk assessment of physical infrastructure

A risk assessment procedure was established in 2011 to define the context and ensure consistent application of likelihood and consequence scales, as well as setting risk appetite through a risk evaluation matrix. Included in the risk assessment procedure is a consequence scale with clear descriptions for each of the 1-5 ratings. The descriptions are aligned with our high level business objectives defined in Secion 4.2.

GWW undertakes periodic risk assessment reviews for events that may impact on our ability to maintain supply to the Territorial Authority supply points. A comprehensive risk assessment review of our physical infrastructure against a range of events is in progress and due for completion in 2012/13. The events being considered are:

- Earthquake – major ground shaking
- Earthquake – Wellington fault movement
- Major rain event
- Fire – single switchboard
- Fire – water treatment plant
- Drought
- Electricity failure of 2 days or more

It is expected that a number of resilience improvement projects will be identified and implemented in the coming years. A risk based methodology has been developed to provide a consistent approach to assessing the benefits of resilience improvements and prioritise the implementation. Provisional sums have been allowed for in the capital expenditure programme.

Major infrastructure risk assessments of the wholesale water supply should occur approximately every 10 years. Factors that could affect the timing of such reviews include major changes to our infrastructure and/or knowledge of the effect of events on our ability to maintain supply.

7.2 Asset criticality

Asset criticality relates to the consequence of an asset failing to perform it's intended function. This is an essential measure for prioritising maintenance and renewal activities. To date, this has been completed using the judgement of experienced technical and operational staff. The intention is to embed this knowledge into a 1-5 criticality rating score against each equipment in the AM database. The 1-5 rating will be consistent with the consequence descriptions developed for the risk assessment procedure. A project has been created to progress this work during 2012/13.

7.3 Key risk mitigation measures

The following sections provide a summary of key control measures for events that could affect our ability to maintain supply.

7.3.1 Seismic risk mitigation

With several water treatment plants and over 180km of pipelines, the water supply system in the metropolitan part of the region is vulnerable to a range of incidents including a major community-wide emergency event. A major earthquake, particularly one involving a movement of the Wellington fault, would lead to considerable disruption to the water supply system.

For some years, GWW has undertaken mitigation work in the metropolitan part of the region to prepare for such an event. For example in the recent past, this has included installation of a number of emergency connection points that allow supply directly into city reticulation systems in the event that service reservoirs or their inlet pipes have been damaged. Greater Wellington has also installed an automated shut-off valve on the Kaitoke-Karori water main at the northern end of the Silverstream Bridge. The Wellington fault is located near the southern end of the Silverstream Bridge and the valve will close off automatically should a fault movement rupture the main. Inlet standpipes have also been installed in customer reservoirs to prevent the reservoirs draining should the inlet pipe rupture.

A review of the location of our stock of pipes and fittings for seismic repairs has resulted in re distribution of the stock closer to where it will be needed and to locations more likely to be accessible following a movement of the Wellington fault. A major part of this work in 2011/12 included relocating our pipelines and mechanical maintenance workshop from Wainuiomata to Pomare in Hutt City. A new sealed storage yard was also constructed at Te Marua water treatment plant.

GWW is nearing completion of a programme to install standpipes on the inlets to a number of City Council service reservoirs. The standpipes will prevent valuable water draining from the reservoirs should there be a major break on the GWW inlet main. This work is expected to be completed in 2013/14.

A $6.5m project is currently in progress to seismically upgrade the Stewart Macaskill Lakes. The project includes rock buttressing to strengthen the embankments and installation of a polyethylene liner. Lake 2 was completed in 2012 and construction work on Lake 1 is due for completion in 2013.

In 2011, GWW commissioned GNS to produce a report on how long it would take to restore water supply to Wellington city after an earthquake. Their report found that estimated restoration time for the reticulated water supply to Tawa residents is between six to seven weeks and for Miramar residents between 18 and 20 weeks. This information is now being utilised in our planning for emergency water supplies.

GNS is currently working on a wider study covering the whole of Wellington city, which is expected to be available by the end of 2012. A similar study for Porirua is planned for 2012/13. Lower Hutt and Upper Hutt are less vulnerable as they are closer to our water treatment plants and significant sources of river water, which could be used in an emergency.

7.3.2 Equipment reliability

While loss of a pump will quickly call a standby pump, loss of a pump station or a major water main will mean that the community supplied by those facilities will be without water as soon as local storage is depleted. GWW therefore pays great attention to reliability through high standards for materials and workmanship.

7.3.3 Equipment automation

All GWW water treatment plants and pump stations are fully automated and able to be controlled remotely. The systems can function without human input for three to four days assuming the support infrastructure is not heavily damaged. It is expected that the control system will be operational within this period and/or key sites able to be attended by operators.

7.3.4 Diesel generators and pumpsets

Power supply to GWW water treatment plants and key pumping facilities are backed up with diesel generators or pumpsets. Diesel storage tanks allow continued operation of the wholesale water supply for 1-2 weeks in the event of a major electricity failure.

8. Lifecycle management plans

This section presents asset condition and performance information and applies the asset management strategies described in earlier chapters to develop specific work programmes required to meet the growth projection and achieve the level of service standards. It presents an analysis of available asset information and the lifecycle management plans covering the three key work activities for each type of asset.

Development plan: To respond to growth demand in the region and to improve parts of the system currently performing below target service standards.

Operations and maintenance plan: Activities undertaken to ensure efficient operation and serviceability of the assets, and therefore that assets retain their service potential over their useful life.

Renewal plan: To provide for the progressive replacement of individual assets that have reached the end of their useful life. Deteriorating asset condition primarily drives renewal needs.

Disposal plan: Disposal of assets that are surplus to requirements.

8.1 Overview of assets

8.1.1 Summary of Greater Wellington Water assets

GWW owns and manages the following key assets summarised below to deliver wholesale water supply services.

- 7 raw water intakes
- 2 raw water storage lakes
- 11 aquifer wells
- 183km of distribution pipe lines
- 10 tunnels (approximate length of 9.3 km)
- 18 pump stations
- 3 active water treatment plants and 1 standby water treatment plant (including associated buildings and fixtures)
- 3 distribution treated water reservoirs
- control systems, telemetry and meters
- access way assets such as roads, bridges, foot paths, and tracks, etc

8.1.2 Overview of lifecycle management

The following apply to all asset groups and lifecycle management of the network as a whole.

Asset development is the creation of new assets or works which upgrade or improve an existing asset beyond its existing condition or performance. Development is in response to changes in use or customer expectations, (eg, new water sources, increasing distribution capacity, improving seismic resilience, etc).

Asset operations/maintenance is the on-going day to day work activity required to keep assets serviceable and prevent premature deterioration or failure. When preparing the long-term financial strategy an estimate of the required maintenance expenditure is made. The Maintenance Plans can be found in the Asset Management System, SAP.

Asset renewal/replacement is major work that restores an existing asset to its original or new condition, (eg, replacing pipes, refurbishing pumps, etc).

Asset disposal is the decommissioning of an asset. Assets may become surplus to requirements for any of the following reasons:

- Under utilisation
- Obsolescence
- Uneconomic to upgrade or operate
- Policy change
- Service provided by other means

The lifecycle management plans for each of the key asset groups is detailed in the following sections. The first part of each section outlines background data for the asset type managed including physical parameters, capacity and condition. The second part describes the management strategies and work programmes to achieve the levels of service to meet anticipated future demand and to manage risk. A 10-year financial summary of the activity as a whole is included in section 9, Financial Summary.

8.2 Overview of quality, operations and maintenance strategies

8.2.1 Overview of quality systems

GWW have established and maintain a Quality Management System (QMS) complying with ISO 9001:2008 and 14001:2004 Quality Standards. The system is detailed in the following hierarchy of documentation:

- Quality manual
- Environmental Management Manual
- Management Systems Manual
- SAP business process documentation
- Site-specific procedure manuals
- Manufacturers' manuals, reference standards, operating manuals

8.2.2 Overview on operations and maintenance strategies

The overall philosophy is that the QMS forms an integral part of the normal operating practices of GWW. It is therefore the primary driver of the operational maintenance strategies. The guidelines for operational maintenance strategies are explained below. Full detail is provided in our SAP business process documentation.

All programmed maintenance is based on recommended industry standards that are progressively modified from experience based on observed failure rates and equipment performance.

All programmed maintenance is initiated by work order and recorded on the Computerised Maintenance Management System (CMMS), SAP.

Asset refurbishment programmes are based on an assessment of operational needs and maintenance history.

All critical pumping plant have standby backup in case of failure. Diesel generators provide standby power supplies to WTP's and key pump stations.

Flow meters, level and pressure sensors and on-line water quality analytical equipment are calibrated regularly. Calibration frequency and history is recorded in the CMMS.

Automatic call out of operational personnel is generated on failure of critical equipment that affects reservoir levels or treatment plant outlet quality or flow.

The cost of maintenance activities is trended and reported regularly.

Planned maintenance: Maintenance generated automatically by the CMMS from maintenance plans is delegated to the operations staff that optimise the work activity required to meet specified minimum service standards.

The frequencies of routine activity are specified in the CMMS. The timing and nature of these works are based on an assessment of factors such as:

- Manufacturer recommendations
- Outcome of Reliability Centred Maintenance (RCM) analysis
- Consequence of failure (water quality, financial, environmental, level of service, etc)
- Rate of asset decay (based on run time, mileage, fixed frequency, etc)
- Economic efficiency (replacement may be less costly)

Plant and equipment maintenance requirements are based on the recommendations outlined in Operations and Maintenance Manuals or (in their absence) manufacturer's information. This literature is retained by the Assets and Compliance team with copies located onsite. Often experience gained from working with the equipment over many years, or detailed analysis such as RCM, indicates that different (in some cases lesser) maintenance requirements are appropriate.

Unplanned maintenance: Cleaning or repair of assets required to correct faults identified by routine inspections, a control system alarm and/or notification from staff, contractors or members of the public. The following tactics are implemented to ensure levels of service are maintained and risks managed. Staff are notified promptly and respond effectively to water quality issues and asset failures. The initial response is to achieve safety, preserve water quality and protect the environment as quickly as possible, making temporary repairs or closing facilities if major repairs or replacements are required. If a permanent repair can not be achieved immediately, then a follow-up corrective work order is initiated to provide the necessary parts and/or staff availability.

8.2.3 Routine inspections

The Quality Manual and associated procedures specify routine inspections and testing to monitor water quality, asset condition, identify emerging risks, and schedule maintenance and repair work.

The overall inspection programme is documented and reviewed in response to unplanned maintenance trends and risks. Regular visual inspections of all aboveground assets will confirm:

- Compliance with Codes and Legislation
- Chemical storage facilities comply with dangerous goods and toxic substances regulations
- Building Act compliance is supported with “Warrants of Fitness”.

Treatment plants are staffed during normal working hours, and pump stations are visited and checked regularly. Because water supply is a 24 hour/day 365 days of the year business, staff members are trained to understand that high standards are necessary in all aspects of the operation. Maintenance needs are noted by operations staff and passed on to management for action. Items which involve capital improvements, replacements, or refurbishment are passed to the Team Leader Assets and Compliance for approval and allocation of funds.

8.3 Asset condition grading

GWW has recently completed a comprehensive asset condition assessment exercise for above ground assets (Water Treatment Plants and Pump Stations). Condition grading is based on the New Zealand Water and Waste Association (NZWWA) publication titled Visual Assessment of Utility Assets. Asset condition assessments are undertaken to support decisions relating to:

- Where the asset is in its lifecycle
- The remaining effective life of the asset
- The rate of deterioration of the asset
- When asset rehabilitation or replacement will be required
- Financial cash flow projections
- The likelihood of failure
- The frequency of inspections required to manage the risk of failure
- The adequacy of the existing maintenance regime

The data collected allows for:

- Planning for the long term delivery of the required level of service
- Prediction of required replacement date
- Prediction of future expenditure requirements
- Management of risk associated with asset failures
- Refinement of inspection, maintenance and rehabilitation strategies
- Selection of work priorities
- Utilisation of cost effective renovation options by avoiding premature asset failure
- Identification of deferred maintenance needs

Condition assessment primarily relates to the physical state of the asset, which may or may not be directly related to the performance of the asset. (The performance of the asset, as noted, is closely aligned to the level of service provided to customers and is typically measured in terms of reliability, availability, utilisation, efficiency, safety, aesthetics, customer satisfaction and compliance with standards and regulations.)

We use condition grading standards to define a minimum acceptable condition for assets, which may differ according to the criticality of each asset in terms of delivering levels of service. These minimum standards can be used in performance based maintenance contracts.

Asset condition is assessed on a 1-5 scale (very good to very poor) as shown in Table 6.

Table 2: Summary of significant effects of the Water Supply activity

Grade	Condition	Action	Description
N	Not Required	No Action required	Asset absent or no longer exists.
1	Very Good	No Action required	New or near new condition. Some wear or discolouration but no evidence of damage. Can include repaired assets where the repair is as good as the original.
2	Good	Monitor to see if there are changes	Deterioration or minor damage that may affect performance. Includes most repaired assets.
3	Moderate	Consider specialist assessment	Clearly needs some attention but is still working. Structure in need of repair. Includes repaired assets where the repair is deteriorated.
4	Poor	Get specialist assessment	Either not working or is working poorly because of damage or deterioration. Condition or structure is poor or structural integrity in question.
5	Very Poor	Replace or repair	Significant damange and is not working. Needs urgent attention.

8.4 Lifecycle management

8.4.1 Renewal Plan

Potential renewal projects are identified by comparing asset performance with level of service targets, or by staff suggestion. A register of potential projects is maintained. The impact of each project is assessed against GWW's high-level business objectives to assist with prioritising funding.

Renewal funding forecasts are based on an assessment of remaining asset lives (integrated with the valuation process). A programme of refurbishment and replacement of facilities and plant items is developed each year as part of the Capital Works Programme. Generally the replacement or refurbishment will reinstate the previous level of service, but sometimes, especially in the case of electronic equipment, an upgrade is incorporated.

The replacement or refurbishment of assets is initially planned by analysing the remaining useful lives contained in the AM database. Following initial identification a detailed condition assessment will be undertaken to confirm that replacement is necessary. Refurbishment or replacement of assets may be advanced or delayed because of:

- Failure history
- Superseded technology or lack of compatibility with other similar assets
- Condition assessment predicts likely failure with unacceptable risk consequences
- Lack of service support and or unavailability of spares
- Uneconomical operational costs

Some assets have been identified as operational beyond their predicted useful life. The reasons for their extended life will be specific to their particular duty. When replacement is due their condition will be assessed as part of capital expenditure planning, with a view to keeping them operational as long as it is financially beneficial. Notable exceptions to this rule are:

- Variable speed drives (where the consequence of failure is likely to cause a significant environmental, quality or supply issue, or significant disruption to other users of the local electricity network)
- Actuators (where the consequence of failure is likely to cause a significant environmental, quality or supply issue)

The standards and specifications for replacement works are generally the same as for development projects. Scheduling of replacement works identified will depend on GWW priorities. Some work may be deferred when higher priority works are required on other infrastructure assets, or if there are short-term peaks in expenditure.

When replacement work is deferred, the impact of the deferral on lifecycle costs and the assets ability to provide the required service standards will be assessed.

8.4.2 Disposal plan

When considering disposal options all relevant costs of disposal will be considered. These may include;

- Evaluation of options
- Consultation and advertising
- Professional services, including engineering, planning, legal, survey
- Demolition, site clearing, make safe costs
- Loss on sale
- Environmental impacts

Improved asset condition/performance data will allow better planning for disposal of assets through rationalisation of the asset stock or when assets become uneconomic to own and operate. In all cases asset disposal processes must comply with Council's obligations under the:

> *Local Government Act 2010, which covers public notification procedures required prior to sale and restrictions on the minimum value recovered;*
>
> *Reserves Act 1977, which covers procedures for changing or revoking the classification of reserves, including public notification prior to sale, resolution of objections, and a requirement to first offer surplus to the original owners; and*
>
> *Public Works Act 1980, which outlines offer-back procedures where land was acquired under the terms of the Act.*

8.5 Raw water intakes

8.5.1 Asset description and capacity

Three water collection areas supply Te Marua and Wainuiomata Water Treatment Plants. The flow from the raw water intakes to the treatment plants is not pumped but is transferred by gravity. The three collection areas are:

- The Hutt River at Kaitoke
- The Wainuiomata River and its tributary George Creek
- The Orongorongo River and its tributary Big Huia Creek

Table 7 summarises the details of raw water intake assets. Additional information is stored in the AM database.

All land upstream of the abstraction points is owned and managed by Greater Wellington. These forested water collection areas have been under the control of Greater Wellington or its predecessor authorities for many years, with only strictly controlled public access and active control of animals. As a result, the quality of the water coming from these catchments is very high and the contamination risks are low. The asset management objectives and practices employed in the water collection areas are described in the separate companion document Greater Wellington Water Asset Management Plan – Water Collection Areas – Hutt and Wainuiomata/ Orongorongo (refer doc #1121099).

8.5.2 Asset condition

Structural assessments are undertaken by engineers at regular intervals, with special attention to weir crests and aprons which are liable to damage. Regular inspections by staff confirm that all valves, stop logs, gates and penstocks can be operated to perform their intended function. The interval between inspections depends on the current condition of the intake, expected degradation rate and significant events that could accelerate the wear (eg, major flood).

The ageing Kaitoke intake is in good condition considering the asset was constructed in 1955 (ie, now more than 56 years old). It has suffered minor damage to the concrete apron and intake grill structure during the recent past. Repairs were carried out as a maintenance item.

Wainuiomata and Lower George Creek intakes are both relatively modern structures built in 1988. They both are in a good condition.

The Orongorongo and Big Huia intakes are in average condition considering that they are over 85 years old. An assessment and internal upgrading of the Orongorongo intake was carried out in 2004. The assessment identified that the reinforcing in the structure is starting to corrode and the remaining life was limited. The superstructure may need to be replaced within the next 20 years. The weir crest has worn down since the last time it was repaired and an inspection is planned for 2012/13.

The Upper George Creek intake is currently not in an operational state. An investigation is planned for 2013/14 to confirm the economics of reinstating the intake and replacing the associated pipeline (due for replacement in 2014/15).

8.6 Raw water storage lakes

8.6.1 Asset description and capacity

Surplus water from the Hutt River at Kaitoke is stored in the Stuart Macaskill Lakes at Te Marua. At times when water cannot be abstracted from the Hutt River because of high turbidity or colour, or when there is insufficient water to meet demand, water is taken from the Stuart Macaskill Lakes and pumped to the Te Marua Water Treatment Plant.

The two lakes have a storage capacity of 2990ML and currently construction work is underway to increase the capacity to 3390ML and improve seismic resilience. Table 8 summarises the asset details of the raw water storage lakes. Additional information is stored in the AM database.

8.6.2 Asset condition

Regular monitoring of the Te Marua Lakes is undertaken according to the surveillance manual. GWW staff members carry out weekly, monthly,

Table 7: Schedule of water intake assets

Intake	Treatment Plant Supplied	Installation date	Construction	Capacity Limitation	Peak Consented Daily Abstraction Rate (ML/d) ***
Kaitoke	Te Marua	1955	Reinforced concrete	140 ML/d (nominal)	150 ML/d
Orongorongo	Wainuiomata	1926	Reinforced concrete	60 ML/d (Estimate)	40 ML/d **
Big Huia	Wainuiomata	1926	Reinforced concrete	20 ML/d (Estimate)	Included above
Little Huia	Wainuiomata	1926	Reinforced concrete	5 ML/d (Estimate)	Included above
George Creek * (upper)	Wainuiomata	1945	Reinforced concrete	10 ML/d (Estimate)	Included below
George Creek (lower)	Wainuiomata	1988	Reinforced concrete	15 ML/d (Estimate)	Included below
Wainuiomata River	Wainuiomata	1988	Reinforced concrete	60 ML/d (Estimate)	40 ML/d **
	Totals			310 ML/d	210 ML/d **

* Not currently in service

** Combined abstraction from Wainuiomata source and Orongorongo source must not exceed 60 ML/d. Effective consented maximum surface water take = 210 ML/d (Aquifer sourced water is additional to this quantity)

*** Consents expire in 2036

Table 8 Schedule of Raw Water Storage Lakes

Lake	Treatment plant supplied	Installation date	Construction	Capacity (ML)
Stuart Macaskill Lake 1 (north)	Te Marua	1985	Earth	1310*
Stuart Macaskill Lake 2 (south)	Te Marua	1985	Earth	1680*

* To soffit of lowest outlet

quarterly and annual evaluations, inspections and reports. Consultants prepare annual reports about lake performance and condition, and 5 yearly Comprehensive Safety Evaluations are undertaken in accordance with the New Zealand Dam Safety Guideline.

8.7 Aquifer wells

8.7.1 Asset description and capacity

The Waiwhetu aquifer, which lies beneath the lower reaches of the Hutt Valley, is an extremely productive and secure aquifer, which has been used for water supply for many years. Water is abstracted from it at two locations, Waterloo and Gear Island. Wells at these locations contain a submersible pump, screened casing, delivery pipe work and valves.

Abstraction from the Waiwhetu aquifer is regulated by the Environment group of Greater Wellington. Table 9 summarises asset details of the wells. Additional information is stored in the AM database.

Table 9: Schedule of wells

Wellfield	Treatment Plant	Number of wells and pumps	Installation date
Waterloo*	Waterloo	6 fixed speed 2 variable speed	1981 1988
Gear Island**	Gear Island	3 fixed speed	1975

* Consented maximum total abstraction from Hutt aquifer = 115 ML/d except that the 365 rolling day average must not exceed 83 ML/d. Consents expire in 2033

** Gear Island is effectively a standby plant and is only used in unusual or emergency situations

8.7.2 Asset condition

Well head security is important for quality compliance and is regularly checked. The integrity of the well casing screen can only be assessed using a special camera and when the pump is not in position. Whenever pumps are removed for maintenance or inspection, the casing and screen will be inspected.

8.8 Distribution pipelines

8.8.1 Asset description and capacity

Pipeline assets serve two functions, these being to;

- Deliver untreated water from the intakes and well fields to the treatment plants, and
- Deliver treated water from the treatment plants to the supply points.

The pipelines are usually buried but because of topographical constraints may be above ground to span waterways or when installed in tunnels. Pipeline assets include numerous components:, eg,, line valves, air valves, scour valves and bypass valves. Chamber structures of varying sizes house these valves.

Branch pipelines of smaller diameter than the main trunk pipelines are used to deliver water from the trunk mains to supply points that are usually at the inlet of customers' reservoirs.

The description of the pipeline assets are summarised in the following three figures.

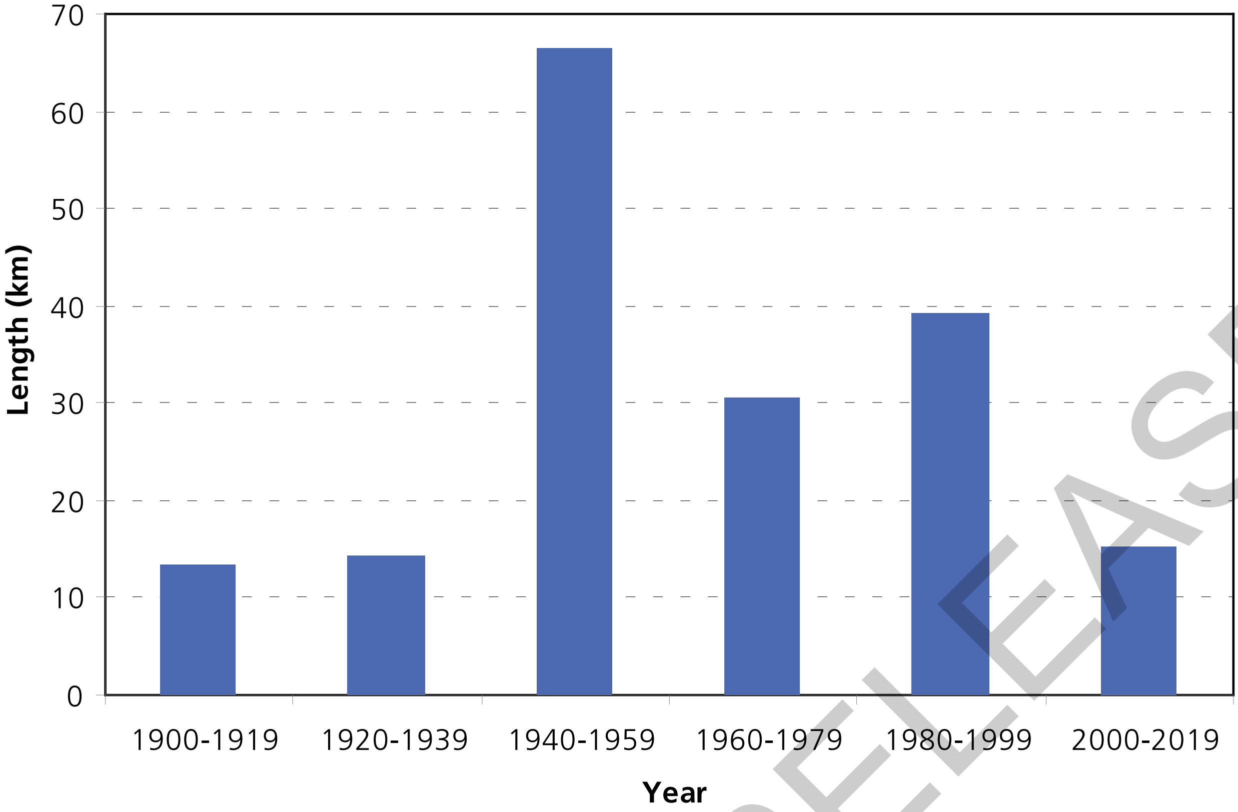

Figure 11: Pipe length by year of construction (source #1087739)

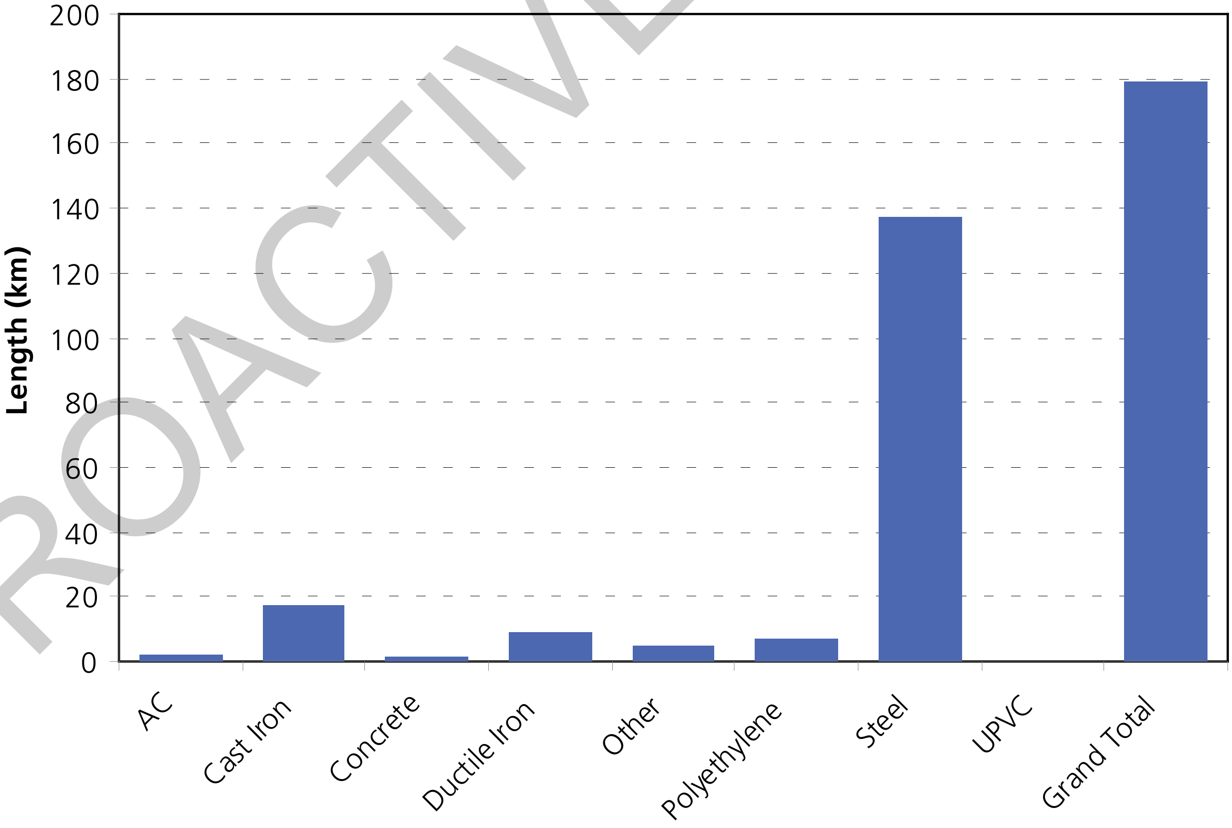

Figure 12: Pipe length by material type (source #1087739)

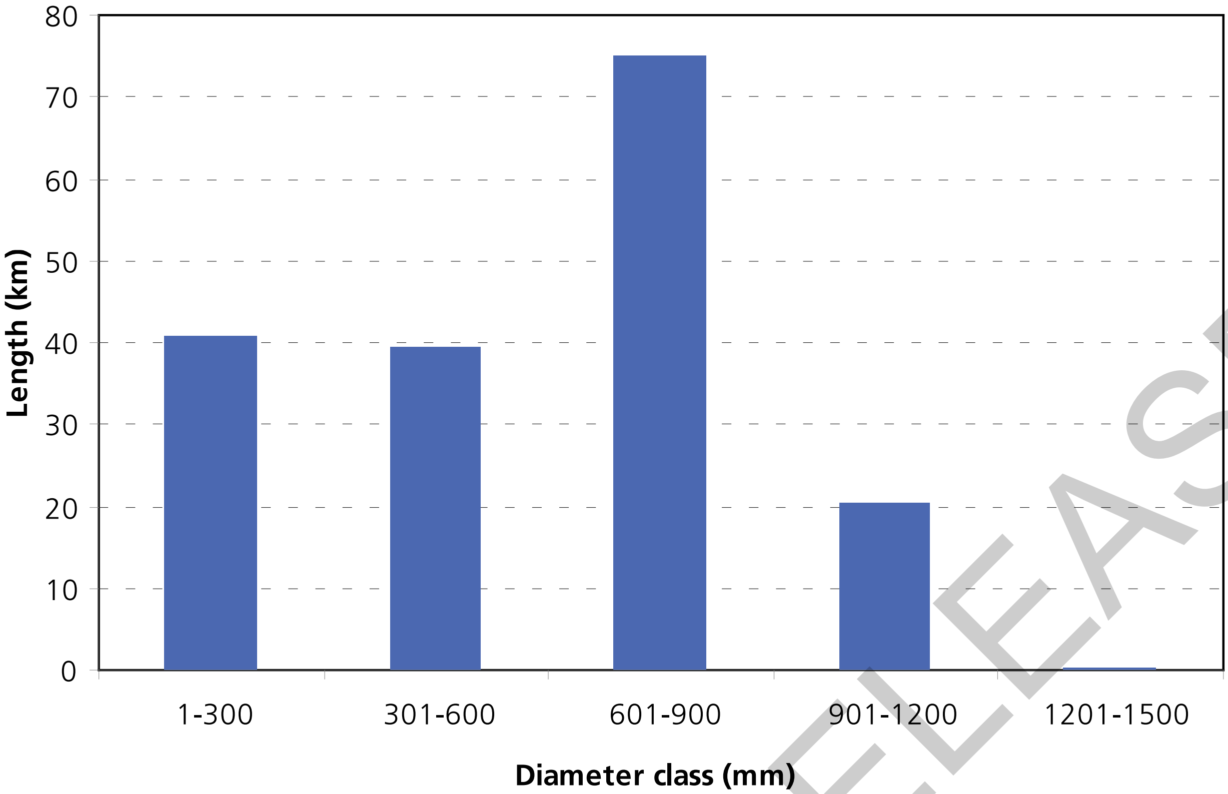

Figure 13: Pipe length by diameter (source #1087739)

8.8.2 Asset condition

All major trunk mains and the majority of branch mains have been either laid or cement mortar lined since 1950. That is, the majority at the pipeline assets have a remaining life of 30 to 50 years at least. Detailed condition assessment work is focussed on assets nearing the end of their useful lives. For example, studies in 2002 led to the replacement of the last section of the 1925 Orongorongo Karori pipeline in 2003/04. The 750mm diameter cast iron main through Wainuiomata, which was laid in 1884 and cement lined in 1989, and continues to provide service. However significant breakages are expected in a major earthquake. Approximately $7m has been scheduled for it's replacement over the period 2016/20.

Pipeline condition assessments are programmed when pipes reach 90% of their anticipated useful life or where there is a significant history of breaks. Pipeline condition assessment will involve taking a number of representative samples and subjecting these to detailed evaluation to determine (primarily) internal and external pitting depths. Extreme value analysis will then be used to estimate when pitting may lead to unacceptable leakage rates. Opportunistic condition inspections are undertaken in association with repairs and other work that involves excavation. A pipe condition inspection record will be completed to document soil types, bedding material, groundwater presence and a description of the condition of the pipe joint or barrel that is exposed (Appendix 6). A similar inspection record will be completed for valves (Appendix 6). Completed condition inspection forms will be used to update the SAP equipment condition rating and determine if further specialist assessment is required.

Asbestos cement pipes have also been the subject of detailed condition assessment in recent years, as AC is recognised in the industry as having a relatively short life. However GWW AC pipes were shown to be performing well and were not in need of immediate replacement.

Losses from the wholesale water mains are currently less that 2%, which is within meter error. Leaks and breaks rarely occur. When they do, the details are recorded and taken account of in detailed condition assessment studies.

Major investment has occurred since the early 1970s in pipeline replacement. The oldest pipes where 100 percent utilisation is required are associated with the Kaitoke to Wellington Supply Scheme. These pipes still have around half of their predicted life remaining.

Apart from pipeline fixtures (valves, chambers, stream crossings), the integrity of a pipeline depends on the integrity of the pipe wall, the exterior coating, the internal lining and the joints.

Regular inspections of pipeline fixtures (valves, chambers, stream crossings) are undertaken. In 2004 a detailed schedule of all above ground pipes was compiled and a programme of maintenance work developed.

Routine investigations in 2007 determined that a number of valves were reaching the end of their economic life earlier than expected. The 2012/13 year marks the completion of a four-year, $1.2 million project, to replace all the air and isolation valves on the Kaitoke trunk main.

All WTP's include pH correction with a target of pH 7.8 to minimise corrosion of downstream pipeline assets (as well as maintain chlorine effectiveness). Investigations are currently underway to determine if chemical dosing can be further optimised by moving to an alkalinity target instead of a pH target.

Cathodic protection (CP) is operational over a limited proportion of the pipeline network. Recent stray current investigations indicate that the problem may be significant in some areas, especially near electrified railway lines. Cathodic protection is often financially attractive, and it is expected that CP infrastructure will be expanded in the coming years as investigations progress.

8.9 Tunnels

8.9.1 Asset description and capacity

Topographical constraints and the need to avoid negative pressure in the pipelines has required pipelines to be installed in tunnels at a number of locations. Pipelines have been installed in tunnels at some locations to carry both treated water and raw water. In addition, there are two tunnels at Kaitoke that act as conduits, conveying raw water without pipes. A schedule of tunnels is given in Table 10.

Table 10: Schedule of tunnels

Tunnel	Length (m)
Raw water tunnels	
Kaitoke No. 1	680
Kaitoke No. 2	2,750
Raw water pipeline tunnels	
Orongorongo No. 1	103
Orongorongo No. 2	3,250
Treated water pipeline tunnels	
Takapu Road Tunnel No. 3	483
Takapu Road Tunnel No. 4	244
Khandallah Tunnel No. 5	352
Karori – Raroa Road	382
Wainuiomata/Hutt Valley 1,100mm steel pipeline tunnel	880
Rocky Point	220
Total	9,344

8.9.2 Asset condition

Tunnels are subject to an engineering inspection every 10 years unless there is a reason to adopt an alternative frequency based on history and/or the nature of their use. Kaitoke No. 1 & 2 are inspected every 5 years because they transport water directly, compared with others that contain steel pipes. The Orongorongo rail tunnel is inspected every two years because it is a crucial transport link into the catchment and because of known issues with loose rock in some areas. The remaining tunnels are inspected every 10 years because they are not accessed regularly, and because they contain pipes to transport water.

Kaitoke No. 1 and 2 tunnels were inspected in 2011 and found to be generally sound. No major areas of instability were found and rock falls of greater than 1 cubic metre are not considered likely. Gravel bed loads are eroding the lining at upstream end of No. 1 tunnel.

Stabilising work is planned for 2012/13 on sections of the Orongorongo tunnel roof, to prevent or reduce the likelihood of a major rockfall. The Karori to Raroa Rd tunnel was strengthened in 2010/11 as part of a seismic improvement project. Wainuiomata tunnel was inspected in April 2011. Water ingress and algal growth were observed, but the structure appeared to be sound.

Takapu Road No. 3 and 4, Khandallah No. 5, Rocky Point and Karori to Raroa Rd have not been inspected since 2003, and are due for inspection in 2012/13.

8.10 Pump stations

8.10.1 Asset description and capacity

Pump stations serve several purposes:

- Deliver treated water from the treatment plants through trunk mains to reservoirs
- Boost flows or pressures on trunk mains
- Lift water from trunk mains to service reservoirs that are higher than the trunk line pressure
- Deliver raw water from the SM Lakes to TM plant
- Transfer water from one part of the distribution system to another (eg, Ngauranga)

Pumps, motors and control equipment are in permanent structures. Standby capacity is installed in all cases. A schedule of collection and distribution pumps is given in Table 11 showing the installed capacity.

Table 11: Schedule of collection and distribution pumps (source #749122)

Pump station	Building constructed	Installed capacity (kW)
Wellington pumps	1981 (Waterloo WTP)	3 x 630kW
Naenae pumps	1981 (Waterloo WTP)	3 x 224kW
Gracefield pumps	1981 (Waterloo TWP)	2 x 224kW
Point Howard	2007	2 x 90kW
Te Marua boost pump 3	1984 (Te Marua PS)	1 x 390kW
Te Marua boost pumps 1/2	1984 (Te Marua PS)	2 x 105/240 kW
Te Marua treatment pumps	1984 (Te Marua PS)	5 x 250kW
Te Marua lake pumps	1984 (Te Marua PS)	2 x 105/240 kW
Wainuiomata No. 1	1961	2 x 150kW
Wainuiomata No. 2 (Moores Valley)	1992	1 x 162kW, 1 x 160kW
Kaiwharawhara	1932	2 x 280kW
Johnsonville	1957	1 x 120kW, 2 x 185kW
Messines Rd pumps	2006 (Karori PS)	2 x 160kW
Kelburn pumps	2006 (Karori PS)	2 x 75kW
Thorndon	1936	2 x 132kW
Ngauranga	1993	1 x 135kW, 3 x 450kW
Haywards	1971	3 x 433kW
Warwick St	1965 (WCC owned building)	1 x 22kW, 1 x 30kW
Lincolnshire	2006 (Lincolnshire PS)	2 x 110kW
Stebbings pumps	2006 (Lincolnshire PS)	2 x 30kW
Gear Island	1976	2 x 350kW, 1 x 315kW
Total (major pumps)		**12,276 kW (50 pumps)**
Wellfield pumps		
Hautana	1981 (Waterloo wellfield)	1 x 57kW
Penrose #1	1981 (Waterloo wellfield)	1 x 57kW
Bloomfield	1981 (Waterloo wellfield)	1 x 57kW
Colin Grove	1981 (Waterloo wellfield)	1 x 57kW
Willoughby #2	1988 (Waterloo wellfield)	1 x 92kW
Willoughby #1	1981 (Waterloo wellfield)	1 x 57kW
Mahoe	1981 (Waterloo wellfield)	1 x 57kW
Penrose #2	1988 (Waterloo wellfield)	1 x 92kW
Gear Island Well-Field	1975	3 x 24.5kW
Total (wellfield pumps)		**600 kW (11 pumps)**
Minor pumps		
Sar St	1986	1 x 18.5kW, 1 x 15kW
Naenae diesel (standby)	1981	1 x 298kW
Gracefield diesel (standby)	1981	1 x 298kW
Kingsley	1976	3 x 37kW
Timberlea	1989	2 x 18.5kW
Pinehaven	1974	2 x 22kW
Total (minor pumps)		**822 kW (11 pumps)**
Grand total		**13,700 kW (72 pumps)**

8.10.2 Asset condition

Haywards pump station is required if a flow of more than approximately 95 ML/d is needed from Te Marua WTP. Haywards PS currently operates very rarely, however the overall system security would be significantly compromised if it was not available. The pumps were installed in 1971 and there was a major refit of controls and motors completed in 1989. The motors have direct current variable speed drives. This technology is now obsolete and motor/drive replacement is scheduled for 2014/15.

Ngauranga pump station enables transfer of water from the Wainuiomata/Waterloo system to the Kaitoke system. This is required when there is insufficient water available from Te Marua WTP (eg, due to maintenance activities), or when low power prices offset the cost of additional pumping.

Thorndon pump station also enables transfer of water from the Wainuiomata/Waterloo system to the Kaitoke system. This pump station supplies water to the downstream end of the Kaitoke system at Karori.

Karori pump station was located very close to the Wellington fault and directly below the lower Karori dam, which is still full (although no longer used for water supply). The Any movement of the Wellington fault would have caused serious damage to the pump station. The station is the only source of water to the large suburb of Karori and therefore a critical asset. Relocation of the pump station to a more secure location on Northland Tunnel Rd was completed in 2006.

A new pump station at Seaview replaced the Pt Howard Pumps at Randwick during 2004. The new pump station is less susceptible to damage from flooding or earthquake events.

Timberlea pump station was constructed to ensure a water supply to the Timberlea reservoir is available when boost pumps at Te Marua are unavailable. This situation has never occurred and the pumps have never operated.

Pinehaven pumps are submersible pumps, located in an underground pit. New pumps were installed in 2004 and the underground chamber up graded. These pumps only operate during periods of high demand.

The installation date of the Kingsley pumps is listed as 1976. The controls were replaced in 1997 and one motor has been replaced. A review of the operation of this pump station has been conducted, but upgrading is not justified. The pumps are only operated during periods of high demand or when the head available in the Kaitoke trunk main is reduced during operation of Haywards PS.

Two of the Johnsonville pumps and the controls were replaced in 2003.

Equipment at Wainuiomata 1, Wainuiomata 2 and Kaiwharawhara Pump Stations is generally new and operating satisfactorily.

A visual condition assessment of pump station equipment was completed in 2012. The results of the assessment are combined with age and replacement value information and presented in Table 12. Graphs showing the percentage of major pump station equipment in each condition grade is given in Figure 14.

Table 12 Pump station asset condition summary (source #1087739)

Site	No. of equipment	No. of assessments	Average condition*	Total replacement value	Average age (expired useful life)	Replacement value of assets with 0-5 yrs remaining life	Replacement value of assets with 6-10 yrs remaining life
Te Marua PS	459	445	1.1	$8,032,573	20	$493,700	$22,790
Waterloo PS	320	315	1.1	$2,889,723	22	$206,000	$1,219,100
Ngauranga	167	159	1.1	$3,948,501	16	$382,500	$150,626
Haywards	122	119	1.6	$3,759,280	32	$249,400	$1,420,300
Kaiwharawhara	66	63	1.2	$1,054,370	21	$54,500	$30,900
Johnsonville	100	95	1.1	$951,433	13	$68,227	$24,900
Thorndon	218	208	1.1	$1,336,844	17	$682,252	$92,400
Timberlea	37	35	1.3	$193,895	20	$41,200	$57,900
Sar St	31	29	1.4	$62,352	21	$22,000	$14,900
Wainui No. 1	74	72	1.1	$498,380	20	$24,200	$14,900
Kingsley	62	59	1.4	$614,357	27	$295,900	$11,900
Lincolnshire	96	94	1.0	$15,695	1	$0	$11,805
Karori	143	140	1.1	$2,306,819	4	$3,000	$7,152
Wainui No. 2	60	58	1.1	$532,354	16	$10,000	$5,900
Pinehaven	34	30	1.6	$259,318	15	$15,000	$900
Point Howard	81	74	1.1	$850,696	4	$0	$0
Grand total	**2070**	**1995**	**1.2**	**$27,306,592**	**18**	**$2,547,879**	**$3,086,373**

*Based on visual assessment

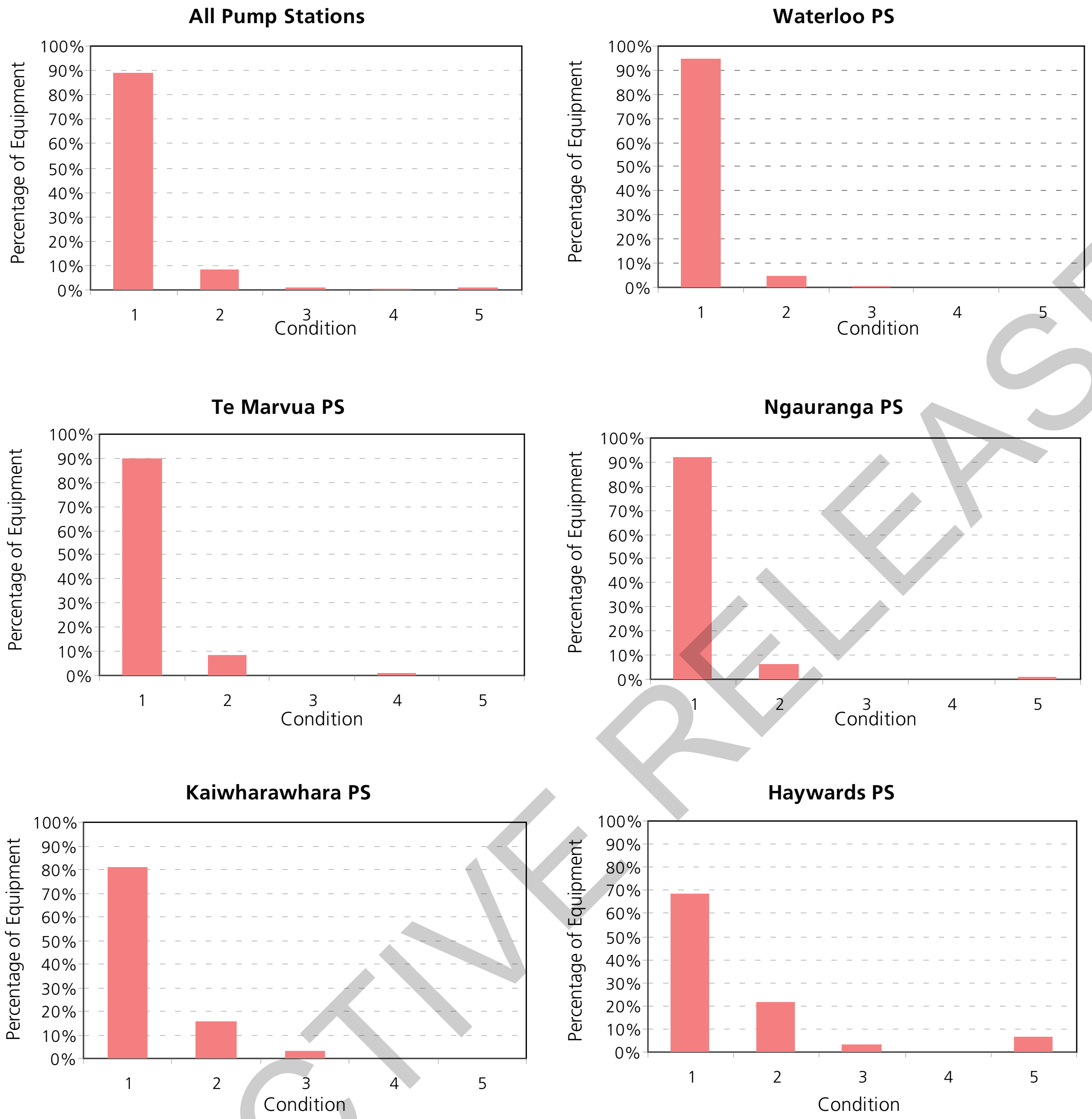

Figure 14: Major pump station – visual condition assessment (source #1087739)

Table 12 shows there is a total of $5.6m in pump station assets nearing the end of their nominal life in the next 10 years. This compares with total capital expenditure provision of $2.7m. The results of the visual condition assessment indicates pump station equipment is generally in very good condition. It is likely that a significant proportion of the assets nearing the end of their nominal life will continue to meet service requirements for some time. Analysis of the notes prepared at the time the condition assessments were completed show a number of assets where refurbishment or replacement should be considered in the next 5 years. The replacement value of these assets is $1.2m (Table 13).

Table 13 Pump Station assets where replacement/ refurbishment should be considered (source #1124943)

Pump station	Replacement value ($000)
Haywards	416
Kaiwharawhara	70
Kingsley	107
Ngauranga	28
Pinehaven	7
Sar St	17
Te Marua PS	518
Thorndon	11
Wainuiomata #1	3
Moores Valley	10
Total	1,187

Pump station assets are typically operated until they fail or until maintenance becomes uneconomic. Additional investigation is required to determine if the useful lives can be extended, or if provision needs to be made for replacement/refurbishment. This will be done as part of the next full revaluation in 2012/13.

8.11 Water treatment plants

8.11.1 Asset description and capacity

Water treatment plants at Wainuiomata and Te Marua treat river-sourced water. The treatment plants at Waterloo and Gear Island receive artesian aquifer water and rely on the secure groundwater to provide a supply free of microbiological contamination.

(a) Te Marua Treatment Plant

This is a modern plant (1989), which incorporates coagulation, flocculation, clarification, dual media filtration, pH adjustment, chlorination and fluoridation. Normally water direct from the Kaitoke intake on the Hutt River is treated, but during times of high colour or turbidity or when river flows are very low, stored water from the Stuart Macaskill lakes is treated. Trials in 2002 determined that river water, which is normally of a high standard, could be more efficiently treated by direct filtration methods, that is, the clarifiers are by-passed. In this mode the plant was ran at 135 ML/d during trials in April 2004. However, when treating lake water use of the clarifiers is necessary, and this down-rates the plant capacity to approximately 80 ML/d. This lead to implementation of an alternative configuration to enable different treatment processes to be employed simultaneously for lake and river water. This enables blending of water when the river is low and demand is high. Te Marua WTP meets the requirements of the DWSNZ:2005.

(b) Wainuiomata Treatment Plant

The Wainuiomata WTP was commissioned in 1993 and incorporates coagulation, flocculation and filtration. The process utilises Dissolved Air Flotation (DAF), where air coming out of solution lifts the floc and is floated off. After the floc is lifted the water passes through a conventional sand filter. The plant also corrects pH and adds chlorine and fluoride. The nominal plant capacity is 60 ML/d. The plant meets the requirements of the DWS NZ:2005.

(c) Waterloo Treatment Plant

Waterloo WTP meets the DWS NZ 2005 by virtue of the fact that the Waiwhetu aquifer has been shown to be secure under the criteria set out in the standard. Treatment includes adjustment of pH by aeration to remove dissolved carbon dioxide, the addition of lime and fluoridation for Lower Hutt (excluding Petone as requested by HCC).

(d) Gear Island Treatment Plant

The Gear Island WTP fulfils two functions. It acts as a stand by plant when water is drawn from the wells, but also routinely chlorinates and fluoridates the water from Waterloo being pumped to Wellington. In this latter role it effectively acts as an extension of the Waterloo Plant. Gear Island Waterloo WTP meets the requirements of the DWS NZ 2005.

8.11.2 Asset condition

A visual assessment of water treatment plant equipment was completed in 2012. The expectation would be for WTP equipment to be in good condition given the acknowledged history of good procurement and maintenance practices. This expectation is supported by the average condition scores summarised in Table 14. There is a small difference in condition across the four treatment plants consistent with equipment age.

Across the four treatment plants there are approximately 2000 equipment that have not had a condition assessment completed. A large proportion of these are electrical appliances (kettles, extension leads, etc) and safety equipment that was not within the scope of the assessment project. There is a high degree of confidence that practically all WTP equipment that can be accessed has had a condition assessment. This was achieved through a comprehensive process of physical site inspections comparing Process & Instrumentation Diagrams with extracts from the AM database.

Figure 15 shows the equipment condition distribution for each WTP and all WPT's combined. The results show a strong bias towards very good and good condition.

Table 14 Water Treatment Plant asset condition summary (source #1087739)

Site	No. of equipment	No. of assessments	Average condition*	Total replacement value	Average age (expired useful life)	Replacement value of assets with 0-5 yrs remaining life	Replacement value of assets with 6-10 yrs remaining life
Gear Island WTP	657	625	1.3	$8,159,452	18	$1,697,303	$244,114
Te Marua WTP	3304	2750	1.2	$102,109,814	15	$3,991,823	$4,425,374
Waterloo WTP	1334	861	1.2	$20,089,897	15	$1,735,228	$3,228,090
Wainuiomata WTP	2835	1701	1.1	$90,139,374	16	$3,349,308	$2,155,431
Grand Total	8130	5937	1.2	$220,498,537	16	$10,773,662	$10,053,009

*Based on visual assessment

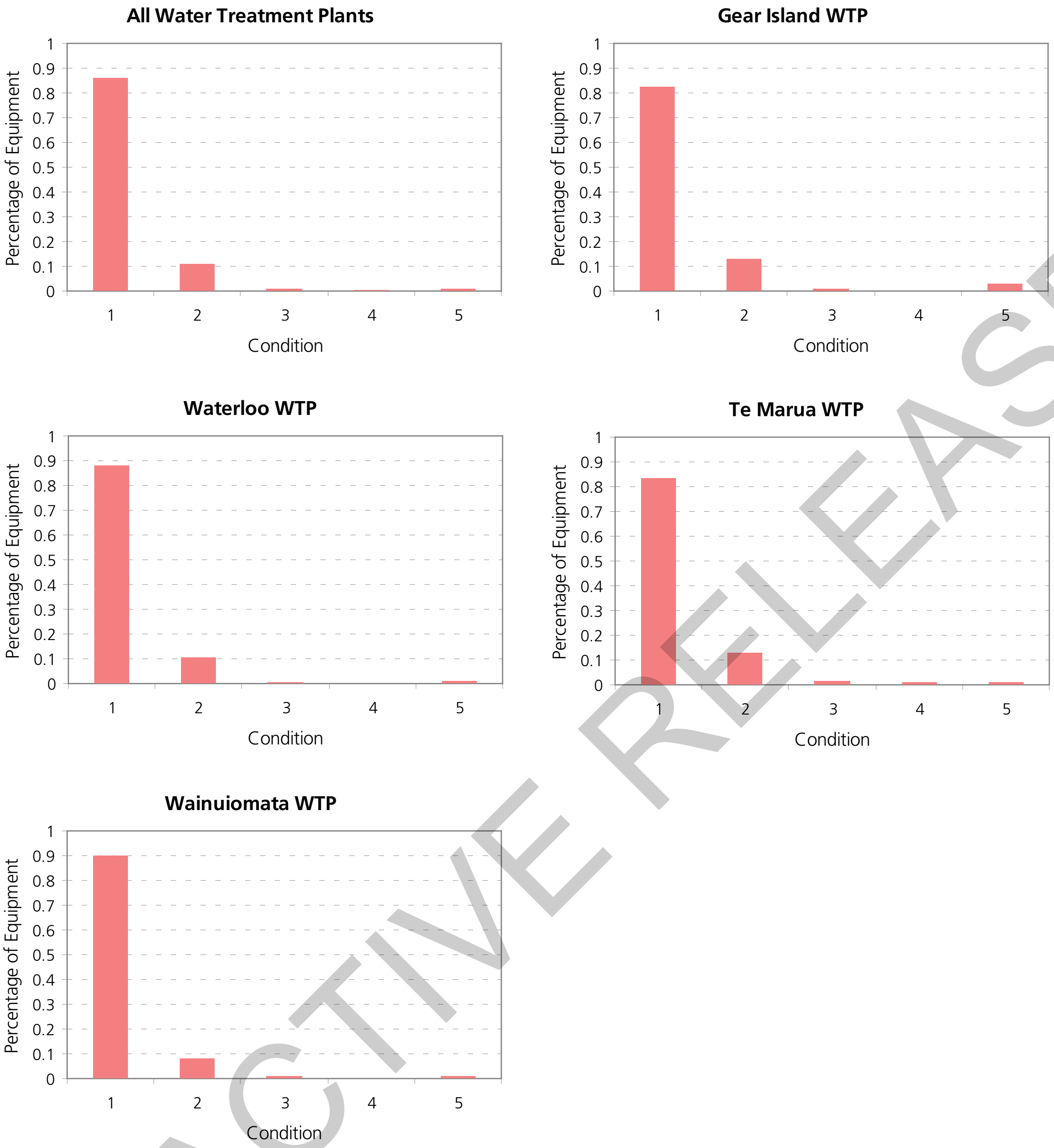

Figure 15: Water treatment plants – visual asset condition assessment (source #1087739)

Table 14 shows there is on average $2m p.a. of WTP assets reaching the end of their nominal life over each of the next 10 years. This compares with capital expenditure provisions of around $1m p.a. Analysis of the notes prepared at the time the condition assessments were completed indicate a significant number of assets where refurbishment or replacement should be considered in the next 5 years. The replacement value of these assets is $3.3m (Table 15).

Table 15: Water treatment plant assets where replacement/refurbishment should be considered (source #1121764)

Water treatment plant	Replacement value ($000)
Wainuiomata	$128
Te Marua	$1,103
Gear Island	$16
Waterloo	$2,101
Total	$3,348

The condition of many of these assets is good, and additional investigation is required to determine if the useful lives can therefore be extended, or if provision needs to be made for replacement/refurbishment. This will be reviewed in conjunction with the next full revaluation in 2012/13.

8.12 Treated water reservoirs

8.12.1 Asset description and capacity

Generally treated water is delivered to service reservoirs that are owned by the city council customers. The reservoirs that are owned by the Wellington Regional Council are constructed at treatment plants for process reasons, or connected to trunk mains to provide diurnal[3] storage or for system control. Treatment plant reservoirs at Te Marua, Wainuiomata, Gear Island and Waterloo are included with treatment plant assets. Other reservoirs are listed below:

Table 16: Schedule of Reservoirs

Location	Constructed	Construction	Volume
Ngauranga	1997	Precast, post tensioned concrete	20 ML
Haywards	1970	Post tensioned concrete	18 ML
Karori contact tank	1960	Reinforced concrete (Service reservoir for Wellington City Aro zone)	2.2 ML

8.12.2 Asset condition

Exterior Inspection Programme: The exterior of reservoirs (walls, roof, and, where possible, underdrain's) will be inspected five yearly. Items to identify and record are cracks, seepage, rust marks, joint deterioration, soundness of ladders, access lids and vents, and any graffiti.

Interior Inspection Programme: The inside of reservoirs should also be inspected at 10-yearly intervals. Items to be identified and recorded are build-up of silt on the floor, sealant loss or degradation, possible slime accumulation on walls and corrosion of ladders and safety equipment.

Current condition:

Recent inspections identified minor seepage from the wall/floor joint of the Ngauranga reservoir and corrosion of the overflow pipework in the Aro reservoir. The overall condition of the reservoirs is good, requiring no significant maintenance or refurbishment expenditure.

Modifications of the valving and pipe work at the No. 2 Hayward's reservoir in 2002 have enabled control of inlet and outlet flows with consequent more effective use of the reservoir for diurnal storage. The site of the reservoir is however likely to be damaged in a large earthquake, with a resultant loss of emergency storage. Options for additional treated water storage are being considered.

8.13 Control systems, telemetry and flow meters

8.13.1 Asset description and capacity

Treatment plants, pump stations, intakes and well fields all contain instrumentation and control equipment. These assets are included on the asset lists associated with the particular facilities. In addition, there is instrumentation for flow and level measurement and electrical control equipment at numerous locations in the distribution system. Usually the equipment will be associated with individual supply points and will be required to control the flow rate into, or level of customers' service reservoirs. Flow meters at supply points are used to measure water quantities delivered for calculation of the water levy to be charged to each city. Communication between supply points, treatment plants and pump stations is achieved using radio telemetry equipment. The equipment is housed in below ground chambers or small above-ground structures.

Considerable resources have been invested in fully automating the water collection, treatment and distribution processes. Water Treatment Plants are only staffed during normal business hours, with operators able to remote access the SCADA system from an offsite location to respond to alarms and adjust control setpoints as required.

A roadmap for development of control system infrastructure has been prepared and is updated continuously as technology changes and as our approach to risk control develops (refer #1128421). The roadmap is divided into the following six sections, each representing a functional system layer:

1. **Instrumentation and controls**
   At this layer we have a substantial installed base of measurement instrument devices to monitor our processes. Our control devices are almost exclusively valves and pump-sets.
2. **Basic control system**
   Our primary platform at this layer is Rockwell Automation's ControlLogix. Within the code base we implement two distinct sub-layers. The Device/Control Module layer interfaces with all process measurement and control devices; while the Application layer above implements the Functional Automation. These two layers are where most of the real-time process control resides, and can be considered the foundation of the control system.
3. **Advanced Process Control**
   Beyond the Basic Control system are new opportunities to implement sophisticated real-time automation strategies that fall under the umbrella term Advanced Process Control (APC).
4. **SCADA/HMI operator**
   Our established platform at this level is Vijeo Citect SCADA. This is the layer that gives plant operators visibility to the process and control system.

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[3] Diurnal storage provides for demand peaks during the day, with the objective of smoothing demand over a 24 hour period.

5. **Historian and data analysis**
   At present we run two platforms in parallel, a legacy Citect Historian and newer Rockwell FT Historian and Vantage Point reporting/analysis tool.
6. **System networks and server architecture**
   The architecture that links all these layers together is critical. The primary considerations are security, bandwidth, latency, determinism and resilience. All our future developments in this layer will be Ethernet TCP/IP based.

8.13.2 Asset condition

Monitoring to ensure instrumentation, automatic controls and telemetry equipment are operational is carried out on a continuous basis. Critical equipment where calibration drift is likely (eg, pH analysers) use triple validation to ensure an accurate signal is used for process control.

Manual calibration checks are initiated from maintenance plans contained in the AM database, and by operators after monitoring trends. Calibration history and calibration records are retained on file.

Replacement of all revenue flow meters with electronic “magflow” meters was completed around 2000. Since completion of this work a very good balance between supply and delivery volumes has been achieved (within 2%).

The inflow of water into customers’ reservoirs is controlled remotely via the telemetry system. Should communications be lost, local controls take over automatically and keep the reservoirs full (provided power supply is still available). For historic reasons, the telemetry systems operated by the Wellington City Council and GWW are closely linked.

Remote reading of revenue meters has been operational since 2004. This has reduced the number of visits required to read meters from weekly to once every six or twelve months.

8.14 Access way assets

8.14.1 Asset description and capacity

The principal roads that are owned by GWW have been constructed and maintained to allow access to treatment plants and into the catchment areas beyond the treatment plants. The more important roads are sealed while remote access tracks remain unsealed, but are constructed with good roadside drainage and traversing culverts to protect them from water damage. In addition, some other installations (eg, treatment plants), incorporate car or truck parking facilities.

8.14.2 Asset condition

Visual inspections of roads and bridges will be completed at 5-10 year intervals (depending on age). Structural assessments of bridges will be undertaken as judged necessary.

The cost of road and bridge maintenance at Kaitoke is shared 50/50 with the Regional Parks Department. Most access bridges have been recently upgraded and all are in good condition.

During a storm in February 2004 damage occurred to the main access bridge to the Wainuiomata treatment plant. The central pier was undermined and displaced. A temporary ‘bailey’ bridge was erected within a few days and repairs were completed by GWW’s insurers.

The programme of inspection and refurbishment/ maintenance work is operating satisfactorily. Work on the Orongorongo pipe bridge was completed in 2012. This included replacing the walkway supports and handrails. Repainting the pipe bridge is scheduled for 2012/13.

A road surface condition assessment scheduled for 2012/13 will identify any roads requiring reseals in the next five years.

9. Financial summary

9.1 Background

9.1.1 Funding strategy

All expenditure incurred in carrying out the operations, maintenance, renewals and capital activities within The Water Group is funded from the wholesale water levy, transfers to and from reserve investments and new debt. Water Supply funds are kept separate from other Council funds and may only be used within the Water Supply group.

The type of expenditure dictates the method that will be used to fund it.

- All expenditure incurred to operate and maintain the wholesale supply network is funded from the wholesale water levy. These costs are a component of each customer Councils' water rates and charges
- Capital expenditure incurred on new assets to enhance and improve the system is usually funded by new debt

Any surplus of income over expenditure on operational activities at financial year end is transferred to debt repayment or reserves.

A transfer to the insurance reserve of $400,000, from which the cost of repairing any damage to self-insured assets is funded, is made each year. Interest is capitalised at the end of each year as it is reinvested thus increasing the value of the fund.

The smoothing of variations in cash flows is assisted as a result of the above strategy. Capital expenditure is uneven because of the nature of the assets and the long life of many of them. Because of this, the actual new debt drawn will vary. This method also meets the intergenerational spread of capital works, which in the Water Group typically have a long asset life.

(a) Assumptions

The main assumption is that Greater Wellington Water will remain in its current structure.

Several attempts to create a more efficient integrated regional water supply organisation have been made over the past few years but change has not yet been supported by GWW. The recent creation of the Auckland "Super Council" and announcements from the Minister of Local Government have created an atmosphere of likely change to the status quo. There is also increasing public comment and protest at the level of rates increases and local authority salary levels. The Local Government Minister in a recent article in The Listener on 25 February was quoted as saying:

"Smith says a key reform will be the abolishing the regional council system, because he believes it has unhelpfully separated issues that need to be tackled on a more co-orperative basis, such as water and land management "We just don't need that extra layer of bureaucracy".

Former Waitakere Mayor Bob Harvey and Far North District Council Mayor Wayne Brown were also coted with similar quotes in support of abolishing Regional Councils. Until such time as concrete change is planned the Water Group will plan and budget based on the Status Quo.

The following general assumptions and explanations apply to the financial information provided:

- The information is made up of all activities funded by the wholesale water levy, as well as the asset acquisitions, asset disposals and capital projects undertaken by GWW for the benefit of the wholesale supply network. Specifically, this includes Operations Administration, Production and Distribution Sections of the Operations Group, and the Strategy and Asset Group
- Costs incurred by the contracting of services from internal business units and the Support Services Department are incorporated in both the reported costs as internal consultant charges, and shown as part of the reported total internal revenue figure (approximately $1m per annum)

(b) Expenditure definitions

Maintenance expenditure	The expenditure required to preserve the level of service provided by an asset. Responsibility for maintenance expenditure lies with the Production and Distribution Managers.
Capital expenditure – renewals	The expenditure required to refurbish or replace an asset to restore or improve its level of service. Responsibility for renewal expenditure lies with the Asset and Quality Manager and it is funded from the Capital Works Programme.
Capital expenditure - extensions	The expenditure required to create a new asset or to extend the level of service of the system. This expenditure may result from growth, changing customer needs, environmental protection, public health protection, occupational health and safety issues or security of supply, eg, seismic, drought or flood protection. Responsibility for capital expenditure lies with the Asset and Quality Manager.
Disposals	Any net costs associated with the disposal of decommissioned assets

Note: all funding programmes are subject to consultation and approval by Council through the Annual Planning process. All funding programmes are reviewed each year

9.1.2 Water supply levy

(a) Legislative basis

The Wellington Regional Water Board Act 1972, (WRWBA) provides for the recovery of all costs of supplying wholesale water from the customer authorities and forms the basis for setting the annual revenue requirement. More specifically:

Section 26(1) of the Act states:

> *"It shall be the function of the Board to investigate, construct, extend, enlarge, maintain, and repair waterworks for the bulk supply of pure water to constituent authorities."*

That is, Greater Wellington has a statutory duty to provide adequate water to the constituent authorities because Greater Wellington acts as the Board. It assumed the functions of the Board when it was formed in 1980.

At present, the constituent authorities are the four city councils in the Wellington region.

(b) Financial basis

The annual levy is set to cover operating costs, interest on debt and a level of debt repayment. As part of the Annual Plan process, city customers are consulted about various aspects of the water supply business including the levy for the year ahead.

Each city pays for their water based on the ratio of their individual usage to the total usage for the year. They make interim monthly payments based on the usage ratios of the previous year. At the end of the year, when each authority's actual usage for the year is known, an adjustment is made so that each authority's payment for the year matches their actual usage. Customers currently prefer this methodology though there is provision in the WRWBA for both, fixed and variable charging, or a combination method.

(c) Historical trends

In the 15 financial years since 1996/97, GW has cut the wholesale water levy three times, held it 10 times and increased it only twice, including a 3% increase for the 2011/12 year

The levy for 2011/12 is $1.05M (4.2%) less than it was in 1996/97. If the levy had increased in line with inflation since 1997, it would now be just over $35M, rather than the present level: $24.2M[3]

The increase in Water Supply expenses (before interest and depreciation) between 1996/97 and 2010/11 was 10.6%. The CPI index has increased some 33% between 1997 and 2011[4]

External cost increases have been offset through operational efficiency and innovation which have helped in the reduction of operating costs. Major gains have been made through the adoption of modern technology to automate the control and monitoring of water treatment plants, pump stations and reservoirs. Increased data collection and the use of sophisticated analysis tools has allowed detailed investigations and analysis work to be carried out which has led to the optimisation of water treatment processes and a reduction in chemical use.

- Treatment process optimisation at Te Marua, including direct filtration, saved almost $250,000 in its first year, through lower electricity and chemical needs (1999/2000)
- Software commissioned to optimise delivery costs of water, by prioritising the use of source water, treatment and distribution with the lowest marginal cost at any given time (2000). The Derceto Energy Cost Minimisation System[5] was a world 'first' and delivered cost savings estimated at $120,000 in its first year of use. The Derceto system was awarded an ACENZ[6] Gold Award of Excellence in 2002 and Highly Commended in EECA's Energywise Awards of the same year[7]
- On-line wide spectrum spectrophotometers installed at Te Marua and Wainuiomata water treatment plants (2003) to identify organic contaminant loading in raw water. Research by

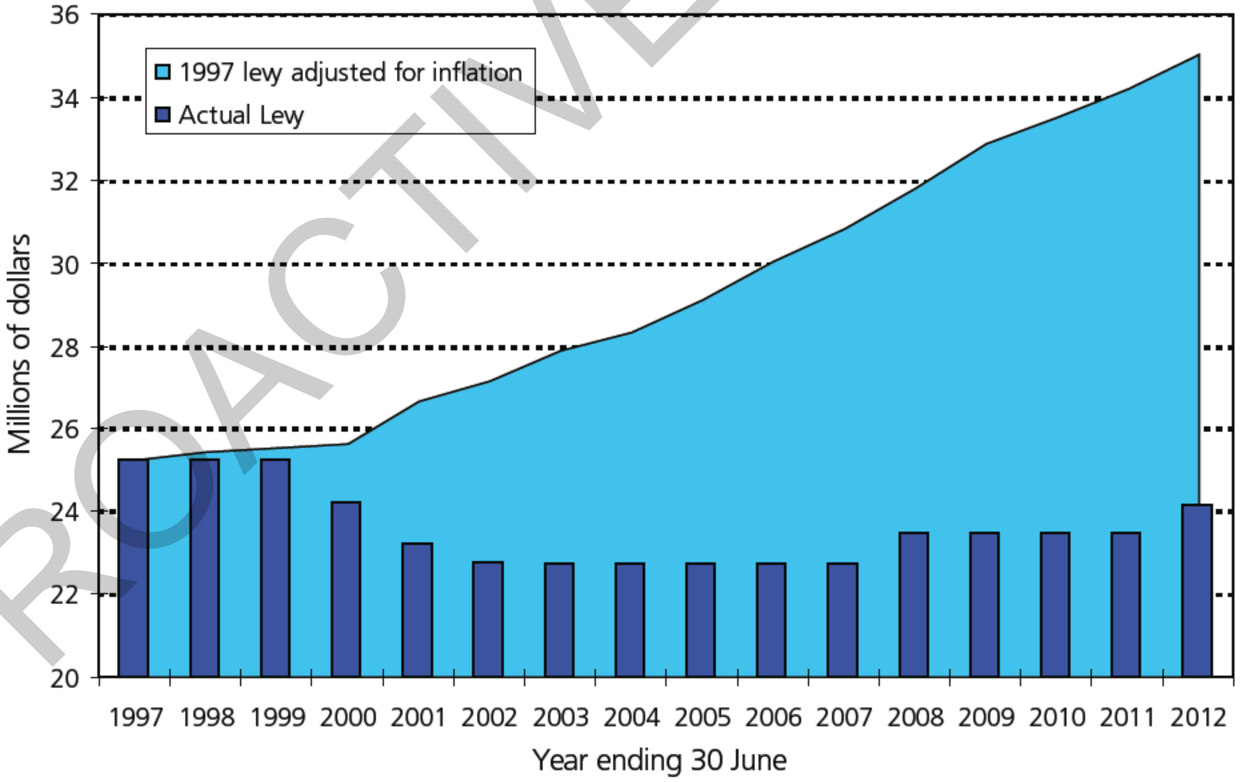

Figure 16: Water levy (net) and CPI inflation (#1063554)

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[3] Levy figures net of GST. The effect of the increase in GST from 1 October 2010 on CPI estimated by Asia Pacific Risk Management, September 2010

[4] CPI figures 12 months to December, CPI for December quarter 2011 forecast at 1165

[5] Developed for Greater Wellington by Beca

[6] Association of Consulting Engineers New Zealand

[7] Contact energy Innovation Award category

consultants using this instrumentation resulted in the development of a unique, feed forward, system for chemical dose control that improves treatment process efficiency, water quality and plant reliability. This feed-forward system was a world-first and has been adopted by water suppliers in Australia and the UK

- Installation of power generating capacity at Wainuiomata. By the end of the second quarter 2012, more than 0.5 GWh of electricity had been generated since the hydro electric generator was commissioned in the first quarter of the financial year. On a yearly basis, about 1.5 GWh is expected. When combined with the 1 GWh from the Te Marua generator, the plants are expected to produce 13% of the Water Supply Group's electricity requirements

(d) Looking Forward

Additional supply capacity will be required by June 2020 to maintain the supply standard. This will be either a storage dam located on the Whakatikei River or a third storage lake at Kaitoke, although further work may show that there is an option for a less costly interim project that could defer construction of one of the major projects by several years. Current cost estimates put the cost of the dam option at approx $140m with associated network upgrades – mainly to pump stations – at a further $20m. The cost of an additional lake is approx $90m.

The Canterbury earthquakes have highlighted the importance of the resilience of regional water supply infrastructure. Our water supply system is vulnerable to earthquakes and our research estimates that following a significant earthquake on the Wellington fault it would take around six to eight weeks to reinstate a wholesale water supply sufficient to meet basic needs. Work is budgeted to enhance network resilience to ensure damage is minimised and what damage does occur can be repaired and water supply restored in the shortest practicable time.

To fund these works and reduce Water Supply's level of debt in anticipation of the major expense involved in a new water source, the Greater Wellington Long Term Plan contains the budgeted Water Levy increases shown in Table 17. A 10-year financial projection showing the levy increases, capital and operating expenditure and the effect on dept is given in Figure 17.

Table 17: Water Supply levy increases for 2012/22

2012/12	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
3%	4%	4%	5%	5%	5%	5%	5%	5%	5%

The proposed levels of Water debt remains within the Councils debt limits. Figure 18 shows Water Supply debt relative to the total Council debt.

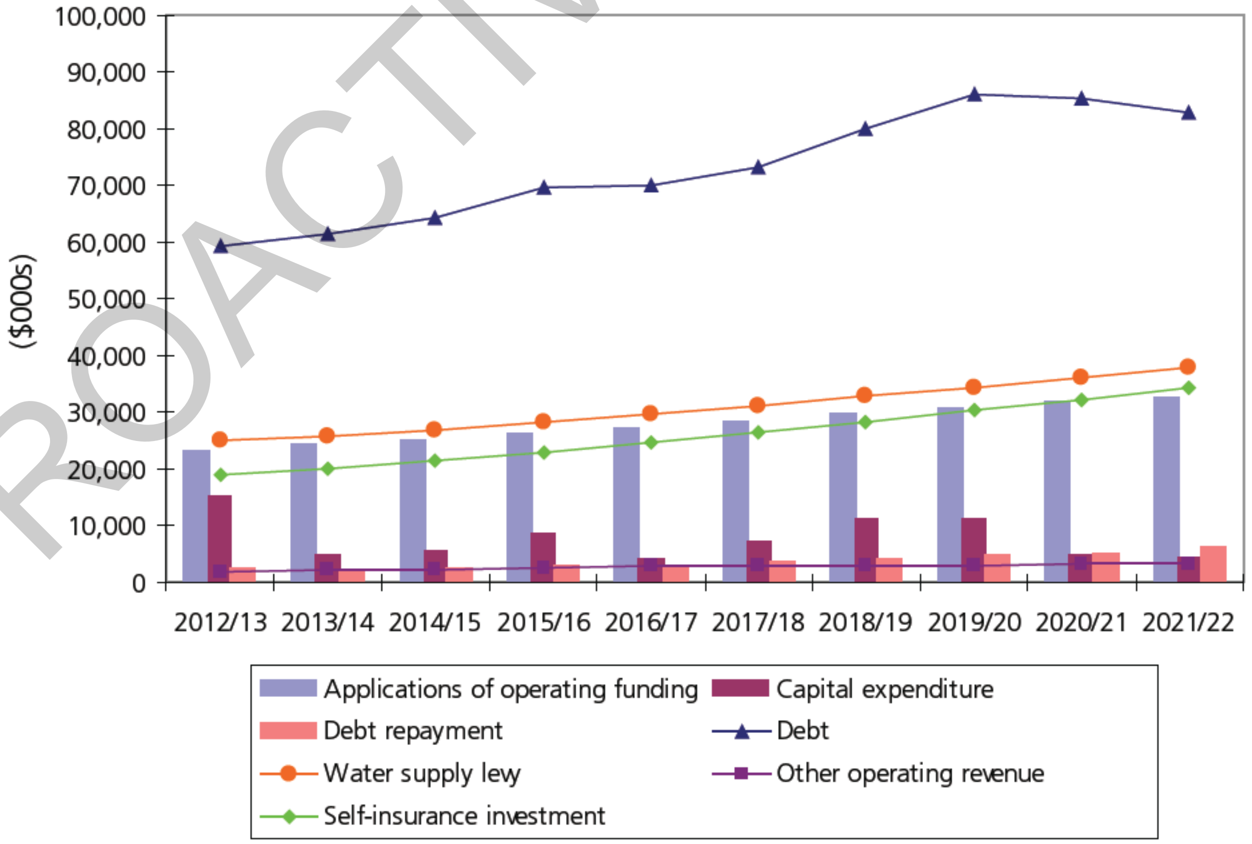


Figure 17: 10-year financial projections (#1063554)

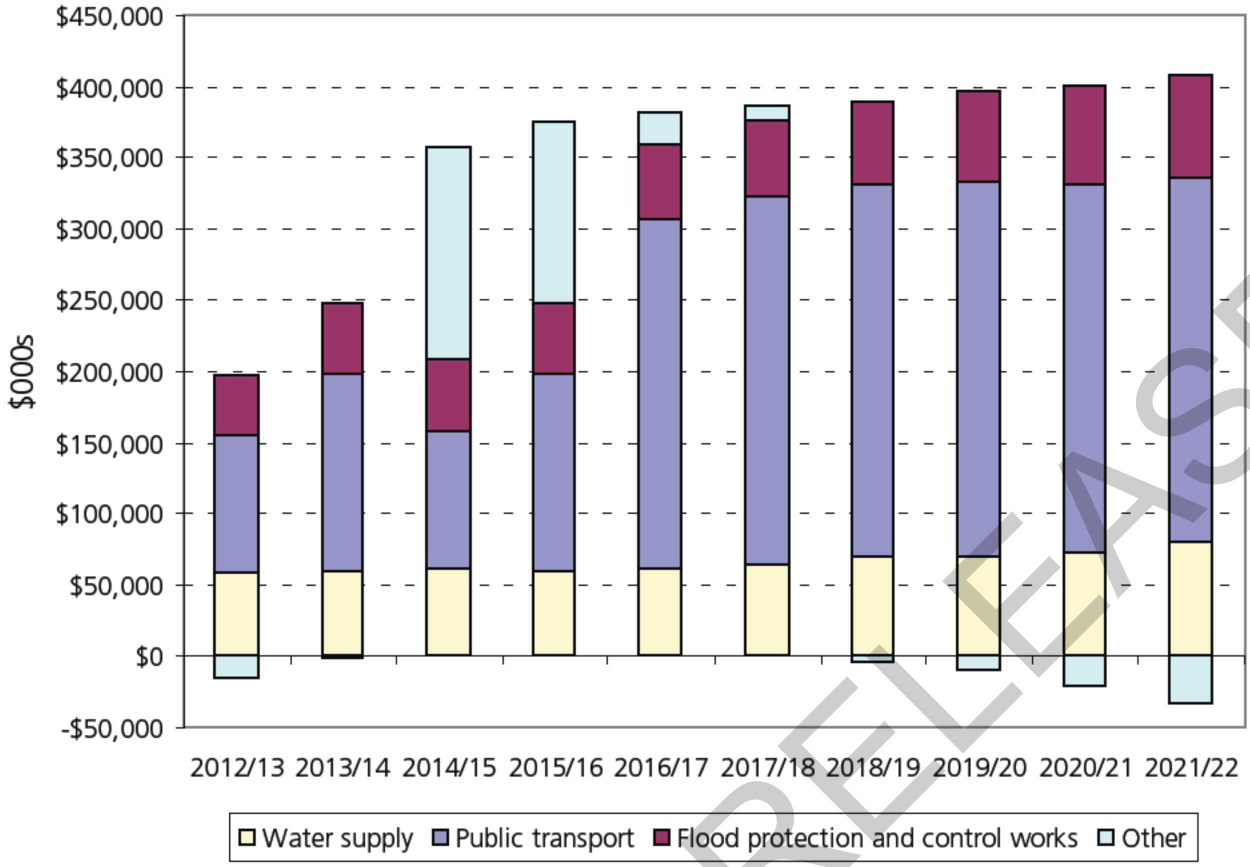


Figure 18: 10-year debt projections (#1063554)

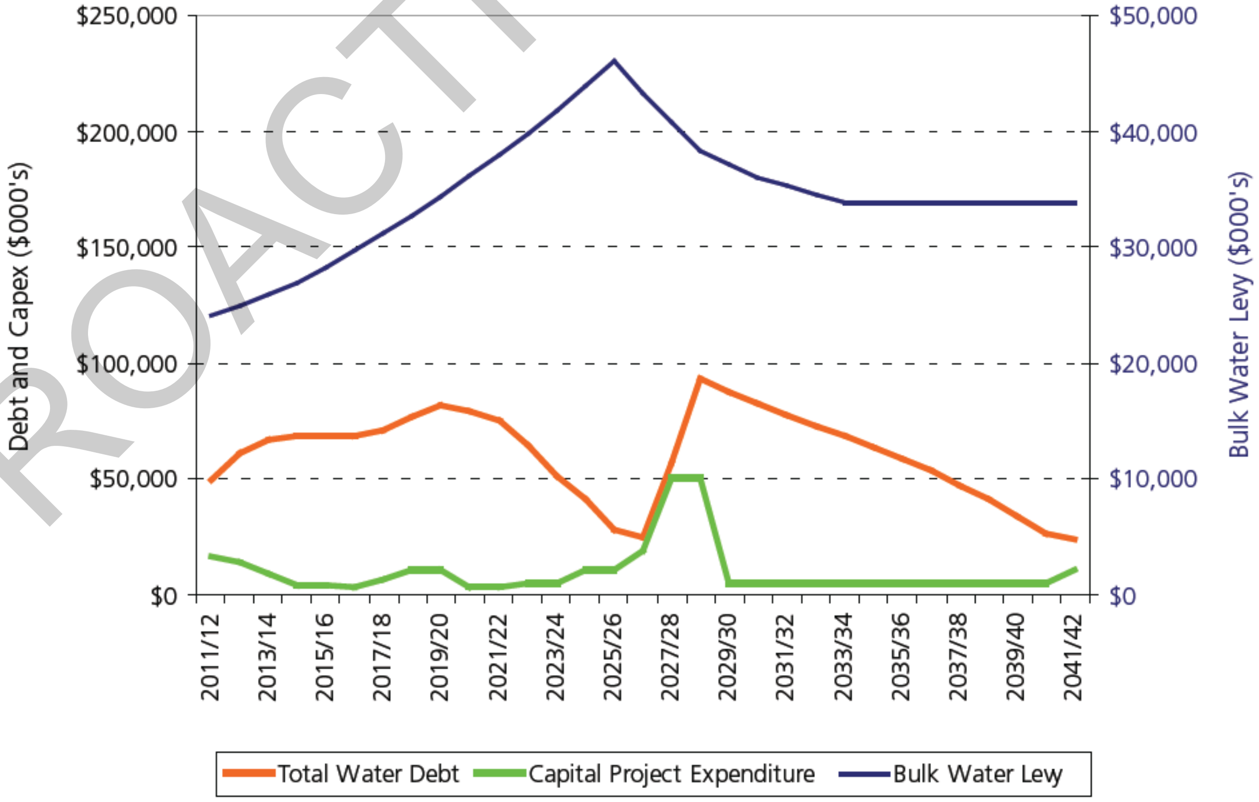


Figure 19: Projected 20 year capital expenditure and debt funding (#1063554)

Water supply has also undertaken some longer range debt forecasting as the major investments required in additional water sources and storage fall outside the range of the Council's long term planning timeframe (Figure 19). Water Supply's projections take into account the need to increase the Water Levy until 2025/26 to reduce debt before the expected $140m expenditure on the next water source. The levy will reduce between 2034/35 and 2041/42 as sufficient surpluses are produced to meet debt and interest servicing. Beyond 2041/42 increases will again be required because it is anticipated at that time – if expected population growth continues – additional source augmentation will be required. These projections are based on the LTP inflated 10-year figures. Allowance has been made in future years for inflation of 2% on general operating expenditure. It is also assumed, beyond the LTP that debt interest rates are held at 8%. The state of the worlds financial markets, particularly with the turmoil currently occurring in Europe over government debt levels make long range forecasting problematic.

9.2 Financial projection

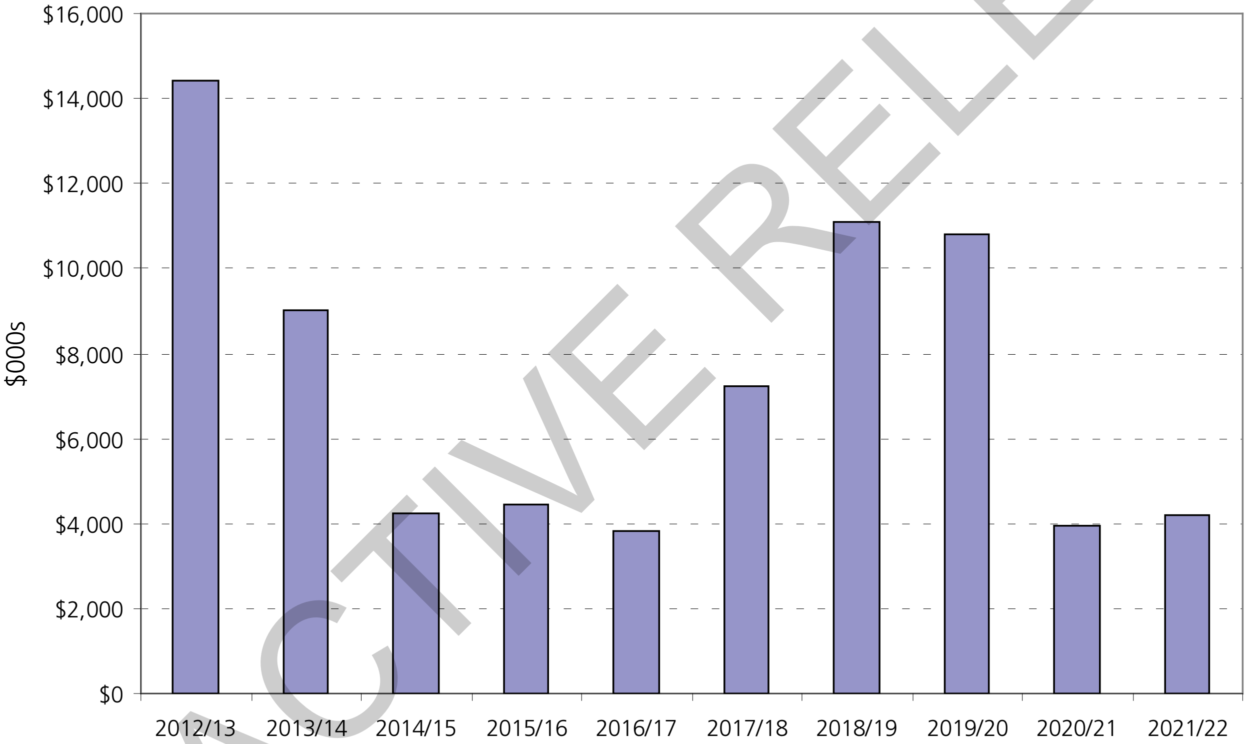
9.2.1 Capital extensions and renewals expenditure

The forecast capital and renewals expenditure is shown in Figure 20. Project budgets are shown in base year numbers with the equivalent inflated LTP figures in summary.

9.2.2 Operations and maintenance expenditure

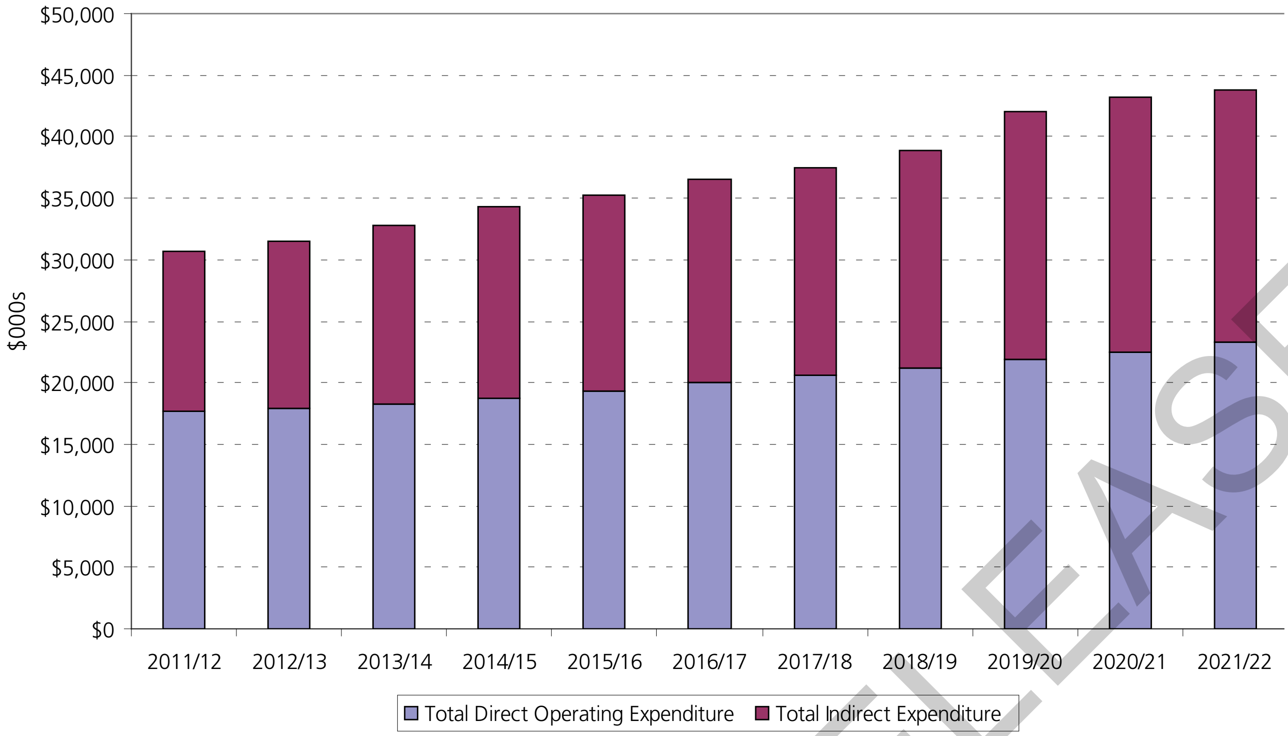
The budgeted major components of operations and maintenance expenditure is shown in Figure 21.

Figures are based on the 2012/13 base budget and adjusted for inflation and known changes. There are no significant changes budgeted for in the 2012/22 LTP.



Year	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**
Water sources	$7,530	$825	-	-	-	-	-	-	-	-
Water treatment plants	$845	$839	$814	$949	$922	$949	$977	$1,006	$1,038	$1,071
Pipelines	$1,827	$537	$501	$628	$1,305	$3,583	$3,774	$2,012	$1,433	$1,483
Pump stations	$490	$103	$692	$771	$251	$118	$122	$126	$130	$135
Reservoirs	-	-	$160	-	-	-	-	-	-	-
Monitoring and control	$740	$815	$192	$418	$205	$212	$219	$226	$235	$243
Seismic protection	-	$826	$852	$881	$228	$236	$243	$252	$261	$270
Energy	$135	-	-	-	-	-	-	-	-	-
Other	$2,410	$4,816	$686	$430	$442	$1,630	$5,331	$6,762	$486	$500
Capital project expenditure	**$13,977**	**$8,761**	**$3,897**	**$4,077**	**$3,353**	**$6,728**	**$10,666**	**$10,384**	**$3,583**	**$3,702**
Land and buildings	-	-	-	-	-	-	-	-	-	-
Plant and equipment	$81	$83	$86	$89	$92	$95	$98	$101	$105	$109
Vehicles	$360	$157	$264	$261	$380	$424	$318	$309	$279	$382
Total capital expenditure	**$14,418**	**$9,001**	**$4,247**	**$4,427**	**$3,825**	**$7,247**	**$11,082**	**$10,794**	**$3,967**	**$4,193**

Figure 20: Forecast capital and renewals expenditure (#1063554)



Year	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**
Total Personnel Costs	$4,301	$3,915	$4,009	$4,106	$4,212	$4,322	$4,426	$4,527	$4,645	$4,771	$4,899
Chemicals	$1,635	$1,547	$1,597	$1,648	$1,704	$1,763	$1,823	$1,883	$1,946	$2,016	$2,086
Property Expenses	$1,732	$1,876	$1,936	$1,997	$2,065	$2,138	$2,210	$2,283	$2,359	$2,444	$2,529
Power - Used in Production	$2,300	$2,381	$2,457	$2,536	$2,622	$2,714	$2,806	$2,899	$2,994	$3,102	$3,211
Insurance	$1,240	$1,910	$1,971	$2,034	$2,103	$2,177	$2,251	$2,325	$2,402	$2,488	$2,576
Total Contractors & Consultants	$2,121	$2,205	$2,105	$2,172	$2,246	$2,325	$2,404	$2,483	$2,565	$2,658	$2,751
Internal Contractors	$2,999	$2,517	$2,603	$2,614	$2,682	$2,752	$2,874	$2,883	$2,958	$3,038	$3,181
Other direct expenditure	$1,333	$1,539	$1,645	$1,676	$1,711	$1,794	$1,855	$1,916	$1,979	$2,009	$2,079
Total Direct Operating Expenditure	**$17,660**	**$17,890**	**$18,323**	**$18,783**	**$19,346**	**$19,984**	**$20,649**	**$21,200**	**$21,847**	**$22,524**	**$23,312**
Total Financial Costs	$3,665	$4,059	$4,563	$4,736	$5,023	$5,599	$5,735	$6,517	$6,814	$7,239	$7,326
Net Corporate Overhead	$1,051	$1,373	$1,543	$1,645	$1,664	$1,728	$1,843	$1,868	$1,947	$2,083	$2,029
Depreciation	$8,359	$8,185	$8,364	$9,274	$9,220	$9,308	$9,334	$9,369	$11,470	$11,379	$11,266
Other indirect expenditure	-$109	$35	-$40	-$79	-$57	-$108	-$136	-$84	-$75	-$66	-$101
Total Indirect Expenditure	**$12,966**	**$13,652**	**$14,431**	**$15,576**	**$15,850**	**$16,526**	**$16,777**	**$17,670**	**$20,155**	**$20,634**	**$20,519**
Total Operating Expenditure	**$30,626**	**$31,542**	**$32,753**	**$34,359**	**$35,196**	**$36,510**	**$37,425**	**$38,870**	**$42,003**	**$43,158**	**$43,830**

Figure 21: Forecast operations and maintenance expenditure (#1063554)

9.3 Insurance management

9.3.1 Insurance policy and self insurance

Certain GWW assets have little risk of fire damage or damage by third parties, but are vulnerable to damage from earthquakes. Our risk management strategy for these assets is to have sufficient financial reserves to meet the first cost of the damage along with top up insurance to cover the estimated probable maximum value of the loss.

For insurance purposes Water Supply assets have been separated into those that are "above ground" (Buildings, Te Marua WTP, Waterloo WTP, Wainuiomata WTP, workshop, and chattels) and those that are "below ground" (pipes, tunnels, and the two Stuart Macaskill lakes).

The assets categorised as above ground are covered under a material damage and business interruption insurance policy while those below ground are provided for under a combination of an earthquake and special insurance cover and an asset rehabilitation fund.

In order that potential insurers can properly assess the risk of seismic damage, an estimate of the maximum probable loss for these assets has been prepared. The probable loss estimate is based on a movement of the Wellington fault which constitutes by far the highest risk to GWW assets. Relative lateral movement of up to five metres is expected to occur when the fault ruptures and this will cause severe disruption to the wholesale water assets (some pipelines cross the fault) as well as other utilities and transport infrastructure that cross the fault.

9.3.2 Stuart Macaskill Lakes

The Stuart Macaskill Lakes are approximately eight km north of Upper Hutt, adjacent to State Highway No.2. The two adjoining lakes are of similar design and are constructed on river terraces, formed partly by excavation and partly by embankments up to approximately 16 metres high. They are lined with a thin layer of site sourced loess/silt material.

Greater Wellington Water is currently undertaking a project to increase the seismic resilience of the lakes. The upgrade will improve the seismic security of the lakes by partially lining them with a membrane liner and increase the storage volume by constructing a wave wall on the top of the embankment and raising the water level approximately 1.3 metres.

A report, *Stuart Macaskill Lakes Estimate of maximum loss due to a Wellington Fault Earthquake* prepared by Tonkin and Taylor Ltd describes a detailed evaluation of the probable cost of damage repair under two scenarios, the current situation and the future situation following the proposed upgrade. This report was the basis for the above project.

9.3.3 Pipelines and tunnels

Apart from isolated short river and stream crossings the pipelines comprising the wholesale distribution network are buried. They are mostly of welded steel construction and there are several crossings of the Wellington Fault.

A recent study by the NZ Institute of Geological and Nuclear Science (GNS) used overseas experience of earthquakes and statistical techniques to estimate the number of pipe breaks between fault crossings. This work is published in *Post-earthquake restoration of the Wellington area bulk water supply network* (GNS Science Consultancy Report 2009/11 April 2009).

Another report, *Seismic Damage to Bulk Water Supply Network and GWW Tunnels – Estimate of Maximum Probable Loss* is based on the GNS analysis. It presents an estimate of the likely cost of repairing damage to pipelines and tunnels following a Wellington fault rupture.

9.3.4 Above ground assets

In May 2011, Bayleys Valuations Limited undertook an "on desk updated valuation" of Greater Wellington's "above ground assets" and this covered the water supply's plant and equipment and infrastructure assets. The total amount insured is at $254m.

Table 18 Above ground assets insurance valuations effective 1 July 2011 (#1063554)

		Total replacement value for insurance purposes $000s	**Reinstatement Est.** $000s	**Inflation reinstatement** $000s	**Demolition** $000s
Treatment plants					
Te Marua	Building structure	$16,770	$14,016	$1,563	$1,191
	Plant & machinery	$83,436	$67,504	$12,895	$3,038
	Chattels	$698	$582	$90	$26
	Te Marua	**$100,904**	**$82,102**	**$14,547**	**$4,255**
Wainuiomata	Building structure	$8,469	$7,079	$789	$602
	Plant & machinery	$44,798	$36,244	$6,923	$1,631
	Chattels	$507	$423	$65	$19
	Wainuiomata	**$53,775**	**$43,745**	**$7,778**	**$2,252**
Waterloo	Building structure	$6,362	$5,317	$593	$452
	Plant & machinery	$23,257	$18,816	$3,594	$847
	Chattels	$278	$252	$14	$11
	Chattels/Oxford Tce	$654	$594	$33	$27
	Waterloo	**$30,550**	**$24,979**	**$4,234**	**$1,337**
Gear Island	Building structure	$2,245	$1,964	$114	$167
	Plant & machinery	$7,783	$6,660	$823	$300
	Gear Island	**$10,028**	**$8,624**	**$938**	**$467**
Pumping Stations					
	Building structure	$11,132	$9,454	$875	$804
	Plant & machinery	$45,967	$38,701	$5,523	$1,743
	Pumping stations	**$57,099**	**$48,155**	**$6,398**	**$2,546**
Other buildings					
(2-3/90 Moores Valley Road & Oxford Terrace	Commercial & residential	$1,776	$1,614	$113	$50
		$1,776	**$1,614**	**$113**	**$50**
		$254,132	**$209,219**	**$34,007**	**$10,906**

Summary	**Total replacement value for insurance purposes** $000s	**Reinstatement Est.** $000s	**Inflation reinstatement** $000s	**Demolition** $000s
Building structure	$44,979	$37,829	$3,934	$3,215
Plant & machinery	$205,241	$167,925	$29,758	$7,558
Chattels	$1,482	$1,257	$169	$57
Chattels – Oxford Tce	$654	$594	$33	$27
Commercial & residential	$1,776	$1,614	$113	$50
	$254,132	**$209,219**	**$34,007**	**$10,906**

Explanation of terms used:

Reinstatement Estimate – this is the estimated cost to rebuild a structure that complies with the Building Act, using an equivalent material, and includes an allowance for any design work and consent fees.

Inflation reinstatement – this is the anticipated amount by which the insured reinstatement and indemnity amounts may increase during the period of insurance and any additional time required to rebuild.

Demolition – this is the cost of site clearance in the event of a loss.

Total replacement value for insurance purpose or the sum insured – is the sum of the reinstatement estimates, inflation reinstatements and demolition estimates, and the insurance premium assessed based on this amount.

Table 19: shows the sum insured and the premium paid for above ground assets over the last four years. In 2011/12, insurance premiums increased markedly with an annual increase over 2010/11 in excess of 261%.

Table 19: Above ground assets insurance premiums by year (#1063554)

Policy year	Sum insured ($000s)	Premium ($000s)
2008/09	$197,136	$401
2009/10	$228,979	$352
2010/11	$245,108	$375
2011/12	$254,132	$981

(a) Claims history

There has not been any significant claim made to this policy in the past five years. A claim was made in October 2006 for fire damage at pump station No. 2 with costs at $32,000.

(b) Maximum probable loss

Insurance cover is based on the Maximum probable loss (MPL) concept. The MPL is an estimate of the largest loss that could result from the destruction and the loss of the use of the water supply property. The MPL is calculated applying a risk-based analysis based on the probability of potential property damage occurring that can reasonably be expected.

David Hopkins, an earthquake consultant undertook an assessment of the Councils MPL that results from an earthquake occurring for insurance purposes. The estimated earthquake losses and damages have been given a low and high level value and these have been assigned a weighting as a percentage of the reinstatement estimate, inflation reinstatement and demolition.

In May 2011, Mr Hopkins reported that overall the Council's MPL was estimated at a low level of damages – $39.4m and high level of damages $134.8m.

The Water Supply businesses share of the MPL for the low level of damages was $27.2m and high level of damages was estimated at $97.1m. These are detailed in Table 20.

A further study was completed in July 2011 and the Council's MPL estimates, including rail assets, were updated with a revised low level of damages – $49.7m and high level of damages $167.0m.

(c) Insurance cover – MPL

For practical purposes insurance cover for a single and total loss has been capped at $150m.

The insurance cover is unusual with a 40% tier insured through New Zealand insurance companies and the balance, 60% through the London market. Each tier has a different level of cover and excesses or deductibles.

(d) Example catastrophic event

An earthquake caused damage at Regional Council Centre, and the Waterloo and Wainuiomata water treatment plants. The total damage amounted to $70m.

Table 20 Above ground assets – summary of maximum probable loss ($000s, refer #1063554)

	Replacement	Reinstatement	Inflation reinstatement	Demolition	Damages (low level)	Damages (high level)
Utility service dwellings	$1,854	$1,678	$130	$45	$222	$667
Wholesale water buildings	$48,196	$41,228	$4,597	$2,371	$5,777	$17,788
Plant and equipment	$198,639	$162,746	$28,568	$7,325	$21,190	$78,626
Total	**$248,688**	**$205,653**	**$33,294**	**$9,741**	**$27,189**	**$97,082**

Table 21: Above-ground assets – example insurance claim for a major loss event ($000s, refer #1063554)

Insured value of the site(s)	5% of the insured value of the site(s) – 60%	Initial excess set at $4m. Above 40% of $10m excess set at 5% of site(s) value	Total excess (amounts paid by the Council to restore infrastructure)	Damages claimed	Expected insurance settlement proceeds
$50,000	$1,500	$4,000	$5,500	$70,000	$64,500
$60,000	$1,800	$4,000	$5,800	$70,000	$64,200
$70,000	$2,100	$4,000	$6,100	$70,000	$63,900
$80,000	$2,400	$4,000	$6,400	$70,000	$63,600
$90,000	$2,700	$4,000	$6,700	$70,000	$63,300
$95,000	$2,850	$4,000	$6,850	$70,000	$63,150

In these examples it is apparent that that the Council has to make up a significant shortfall or excess from other sources of funds directly ($5.5m – $6.85m).

9.3.5 Assets below ground

These assets are considered to be at a lower level of risk than those held above ground because this group of assets is less likely to be subjected to any accidental damage or damage from fire or flood. Initially, this group of assets has been partly self insured through an asset rehabilitation fund and bank credit lines. The fund has been increased from additional funds deposited and interest earned each year.

Insurance cover was first taken out from November 2008, replacing bank credit lines, and the premium has not been changed significantly over the period. For the 2011/12 year the premium was held based on the previous year. However, for the next insurance year, 2012/13 we anticipate that the insurance cost for this cover will increase at a rate similar to other insurances for property.

Specific earthquake and special insurance cover has been provided for assets below ground. This insurance covers the difference between the maximum probable loss and the balance of funds held in the asset rehabilitation fund. The asset rehabilitation fund has operated since May 1995 with some $16.835m held as at 30 June 2011 (Table 22).

Table 22: Assets below ground – earthquake and special insurance cover and a contingency reserve (#1063554)

Water supply assets	$000s
Te Marua Lakes, tunnels, pipelines	$490,054
Maximum probable loss – actual cover	$43,400
Sum insured	$26,500
Deductible each and every loss	$15,600
Asset rehabilitation fund as at 30 June 2011	$16,835
Insurance premium 2011/12	$368

Table 23: Assets below ground – summary of maximum probable loss estimates (#1063554)

Asset	Total Asset value ($000s)	Maximum probable loss ($000s)
Te Marua Lakes	$57,853	$23,700
Tunnels	$122,889	$8,300
Pipelines	$309,313	$8,800
Total	**$490,054**	**$40,800**

Insurance cover taken out to allow for cost increases was $43.4M.

(a) Claims history

No claim has been made on this policy.

9.4 Asset valuation

9.4.1 Background

Water supply assets are valued by Registered Valuers. The last full asset valuation was completed in 2008 by CBRE Ltd. Greater Wellington's Finance Department undertakes an assessment each year to confirm the current valuation for each department represents fair value, and schedule revaluations where required. The next valuation is due for completion in 2012/13.

9.4.2 Current valuation

Regional water supply plant and equipment assets were valued by John Freeman, FPINZ, TechRICS, MACostE, Registered Plant and Machinery Valuer, a Director of CB Richard Ellis at 1 July 2008 using Optimised Depreciated Replacement Cost (ODRC) methodology.

Water supply buildings were revalued by Paul Butcher, BBS, FPINZ, Registered Valuer, a Director of CB Richard Ellis as at 1 July 2008 using ODRC methodology.

Water Urban based land assets were valued by Telfer Young (Martin J Veale, Registered Valuer, ANZIV, SPINZ) as at 30 June 2008 using current market value methodology in compliance with PINZ professional Practice (Edition 5) Valuation

Table 24: Asset valuation (#1063554)

	Deemed cost ($000s)	Revaluation reserve ($000s)	Accumulated depreciation ($000s)	Net book value ($000s)
Land	$2,925	$4,941	-	$7,866
Water supply infrastructure	$245,401	$96,242	$30,363	$311,280
Office equipment	$311	-	$256	$55
Plant and equipment	$393	-	$354	$39
Motor vehicles	$1,529	-	$920	$609
Work in progress	$9,287	-	-	$9,287
Total	**$259,846**	**$101,183**	**$31,893**	**$329,136**

for Financial Reporting and NZ IFRS re Property Valuations.

Water catchment and rural based assets were valued by Baker & Associates (Fergus T Rutherford, Registered valuer, BBS (VPM), ANZIV) as at 1 July 2008 using current market value methodology in compliance with PINZ Professional Practice (Edition 5) Valuation for Financial Reporting and NZ IAS 16 re Property Valuation.

Table 24 shows the Water Supply group asset values as at 30/06/2012. A breakdown of infrastructure assets by location and type is given in Appendix 5.

9.4.3 Asset ownership rationalisation

Some of the infrastructure used in the wholesale water supply system dates as far back as the 1880s and its use in some cases has changed over time. Accordingly, there are some assets that, with the change in use would be better owned by the customer TA's. Likewise, there are a small number of customer owned assets that could be better managed as part of the wholesale water supply system. Assets currently identified include:

- The cast iron 525mm diameter pipeline between Thorndon and Ngauranga used by the Wellington City Council (WCC) but owned by GWW
- The 2.17 ML reservoir at Karori that serves as a WCC service reservoir but previously served as a chlorination contact tank, and is owned by GWW
- The pipeline from Thorndon to Macalister Park owned by the WCC is essentially a wholesale pipeline in size and function. GWW keeps spares for this size of pipe and has the expertise to carry out repair work

There is a project currently underway between GWW and WCC looking at progressing the asset transfers.

10. Improvement plan

Greater Wellington Regional Council (Greater Wellington) formed an Asset Management Development Group (AMDG) in 2012. The purpose of the group is to guide development of asset management plans and practices. It also aims to ensure that management of Greater Wellington's infrastructure assets is carried out in a consistent and appropriate way, and according to accepted best practice.

The first project, initiated by the AMDG in 2012, was to review asset management practices across activity areas. The review was completed by consultants Kathy Dever-Tod (Dever-Tod Advisory Services) and Lisa Roberts (Infrastructure Decisions Limited). The objectives were to:

1. Produce a gap analysis for each department based on the International Infrastructure Management Manual (IIMM) and using the Treasury spreadsheet tool which is based on the IIMM maturity index
2. Develop a programme of the activities, resources and costs required to achieve the desired standard of infrastructure AM practice for all departments

A summary of the results follows. The supporting asset management maturity assessment worksheet is given in Appendix 4.

10.1 Results of gap analysis

The Water Supply activity is considered the strongest across Greater Wellington in terms of AM capability and process development. It rates particularly well, and has achieved advanced status, in quality management (ISO 9001 and 14001 certification), demand forecasting and operational planning.

As a high value, critical activity, water supply seeks to achieve high intermediate to advanced scores across all functions.

Figure 22 provides a summary of the gap analysis. The largest gaps exist in the following areas:

- The AM Policy – which was never completed, issued or socialised.
- Improvement Planning – while broad improvement tasks have been identified, resources and timeframes are not specified.
- The AM Plan, the version which provided the basis for the 2012 LTP is not complete.

10.2 List of improvements

Table 25 gives the improvement plan derived from the asset management practices gap analysis. Priority has been assigned with 1 being minor through to 4 being highly significant.

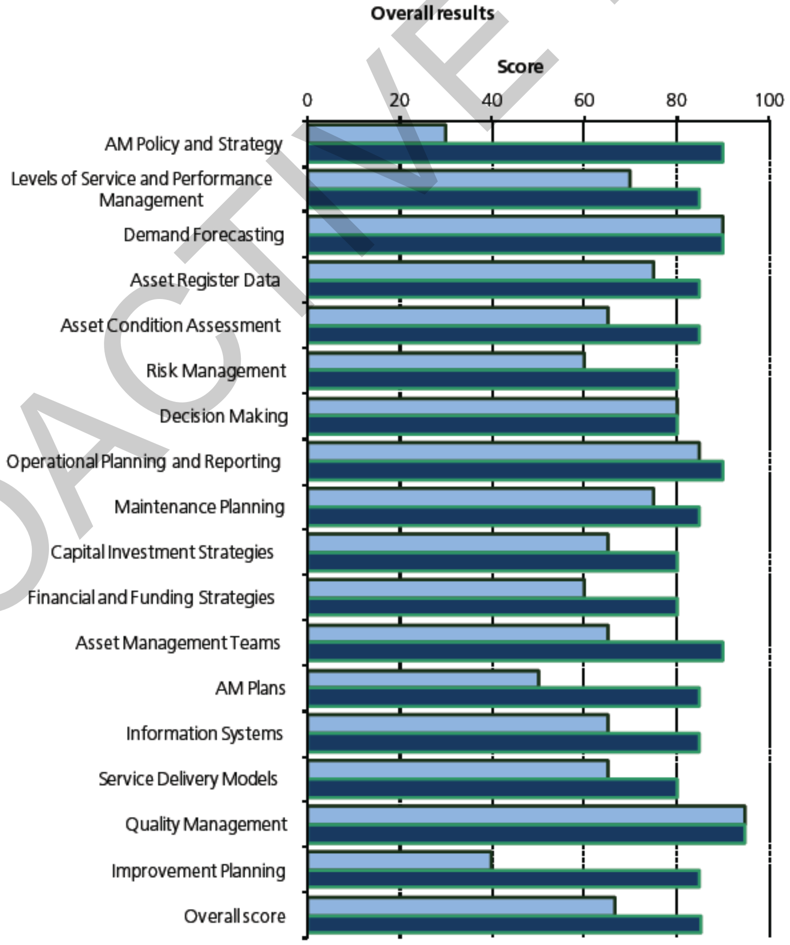


Figure 22: Summary of asset management gap analysis

Table 25: Improvement plan

Improvement task	Priority	Contribution to	Resources	Timeframe	Contribution to closing gap
Develop and adopt AM policy	4	AM policy and strategy	$5k – existing opex adequate	2012/13	Closes gap
Customer engagement over level of service options and confirm SLA	3	Levels of service and performance	$10k – existing opex adequate	2012/13	Closes gap
Review asset lives with updated condition/performance data and align SAP/AMP lives	3	Asset Register Data	$5 – existing opex adequate	2012/13	Closes gap
Continue development and implementation of condition assessment strategy and technical guidelines, tailored to asset criticality	3	Condition Assessment	$100k – existing opex adequate	2012/15	Closes gap
Develop risk framework and strategy. Establish asset risk register, subject to regular monitoring and review	3	Risk Management	$15k – existing opex adequate	2013/14	15 points
Establish asset criticality rating in asset register, and strategy for managing critical assets	3	Risk Management	$30k – existing opex adequate	2012/13	10 points
Review Business Continuity Plan	2	Operational Planning	$5k – existing opex adequate	2013/14	Closes gap
Review/agree processes for maintenance team input to AM analysis/AM plans/maintenance plans/ budgets and establish continuous review process	2	Maintenance Planning Financial/Funding Planning	$10k – existing opex adequate	2014/15	Closes gap 5 points
Review CAPEX programme, with supporting project scope/estimates for all projects on 3 year list (expand from one year to three year), plus major projects on 10-year list	4	Capital Investment Planning Financial Strategy	$10k – existing opex adequate	2012/13	Closes gap 5 points
Develop renewal programme from condition assessment and asset lives review (clarification of forecast and sustainable funding levels)	3	Financial/Funding Planning	$10k – existing opex adequate	2013/14	10 points
Complete AM Plan. *Outcomes from other AM improvement projects will provide ongoing improvement to this score.*	4	AM Plan	$10k – existing opex adequate	2012/13	20 points *15 points*
Collaborative AM Planning – workshop across teams to identify opportunities for shared projects/skills and embed into AMDG terms of reference and AM improvement plan	3	AM Teams	$10k then ongoing through AMDG – existing opex adequate	2012/13	Closes gap.
Develop standardised asset reports that support AM analysis (eg: work history trends)	3	Information Systems	$50k – existing opex adequate	2013/14	15 points.
Integrate SAP/GIS data and improve accuracy of spatial data	4	Information Systems	Additional staff required (1 FTE for 2 years)	2012/15	10 points.
Review data integration between systems for more efficient analysis	2	Information Systems	$20k – existing opex adequate	2013/14	10 points
Documented strategy for in-house vs external service delivery	1	Service Delivery	$5k – existing opex adequate	2014/15	5 points
Review SLAs with other departments and complete where required	2	Service Delivery	$10k – existing opex adequate	2013/14	5 points
Collate all improvement actions arising from this review, prioritise and allocate resources to close gaps within three years	4	Improvement Planning	$5k – existing opex adequate	2012/13	Closes gap.

Appendix 1 – Annual Performance Targets

The following table shows the current GWW Annual Performance Targets (APTs) and the links with high level business objectives and levels of service performance measures. The document is updated annually, so refer to document #960223 for the latest version.

Objective 1 – Ensuring there is a secure water supply

Service level statement	Target ref.	Target	LTP Performance Measure (2012/22)
We will maintain or improve both the resilience of the water supply system and our emergency response capability	1.1.1	Prepare an annual plan, by September each year, for improving security of water supply, system resilience and speed of reinstatement	6. Improve the resilience of the wholesale water supply to catastrophic events such as earthquakes
	1.1.2	Complete at least 80% of system security projects (expenditure vs budget) by 30 June of the agreed financial year	6. Improve the resilience of the wholesale water supply to catastrophic events such as earthquakes
	1.1.3	At least maintain modelled reinstatement time following a Wellington Fault movement (based on GNS modelling) and develop a measurement method for reinstatement time following an event	6. Improve the resilience of the wholesale water supply to catastrophic events such as earthquakes
Our raw water sources will be protected against contamination	1.2.1	Maximum daily flow from the Waiwhetu Aquifer does not exceed 115 ML/day and the 24-hour mean level at McEwan Park does not fall below 2.3 metres	8. Compliance with environmental regulations
The treatment plants and distribution system will be protected from damage	1.3.1	Maintain a record of damage and near miss incidents. Process all mark-out ("Dial Before You Dig") applications within two days	N/A

Objective 2 – Providing safe, high-quality water

Service level statement	Target ref.	Target	LTP Performance Measure (2012/22)
Comply with Health (Drinking Water) Amendment Act 2007	2.1.1	Public Health Risk Management Plans (PHRMPs) will be reviewed annually	1. Number of waterborne disease outbreaks
Comply with the requirements of the DWSNZ 2005. Aesthetic and microbiological for treatment and distribution 100% of the time, chemical 85% of the time	2.2.1	Aesthetic compliance 100%	2. Number of taste complaint events received from one or more territorial authorities
	2.2.2	Microbiological compliance – water treatment plants 100%	3. Percentage compliance with the Drinking Water Standards of New Zealand
	2.2.3	Microbiological compliance – distribution systems 100%	3. Percentage compliance with the Drinking Water Standards of New Zealand
	2.2.4	Achieve a level of fluoride in treated water within the range recommended by the Ministry of Health – 0.7-1.0 parts per million – for optimal dental health at least 85% of the time	3. Percentage compliance with the Drinking Water Standards of New Zealand
Operate a quality management system that is certified to ISO 9001	2.3.1	Full compliance	N/A
Water treatment plant and distribution system gradings will be maintained or improved	2.4.1	Te Marua – A1	4. Treatment plant and distribution system grading
	2.4.2	Waterloo – B	4. Treatment plant and distribution system grading
	2.4.3	Wainuiomata – A1	4. Treatment plant and distribution system grading
	2.4.4	Gear Island – A1	4. Treatment plant and distribution system grading
	2.4.5	Distribution system – A1	4. Treatment plant and distribution system grading
Operate a quality management plan for the Stuart Macaskill Lakes	2.5.1	Plan will be reviewed annually	N/A

Objective 3 – Ability to meet current and future demand

Service level statement	Target ref.	Target	LTP Performance Measure (2012/22)
Maintain reservoir levels and distribution system pressure as per the draft Bulk Water Supply Agreement	3.1.1	Reservoirs at least 60% full for at least 98% of the time	N/A
	3.1.2	Reservoirs at least 70% full for at least 90% of the time	N/A
	3.1.3	Thorndon pressure between 80 and 100 metres head for at least 98% of the time	N/A
	3.1.4	Thorndon pressure above 85 metres head for at least 90% of the time	N/A
Sufficient water is available to meet the unrestricted (other than by routine hosing restrictions) demand in all but a drought situation that has a severity equal to or greater than a 1 in 50-year drought	3.2.1	Calculate shortfall probability by 30 June each year	7. Modelled probability of annual water supply shortfall
	3.2.2	Identify options for developing and extending the water supply infrastructure, including new sources, as required, to ensure that sufficient water is available to meet demand	7. Modelled probability of annual water supply shortfall

Objective 4 – Working sustainably

Service level statement	Target ref.	Target	LTP Performance Measure (2012/22)
Comprehensive details, including age and condition rating, of all assets and equipment will be recorded in the Asset Management System (SAP)	4.1.1	All new equipment will have details recorded in SAP within three months of commissioning	N/A
	4.1.2	Each year the condition of assets falling within 4 years of their predicted life in the previous 12 months will be assessed.	N/A
Maintenance plans are produced for all equipment and critical maintenance is not deferred	4.2.1	All new equipment will have maintenance plans in place within three months of commissioning	N/A
	4.2.2	95% of compliance-related maintenance activities are carried out on time	N/A
A comprehensive AMP is in place to guide maintenance, renewal and replacement programme so that assets are replaced or refurbished to maintain overall asset condition rating	4.3.1	The Asset Management Plan (AMP) is updated annually and peer-reviewed every three years, in line with Long-term Plan preparation	N/A
	4.3.2	That the average asset condition meets the requirement of the AMP	N/A
	4.3.3	Consult with the customer territorial authorities regarding the content of each proposed Capital Works Programme (Annual Plan)	N/A
Projects are managed to meet quality, time and cost standards	4.4.1	For 80% of projects on capital works programme (KIPs), the full-year expenditure is within 5% of 3rd quarter forecast, 10% of 2nd quarter forecast and within 25% of allocated budget	N/A
	4.4.2	90% of projects that are scheduled to be complete within the current year are complete within the current year	N/A
Maintain an active, up to date, health and safety management system that helps achieve the requirements of the HSEA	4.5.1	Health and Safety system meets the requirements of the ACC Workplace Safety Management Practices Standards (secondary level)	N/A
	4.5.2	All building Warrants of Fitness are current	N/A
	4.5.3	The ratio of proactive to reactive health and safety reports will be no less than 2:1	N/A
	4.5.4	The lost-time injury frequency rate will be less than one incident per 10,000 hours worked	N/A
	4.5.5	The lost-time injury severity rate will be less than one day per 10,000 hours worked	N/A
Ability – our staff have the knowledge, skills and competence to perform the role they are in	4.6.1	Annual Training and Development Plans are in place for all staff	N/A
	4.6.2	All annual competence-based training activities and 85% of development-based training activities are complete by June	N/A
	4.7.1	The ratio of days worked to sick days is greater that 30:1 (based on 224 working days/year)	N/A

Direction – our staff know what is expected and understand the priorities	4.9.1	Conduct six-monthly performance review discussions with all staff	N/A
	4.9.2	Conduct annual review of job descriptions (at the end of year performance review)	N/A
Be aware of, comply with, and report on compliance with all legislation, regulations, bylaws and standards that are relevant to the environmental performance of Greater Wellington's Water Supply group	4.10.1	Achieve full compliance with all resource consents	N/A
	4.10.2	Maintain a list of all relevant legislation and review annually	N/A
	4.10.3	All Trade waste permits are kept current	N/A
	4.10.4	All HSNO location test certificates are current	N/A
	4.10.5	All HSNO stationary container test certificates are current	N/A
Adopt all practicable means to prevent pollution of the environment	4.11.1	All Solid waste will be disposed of to a properly consented landfill	N/A
	4.11.2	All Liquid waste will be removed and disposed of by the correct codes of practice	N/A
	4.11.3	All accidental discharges of substances with the potential of harming the environment will be recorded with a target of zero	N/A
	4.11.4	Chemical delivery and spillage procedures are current and audited annually	N/A
Conserve non-renewable resources such as fuels, energy and materials and minimise waste	4.12.2	Monitor for water losses and report on trends quarterly	N/A
	4.12.4	Carry out water conservation programmes and report on effectiveness by June each year	N/A
	4.12.5	Prepare an annual plan for pump efficiency testing and complete at least 80% of testing by June	N/A
Consider the environmental implications of business decisions	4.13.1	Provide awareness training for all staff and specific training to all staff whose actions have potential environmental impacts – within three months of commencing employment	N/A
	4.13.2	Include environmental performance as an attribute when assessing quotations for all major works and supply contracts	N/A
	4.13.3	An environmental aspect and impact assessment will be completed for all new activities and projects	N/A
Operate an environmental management system that is certified to ISO 14001	4.14.1	Achieve full compliance	N/A

Objective 5 – Being cost effective

Service level statement	Target ref.	Target	AMP Performance Measure (2012/22)
Ensure that the actual direct operating costs do not exceed the budgeted value	5.1.1	Full-year costs are within budget	N/A
Areas of significant operational expenditure will be routinely monitored and opportunities for cost reduction will be identified	5.2.1	Unfavourable variances greater than $20,000 or 10% of budget are identified and reported on monthly	N/A
	5.2.2	Monitor power use, produce monthly summaries and report quarterly on performance and trends	N/A
	5.2.3	Monitor chemical use, produce monthly summaries and report quarterly on performance and trends	N/A
Practice prudent financial management	5.3.1	Ensure that the asset value recorded in the financial statements is materially correct, desktop valuations will carried out annually and full valuations carried out every three years	N/A
	5.3.2	The risk from overseas purchases will be minimised by purchasing financial currency hedges for purchases over $100,000 or delivery times longer than one year	N/A
	5.3.3	Asset insurance cover is reviewed annually to insure that there is sufficient cover for maximum probable loss through a mix of external insurance and reserve fund so that the financial impact of any natural disaster is minimised	N/A

Appendix 2 – Water Supply System Models

a) Sustainable Yield Model

The Sustainable Yield Model (SYM) is a daily supply model that takes into account climatic conditions, demand, population, river flows, aquifer storage, reservoir storage, and system constraints. NIWA completed the initial model, which is based on WATHNET software and net work linear programming in 1997.

Approximately 42,000 days (1890 to 2008) of river flow and demand data, constructed from available hydrological and meteorological data, are incorporated in the model. Environmental constraints include complex surface water and aquifer abstraction rules, and graduated minimum aquifer level rules to reduce the risk of aquifer saline intrusion. Penalties and artificial costs are used to determine source priorities. Included in the model is an aquifer sub-model that is used to mimic the response of the Waiwhetu aquifer to pumping.

The model can be used in Monte Carlo simulation mode to generate up to 10,000 two-year replicates (2,000 replicates is usually used) to statistically assess system reliability. A system annual probability of failure, daily demand shortfall, and shortfall quantity estimates can be derived for given population projections. Note that a failure is defined as the occurrence in any one year of at least one day when insufficient water is available to meet the modelled demand. Scenario modelling is used to assess the impacts of system constraint changes in relative rather than their absolute terms. A comparison of failure probability against the GWW 1 in 50 year standard for the system can be made.

The following points give a brief history of significant changes to the SYM since 1997.

1. In 2001/02, the model was updated in the light of new data, structural changes to the network and revised environmental consent conditions
2. In 2006, the Pakuratahi, Whakatikei and Skull Gully potential future water storages were added to the model. Also, a component model of the Upper Hutt aquifer was developed and inserted into the SYM. The rainfall-runoff model was replaced with a spatially distributed Top net model, which produced revised stream flow records for input into the SYM
3. In 2007, the demand model was upgraded using the additional data available. The demand model uses relationships with climate parameters to generate daily per capita demand for input into the SYM. In 2007, NIWA was also completed a project to develop a methodology for assessing the potential effect of climate change on the wholesale water supply (IPCC third assessment). Revised stream flow and demand data complement the methodology, as well as minor adjustments to the network
4. In 2008, the Upper Hutt aquifer component of the SYM was recalibrated in light of the improved data made available from 2007 investigation drilling
5. In 2010, the demand model was disaggregated. This allowed per capita demand to be modelled for each of the eight demand centres, rather than the same PCD being used for all demand centres. In addition, the climate change adjusted data files were updated consistent with the results of the IPCC fourth assessment

Figure A1 shows the schematic layout of the SYM network. Boxes labelled “D” represent the demand centres of Upper Hutt (61), Porirua (60), Lower Hutt (31), North Wellington (110) Wellington Low Level (47), Wellington High Level (35), Petone (48) and Wainuiomata (39). Blue lines represent stream channels and flow through the Hutt aquifer and link stream nodes that are confluences or locations where abstractions or discharges may occur. Green lines represent pipelines and link nodes that may be pipe junctions, water treatment plants or pump stations. Boxes labelled “R” represent actual storage at Stuart Macaskill Lakes (5), Ngauranga (33); proposed storage in the CBD reservoir (74), Pakuratahi (80), Whakatikei (83), Skull Gully (87); or conceptual storage in the Upper Hutt aquifer (95 – 101) and Lower Hutt aquifer (28, 7, 22, 23, 24, and 29).

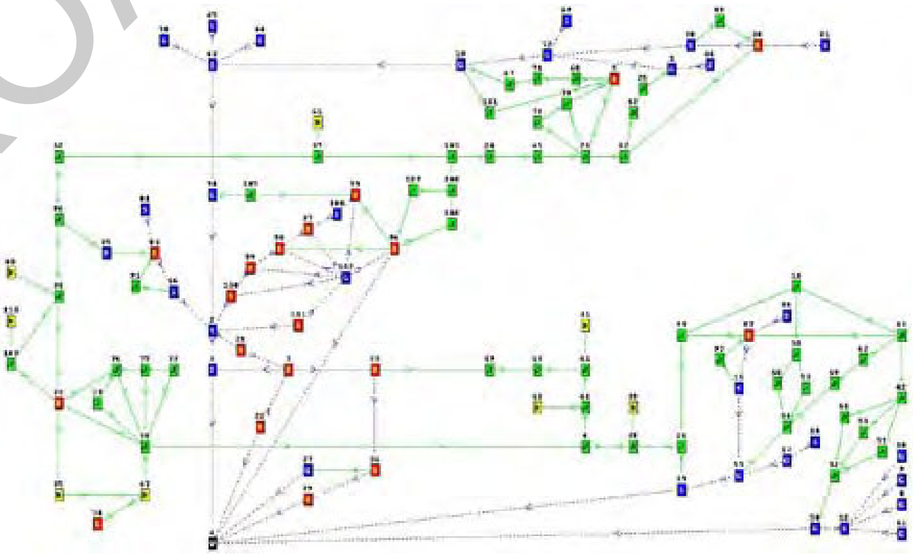


Figure A1: Sustainable Yield Model (SYM) network

The following section provides more detail on the changes made to the demand model since 1997.

Demand model upgrades

A demand model has been developed and used to generate daily per capita demand from 1890 to 2011. Since completion of the original SYM work, significant improvements to the available demand data set have been made. The 1997 model was a function of household size, percentage of detached dwellings, daily rainfall, soil moisture storage and maximum daily temperature. For the 1997 model, the long-term average of the generated data was 500 L/p/d with a coefficient of determination, R2 of 0.54 between daily values.

More accurate daily demand data available from February 1997 was used to prepare a new demand model in 2002. The 2002 model produced a mean of 450 L/p/d, and an improved R2 of 0.73. The improved performance was caused by reduced error in the demand data enabling better connections between demand and causative factors, such as temperature, to be identified. The 2002 demand model uses maximum daily temperature, soil moisture storage, and sunshine hours classified as summer (November to March) and winter (April to October). A stochastic component was added to further improve the realism of the generated demand record. The 2011 model produced a mean of 387 L/p/d

The second major upgrade of the demand model was completed in 2007. Part of the 2007 upgrade included testing the 2002 model against a validation data set extended with new data. The 2002 model performance was somewhat reduced in this validation exercise (R2 = 0.58). The coefficient of determination was improved to 0.68 following the 2007 revision, which included addition of a 10-day Christmas-New Year mini season and a full review of the model equations.

Within-region demand variation is thought to be the most significant component of the unexplained demand variation. The 2007 review considered that including within-region variation in the demand modelling was not practical given data constraints. Other factors contributing to the unexplained variation include water use during major sporting events, use for flushing and fire fighting, and water conservation campaigns (including those of other regions).

Population is the only "social" data included in the demand model. Other variables such as number of duplexes and multi-story residential dwellings have not been included because it is not clear how the effect could be accounted for over the full 115 year historic sequence.

The 2007 study identified a gradual decline in per capita demand (PCD) of approximately 4 L/p/d per year over the nine year period 1997 to 2005. The uncertainty associated with how long the decline may continue was managed by preparation of three PCD series for scenario assessment: high, medium and low, with long term means of 452 L/p/d, 427 L/p/d and 387 L/p/d respectively. The high series represents the assumed PCD for the period 1890 to 1991. The medium series has a mean corresponding approximately to that of 2001 (the mid-point of 1997 to 2005). The low series is the rate from 2011 and beyond based on an assumed relationship of the form shown in Figure A2.

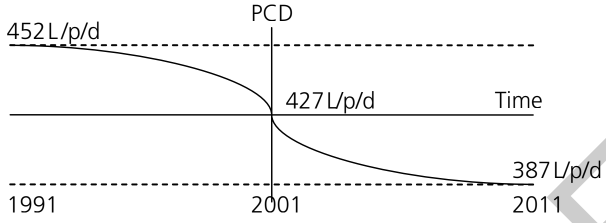


Figure A2: Assumed decline in per capita demand (PCD)

Given the uncertainty associated with PCD trends, the medium series was adopted for planning purposes. This was slightly conservative; however its use avoided criticism of being premature or overly optimistic. The 2007 study also included development of a methodology for assessing the impact of climate change based on the results of the IPCC third assessment.

The 2010 demand model update made use of the additional daily flow data available since the 2007 update, and achieved disaggregation of the model into each demand centre. In addition, the Porirua/ Johnsonville node was split into the two component nodes. This overcame one of the previous limitations of the single PCD model where Wellington city (the most hydraulically disadvantaged part of the network) had the highest PCD. In effect, slightly underestimating the flows required. By effectively creating eight demand models, accounting for the effects of within region demand variation was no longer a limitation. The 2010 update also included an update of the climate change adjusted input files consistent with the IPCC fourth assessment. The A1B 12-model average scenario was adopted for assessing the impact of climate change through to the end of this century.

In 2011, a review of water demand showed the continued reduction in PCD justified a reduction in the adopted long term mean used for planning purposes. A PCD of 387 L/p/d was adopted, which was based on the five year mean ending 30 June 2011. Given the PCD trend has been generally downward for some time it is likely that additional downward movements will be justified in the future. The planned 5-yearly demand model update is seen as an appropriate mechanism for capturing long term changes in mean PCD, without needing to "forecast" reductions.

While the model statistically accounts for demand variations over the modelled period, there can be significant variation on a day to day basis. The correlation of the timing of peak demand against low river flows becomes important when there is limited plant inlet storage available. Apart from the Wainuiomata water treatment plant, all GWW plants effectively have storage available on the plant inlet side.

Population is used as the sole basis for assigning demand to each demand zones. Since the demand zones actually have different mixes of population and industry, disaggregation of the regional demand on a population basis is a potential source of error and is seen as a limitation to further disaggregation of demand zones.

System constraints

New surface water abstraction consents were put in place during 2001. Aquifer abstraction has also shifted from the Gear Island water treatment plant at the Petone foreshore to the Waterloo water treatment plant approximately 3km inland to reduce the risk of saline intrusion. Surface water abstraction requirements are complex with minimum, maximum and flow sharing conditions for six surface water intakes. There are also high turbidity cut-off thresholds for each of the catchments set by the practicality and cost of treating highly turbid water. For the Orongorongo and Wainuiomata catchments there are rules regarding the maximum combined abstraction allowed.

The minimum flow setting for Wainuiomata WTP is governed by the turn-down ratio of the plant. This setting was lowered from 15ML/d to 8ML/d in 2008 following control system improvements.

A number of new system constraints were added to the SYM in 2006 and 2007 to allow modelling of proposed future water sources. These constraints are selected on a case by case basis depending on the scenario being considered. Storage sources not being modelled have their commissioning date set to the year 3000 to prevent them influencing the system mass balance.

Depending on the scenario being considered, pipe capacities are set to correspond to the required combination of new and upgraded booster pump stations. The appropriate maximum daily transfers for these have been determined by the hydraulic model (refer Section C later in this appendix).

The existing system model has a good balance between source capacity and demand for the Kaitoke and Waterloo/Wainuiomata systems. The constraints governing transfers between the two systems do not require continuous transfer of water to make up for any average excess or deficit. This is not the case when considering addition of a new source to the system. Care must be taken to ensure the system constraints are set to make best use of the additional water available. In particular, any supply side augmentation of the Kaitoke system requires a corresponding reduction in the "cost" of transfer to the Waterloo/Wainuiomata system so that the additional water is fully utilised. There are a number of ways this could be achieved. To date, the method adopted has been to incrementally increase the capacity of the "continuous" supply down Ngauranga gorge until the best (highest sustainable population) result is achieved (refer Figure A3). Other methods have been considered, but so far, none have been conceived that would eliminate the need for some form of iterative network optimisation.

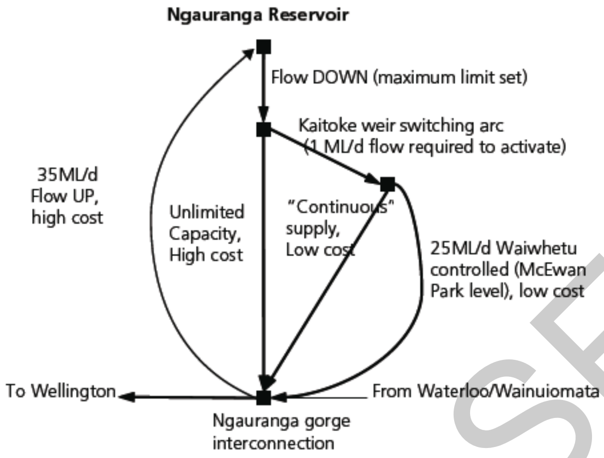


Figure A3: Ngauranga gorge transfer in the SYM

Accuracy

Model accuracy has been assessed with a focus on the model's long-term performance. To focus on individual extreme days can be an unreliable guide to overall performance because of the ability of within day operational requirements to completely negate the value of a single day's result from the SYM. The SYM was estimated as having an absolute accuracy of ±10% for 95% of the simulated values it calculates. When this value is compared with the 10% error arising from the demand data it suggests that the demand data is still the major source of model error.

Future updates

In accordance with standard modelling protocol, the sustainable yield model will be subjected to periodic review, improvement, and calibration verification as new data and information becomes available.

While the computational engine behind the SYM is still thought to be of "world leading" quality, the WATHNET software front-end is virtually obsolete. NIWA provide support and maintenance for the software, however the user interface is essentially unchanged since implementation at Greater Wellington in 1997. WATHNET is no longer being actively developed by the author, George Kuczera of the University of Newcastle in Australia, and this situation is not likely to change in the foreseeable future.

Future update would include:

- Verification of the Lower Hutt Aquifer sub-component.
- Review options for upgrading or replacing the WATHNET software in 2014.
- Ongoing structural improvements to the network model including removal of obsolete components.

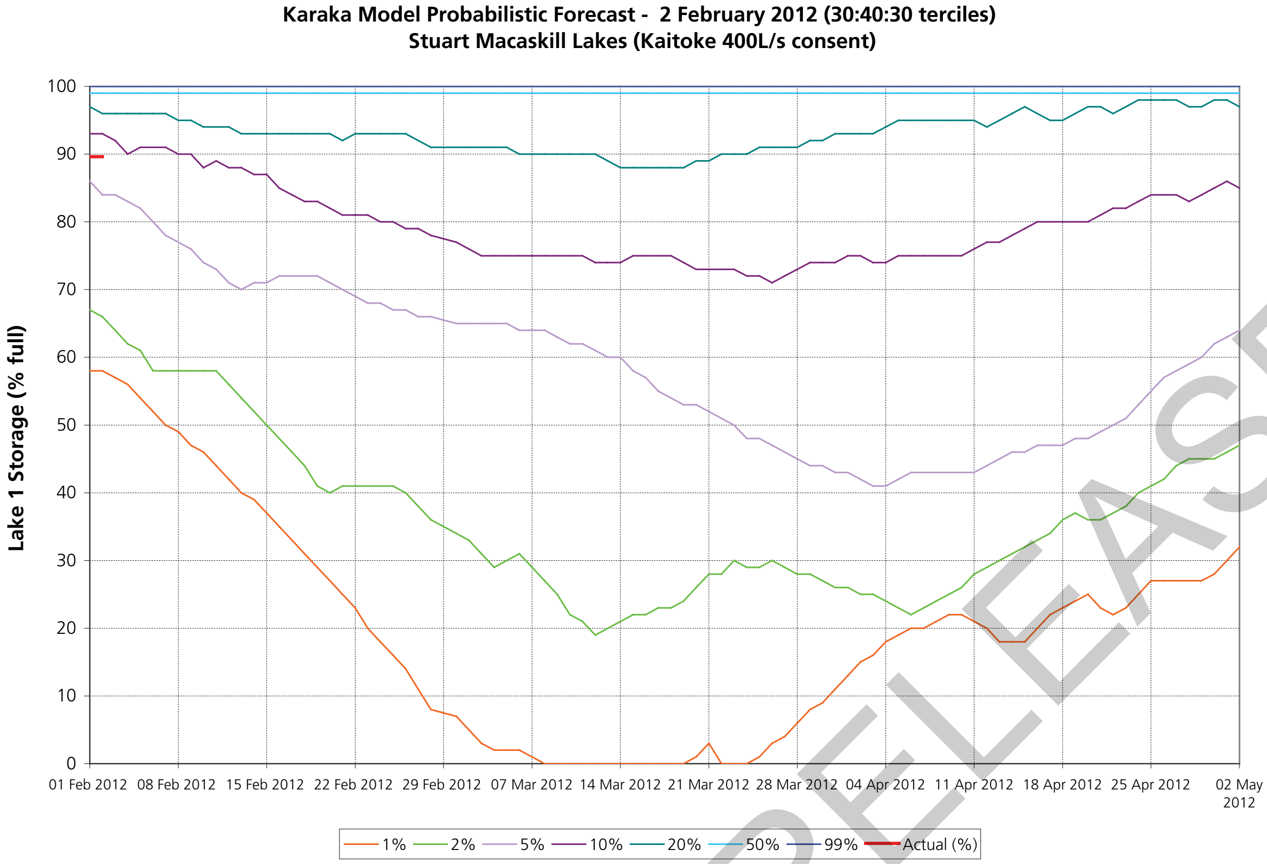


Figure A4: Example Karaka model output

b) Karaka model

The Karaka model, developed by NIWA in 2004, is a seasonal water availability model based on the SYM. It uses the NIWA Climate Update predictions of river flows for the coming 3 months as well as information about the current state of the system to derive reservoir storage risk information on which discussions about demand restrictions can be based. Figure B4 shows an example of Karaka model output for the Stuart Macaskill Lakes for the period 1 January 2008 to 31 March 2008. It indicates that there is a 2% chance of the Stuart Macaskill lakes being emptied if demand remained unrestricted.

The model also has the capacity to assess the impact of proposed water use restrictions on the storage probability profile.

The model originally included a shadow reservoir representing the active storage of the Waiwhetu aquifer. However this approach was abandoned due to the significant hydro geological uncertainties associated with the aquifer and the corresponding limited ability of the model to replicate the actual performance of the aquifer. Setting reliable initial conditions for the conceptual storages of the aquifer is also difficult to achieve. The Karaka model is therefore used in combination with other operational information and operator experience to help determine appropriate levels of water use restrictions.

c) Hydraulic model

A hydraulic model of the supply system is used to aid decision making on hydraulic aspects of the system. This model was originally developed in 2000/01 using EPANET software, and calibrated in 2001/02. Model development was undertaken in a staged manner including data gathering, development of a skeletal model, demand analysis, gross anomaly resolution and finally calibration.

The model included many rule based and simple controls for handling scheduling and control of reservoirs and pump stations. As an approximation of reality the model included a number of modelling techniques such as the use of pressure sustaining and flow control valves in place of variable speed controlled pumps.

A review was made of how to model demand from over 50 reservoirs. Taking into account the buffering effect of storage between customer demand and the wholesale delivery systems, seven regional demand curves were adopted to allow for regional variations in demand.

Weaknesses of the EPANET model included modelling diurnal variations on the Kaitoke main, inability to model Thorndon pressure control, very limited pump control features and limited scheduling ability. Based on these limitations, the model was converted to the InfoWorks WS software in 2003.

The InfoWorks software is a state-of-the-art network hydraulic modelling package being actively developed by Innovyse. The software is capable of modelling complex components such as pumps with variable speed drives and control valves with remote parameter inputs. Almost any imaginable control

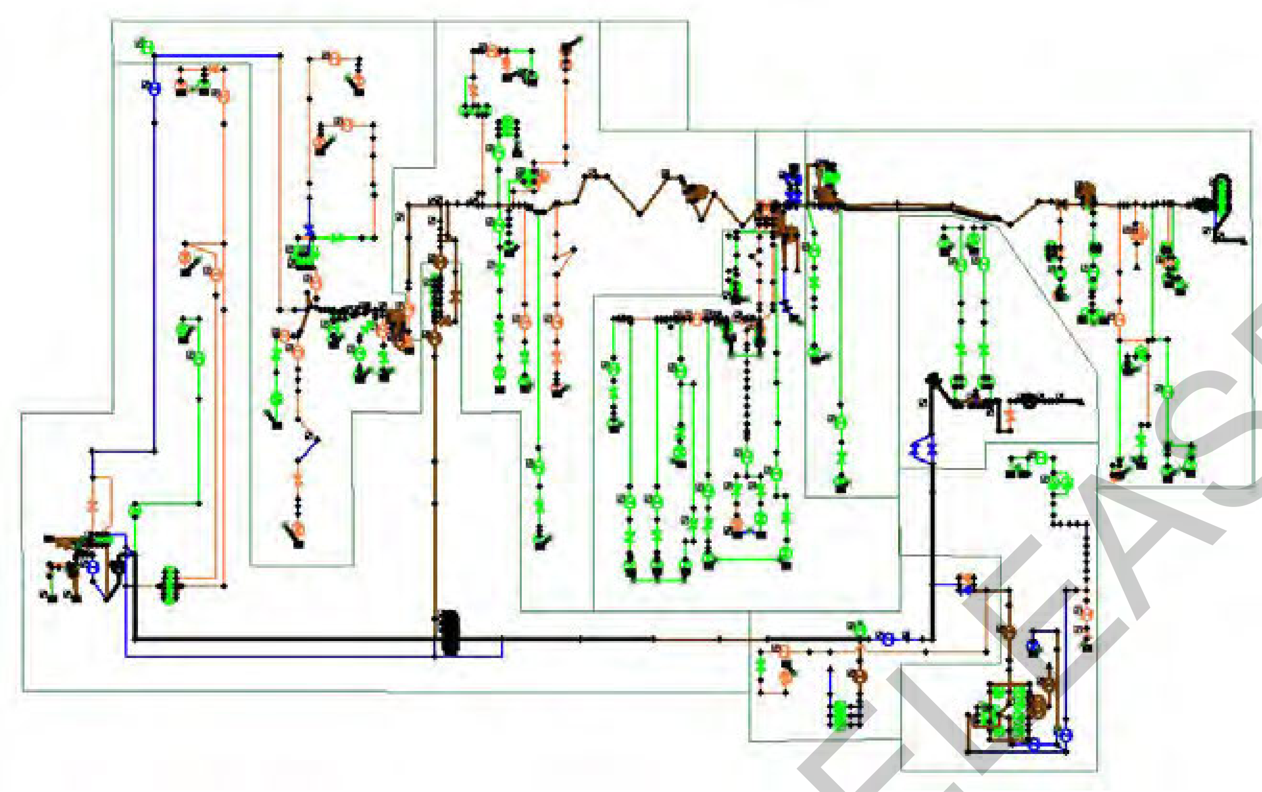


Figure A5: Network geometry from hydraulic model

logic with numerous inputs can be modelled using the sophisticated User Programmable Control system. The GWW model makes extensive use of the complex control capabilities.

The development and calibration of the hydraulic model has proven very useful and has been used extensively for modelling the system over extended periods (24 hours to 5 days) to assess segment capacities for the SYM, distribution upgrades for the proposed future sources, and water age for assistance with water quality assessments. Figure A5 shows the schematic layout of the current InfoWorks model.

The model is subject to continuous enhancement. Some of the recent improvements include:

- Six-monthly software updates from Innovyse
- Addition of proposed booster pump stations at Te Marua (upgrade), Silver stream, Upper Hutt aquifer, Haywards (upgrade), Takapu Rd, Maldive St, Hutt Rd
- Addition of new assets as they are constructed (eg, Karori PS, Pt. Howard PS, Tunnel Grove control valve, etc)
- Created Demand Scaling groups with separate demand areas for each demand node
- Added pipe pressure rating of all trunk mains and selected branch mains. Progressively adding pipe material and age
- Improved the pump curves for the major pump stations to include 10 data points
- Recalibrated the Porirua branch component of the model, including conversion from Hazen-Williams to Colebrook-White friction loss calculation. Two high resolution pressure loggers were purchased in 2007 to assist with this. They have inbuilt GSM SMS communications to allow data to be remotely captured anywhere there is Vodafone GSM coverage
- Use of data flags to allow grouping of changes to the model and separate pipes that transfer un-chlorinated and/or un-fluoridated water
- Use of the SQL query feature for complex network object selection
- Created object groups where multiple pumps make up a pump station
- Addition of supply zones to the network to delineate the relationship between Hydraulic model demand areas and SYM demand nodes
- Extensive use of hyperlinks to as-constructed drawings and reference documents
- Recalibrated the Wainuiomata to Thorndon segment including conversion from Hazen-Williams to Colebrook-White friction loss calculation

Future hydraulic model enhancements may include:

- Ongoing network recalibration and conversion from Hazen-Williams to Colebrook-White friction loss calculation. Priorities include sections of pipe where major capital investments are planned, where peak transfers are close to the maximum achievable or where new assets have been constructed. Recalibration of the complete model approximately every 10 years is desirable
- Replacement of "modelling fixes" (eg, pump stations with flow control valves representing variable speed drives) with more sophisticated controls
- Water quality and/or additional water age analysis
- Migration of the schematic model to a geographically representative layout with inclusion of aerial photographs and topographical maps. The ability to switch between schematic and geographical layouts would be ideal

Appendix 3 – Standard Asset Lives

The following table shows standard asset lives used by GWW for capitalisation purposes. Variations are permitted provided appropriate justification is documented on the capitalisation form. This document is maintained by the Assets & Compliance team (source #991944).

Source/treatment assets	**Life in years**
Air compressor	25
Blowers	25
Chlorinators	25
Dust collector	25
Extractor fans	20
Fences	25
Fire hydrants	60
Flume bridge	80
Foot bridge	40
Fords	20
Intakes	100
Lagoons	100
Lakes	150
Lake structures	100
Miscellaneous infrastructure	45
Road bridge	60
Distribution assets	**Life in years**
Asbestos cement	50
Concrete	50
Cast iron	100
Cast iron lined	130
Ductile iron	100
Polyethylene	90
Upvc	90
Steel	70
Concrete lined steel	90
Various	60
Exposed pipe (river crossings)	70
Piping assets – treatment	40
Process buildings and structures	50
Process water reservoir	50
Large pumps (>50KW)	40
Small pumps (<50KW)	20
Pump stations and buildings	80
Railway	60
Rapid mixers	25
Air receivers	30
Reservoirs	80
Runway beam and hoist	40
Screw conveyor	25
Sealed yards and roads	40
Separators decanters	25
Sludge rakes	25
Switch panels/boards	25
Plastic tanks	40

Welded mild steel tanks	30
Telemetry	10
Tunnels	150
Utility shed	25
Silo	40
Valve assets	**Life in years**
Pneumatic actuator	25
Electric actuator	20
True blue	15
Valve chambers	80
Air valves	40
Distribution valves	60
Control valves	40
Pvc valves	20
Solenoid valves	10
Large treatment plant valves	40
Small treatment plant valves	40
Non – return valves	40
Weirs	80
Wells	30
Electrical and control system assets	**Life in years**
Programable logic controller (plc)	17
Plc software	17
Uninterruptible power supply (ups)	10
Batteries	5
Solar panels	15
Pump motors	20
Variable speed drives (<15kw)	15
Variable speed drives (>15kw)	12
Soft starters	15
Computer	4
Circuit breakers > 250 amps	15
Heat pump	5
Instrumentation	**Life in years**
Turbidity meter	10
S::can spectrolyser	10
S::can constat	5
Chlorine analyser	15
Fluoride analyser	15
Pressure transmitter	15
Level transmitter (pressure based)	15
Level transmitter (ultrasonic)	10
Ph meter	15
Magnetic flow meter	15
Alkalinity meter	10
Conductivity meter	15
Temperature meter	15
Power meter	15
Gas leak detector	15
Load cells	15
Particle counters	10

Appendix 4 – Asset Management Maturity Assessment Worksheet

The following table shows the asset management maturity assessment worksheet completed by consultant Lisa Roberts (Infrastructure Decisions Limited) through interview with the following water supply staff in September 2012:

- Kim Bouzaid, Management Systems Analyst
- Vic Pratt, Maintenance Planner
- Geoff Williams, Team Leader Assets and Compliance
- Murray Ruddell, Group Accountant
- Noel Roberts, Operations Manager

The assessment was completed using the Treasury spreadsheet tool which is based on the IIMM maturity index.

Section	**Current score**	**Appropriate target**	**Reason for scores**
Understanding and defining requirements			
AM policy and strategy	30	90	Draft policy hasn't been issued or socialised. More of a bottom up driven thing – at a group level rather than a corporate commitment. Not a lot of cohesion across the Council – doing the things in different ways. Appropriate level has not been expressed in any way. SAP user group is a way of starting to engage across departments. For water, the level of appropriate practice is more well defined.
Levels of service and performance management	70	85	Good range of performance measures in place reported on annually with linkage between LTP and AM Plan measures. Have not formally presented formal LoS options. Have been trying to get a customer agreement with the TLAs for 15 years without success, though they have regular customer meetings and decided to develop SLA in favour of MoU. It is generally implicit that customers accept targets but not documented or formally agreed. Customers have the opportunity to comment on LTP and annual report. Have had international peer review in respect of security of supply standard.
Demand forecasting	90	90	Demand model developed by NIWA – have analysed historic consumption and developed a series of models by demand centres. Feeds into strategic planning model. Only gap is lack of customer metering information which limits the ability to analyse demand. However, within that constraint, have achieved best practice and continue to monitor improvement opportunities as technology changes. Ongoing maintenance.
Asset register data	75	85	Good level of confidence in core asset data – have invested $500K in asset collection project – comparing drawings with what's on site and in the asset register. Above ground asset data is strong. Asset valued by professional valuer. Some anomalies re: asset lives partly as a result of the asset register restructuring – some different lives in SAP and AMP. Good records for below ground assets. Future improvement is around valuation of assets and reviewing lives/replacement rates data.

Asset condition assessment	65	85	Asset condition data for above ground assets is being put in SAP (recent visual inspection). Would like to see more robust, unambiguous condition inspection guidelines by equipment type. 3-5 year objective and expanded to include performance monitoring, eg: vibration testing. Below ground asset condition data – overall have a simplified approach – an age-based condition assessment with inspections where assets near end life. Some coupon sampling done on steel and prediction of end life, but not comprehensive. Future improvement would be good to have improved knowledge of end of life forecast and potential interventions, eg: concrete lining. Monitoring research going on in this area – such as non invasive techniques. There is more advanced condition assessment for major assets eg: weirs.
Risk management	60	85	Risks are managed well through good institutional knowledge and a variety of systems such as health and safety, rail management, environmental risk assessment, but not sitting in an overarching risk policy. Quantate – corporate risk register – records strategic corporate risks. Physical infrastructure risks identified through periodic risk assessment process, risk assessment framework and methodology for assessing risks. Engineering staff inspect sites to assess seismic risk (10 years ago, just undertaking another one now, this is looking at a range of events). The assessment generates a CAPEX programme but not a risk register. Also looking at trying to define at an equipment level what critical assets and capture staff knowledge.
Lifecycle decision making			
Decision making	80	80	Any project is assessed against business objectives, MCA approach, objectives have been weighted. Benefit is the weighted result and cost is plotted on a graph. Project results are reviewed for 'sensibility' and generally are appropriate. Consequence factors are based on their risk management framework.
Operational planning and reporting	85	90	IMS manual covers off response to various events. There is a BC Plan, but needs review. For example IS is not fully replicated in Masterton. Need to prioritise different council systems for restoration following an event. Asset utilisation 'the Optimiser' is fully implemented. There is a project underway to improve Optimiser, ongoing monitoring of developments. Demand management is done by Capacity. But do marketing programmes and surveys. Drought management plan with agreed levels of escalation actions. Debriefs occur following incidents.
Maintenance planning	75	85	Maintenance programme is based on manufacturer's decisions then modified based on staff knowledge and performance. RCM analysis undertaken in some areas to target reliability issues. Each of the planner groups are being more proactive at looking at maintenance plans. Root cause analysis applied to major break downs. Operators are looking to provide more input to this area. Need stronger communication with maintenance team to apply their knowledge. Some maintenance plans are out of date, need to embed ongoing review and improvement process.
Capital investment strategies	65	80	Capital works programmes scoped for year 1-2. From year 3 have nominal budget lines. Seeking to develop a 3 year programme of scoped works. Microsoft Enterprise Project has been implemented which requires detailed scoping to mobilise project. Would like to have better scoped projects on the 10-year work programme. Renewal programme – not a lot of pipe replacement expenditure and tends to be quite lumpy. less so for plant replacement.

Financial and funding strategies	60	80	Improvements are around the up front scoping of projects. Dedicated accountant can help with costing models. Improve linkages between maintenance plans and costs and AMPs and budgets. Once improved condition data comes through, will improve financial forecasts.
Asset management enablers			
Asset management teams	65	90	Strong support for training and good capability in water supply area. AMDG is just in its infancy. Improvements are around improved coordination and commitment across council.
AM plans	50	85	Last done in 2004, updated 2008, still being updated. Setting it up to make it easier to update. Eg: references to source documents.
Information systems	60	85	A wide range of systems used – SAP, Project Service, Optimiser, Qpulse (document management), Quantate, Citect, Tortoise, Vantage Point. SAP provides the data that is required, but need to export into Excel to manipulate. Would like easier reporting production for AMPs and other analysis. Would like to have document links in SAP. Operational data systems are not integrated with SASP. There is operational performance data in the SCADA system. Could get smarter in some areas. eg: reporting on breakdowns is in operational system and then needs to be manually entered into SAP and works order created. Don't budget in SAP – it is done in ESSBASE – SAP was too expensive.
Service delivery models	65	75	Historical decisions have been around retaining knowledge and internal resourcing. Strategy is based on contracting out around half of what they do. All external work is competitively tendered, policy in place, etc. SLAs in place with other Council departments. There are some SLAs still being developed. Ownership and delivery of water is a political issue and there are constraints on what can be done privately. Improvements: Documented strategy for in-house vs external delivery. Completion of SLAs.
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Quality management	95	95	ISO 9001 and 14001 certification. PAS-55 is very similar.
Improvement planning	40	85	The AM improvement plan from the previous AM Plan was never formally monitored or reviewed. As yet, an updated improvement plan has not been developed (though this is an expected outcome of this review).

Appendix 5 – Asset Valuation by Location and Type

A breakdown of infrastructure assets by location and type is given below (source #1125561)

Replacement value		Asset Type						
Location type	Location	**Equipment**	**Water storage units**	**Water Miscellaneous**	**Wells**	**Water Mains**	**Valves**	Grand Total
Treatment plants	Te Marua Water Treatment Plant	$23,713,532	$24,621,488	$56,247,472		$6,425,900	$17,818	$111,026,210
	Wainuiomata Water Treatment Plant	$10,414,902	$14,649,136	$54,294,431		$12,459,812	$343,762	$92,162,043
	Waterloo Water Treatment Plant	$9,599,914	$3,746,762	$5,338,821	$1,563,168	$2,684,400	$148,400	$23,081,466
	Gear Island Water Treatment Plant	$2,905,696	$1,919,700	$2,031,622	$540,000	$773,700		$8,170,718
Treatment plants total		**$46,634,044**	**$44,937,086**	**$117,912,346**	**$2,103,168**	**$22,343,812**	**$509,979**	**$234,440,436**
Distribution pipelines	Kaitoke to Karori			$9,814,219		$112,318,748	$2,058,509	$124,191,476
	Wainuiomata to Wellington			$17,169,461		$68,008,589	$1,599,459	$86,777,509
	Waterloo Artesian System			$67,200		$19,532,000	$551,115	$20,150,315
	Monitoring & Control/Misc Equipment	$1,359,658		$219,365			$11,500	$1,590,522
	Porirua Branch			$188,999		$16,142,300	$529,285	$16,860,584
Distribution pipelines total		**$1,359,658**		**$27,459,244**		**$216,001,636**	**$4,749,868**	**$249,570,406**
Pumping stations	Ngauranga Pumping Station	$2,094,405		$2,217,624				$4,312,029
	Haywards Pump Station	$1,876,900		$1,842,380				$3,719,280
	Thorndon Pumping Station	$811,376		$536,367			$1,220	$1,348,963
	Satellite Pumping Stations	$3,911,031		$3,435,904				$7,346,935
Pump stations total		**$8,693,712**		**$8,032,275**			**$1,220**	**$16,727,207**
Reservoirs	Stuart Macaskill Lakes	$1,075,523	$35,500,000	$7,141,297		$2,406,900		$46,123,720
	Ngauranga Reservoir	$150,738	$5,200,000					$5,350,738
	Haywards Reservoir	$355,426	$4,400,000	$60,500				$4,815,926
	Customer Service Reservoir	$1,246,142	$800,000	$407,036		$256,200	$4,000	$2,713,378
Reservoirs total		**$2,827,829**	**$45,900,000**	**$7,608,833**		**$2,663,100**	**$4,000**	**$59,003,761**
New sources	Upper Hutt Aquifer				$100,000			$100,000
New sources total					**$100,000**			**$100,000**
Grand total		**$59,515,242**	**$90,837,086**	**$161,012,698**	**$2,203,168**	**$241,008,549**	**$5,265,068**	**$559,841,811**

Book value		**Asset Type**						
Location type	Location	**Equipment**	**Water Storage Units**	**Water Miscellaneous**	**Wells**	**Water Mains**	**Valves**	Grand Total
Treatment plants	Te Marua Water Treatment Plant	$10,614,715	$18,391,511	$34,638,971		$2,968,642	$17,150	$66,630,987
	Wainuiomata Water Treatment Plant	$5,490,643	$11,266,096	$24,302,938		$9,646,348	$217,742	$50,923,767
	Waterloo Water Treatment Plant	$4,224,995	$2,460,925	$3,076,080	$644,502	$1,814,152	$98,337	$12,318,990
	Gear Island Water Treatment Plant	$1,202,002	$1,068,300	$772,156	$239,382	$472,167		$3,754,007
Treatment plants total		**$21,532,355**	**$33,186,832**	**$62,790,145**	**$883,883**	**$14,901,308**	**$333,229**	**$133,627,752**
Distribution Pipelines	Kaitoke to Karori			$6,099,132		$45,236,545	$1,607,663	$52,943,340
	Wainuiomata to Wellington			$12,943,394		$30,029,947	$1,226,220	$44,199,561
	Waterloo Artesian System			$39,183		$10,337,715	$371,746	$10,748,644
	Monitoring & Control/Misc Equipment	$897,697		$211,953			$9,349	$1,118,999
	Porirua Branch			$153,209		$9,484,287	$414,480	$10,051,976
Distribution pipelines total		**$897,697**		**$19,446,871**		**$95,088,495**	**$3,629,458**	**$119,062,521**
Pumping stations	Ngauranga Pumping Station	$995,209		$1,628,609				$2,623,818
	Haywards Pump Station	$397,246		$712,310				$1,109,556
	Thorndon Pumping Station	$395,031		$48,592			$4,141	$447,764
	Satellite Pumping Stations	$2,226,176		$2,433,247				$4,659,423
Pump stations total		**$4,013,662**		**$4,822,759**			**$4,141**	**$8,840,561**
Reservoirs	Stuart Macaskill Lakes	$626,142	$30,950,536	$5,417,001		$1,676,638		$38,670,316
	Ngauranga Reservoir	$88,896	$4,415,798					$4,504,694
	Haywards Reservoir	$252,310	$2,548,894	$52,486				$2,853,690
	Customer Service Reservoir	$703,104	$383,441	$277,348		$55,730	$2,577	$1,422,200
Reservoirs total		**$1,670,452**	**$38,298,670**	**$5,746,835**		**$1,732,368**	**$2,577**	**$47,450,901**
New sources	Upper Hutt Aquifer				$91,660			$91,660
New sources total					**$91,660**			**$91,660**
Grand total		**$28,114,166**	**$71,485,501**	**$92,806,610**	**$975,544**	**$111,722,170**	**$3,969,404**	**$309,073,396**

Note: There is a difference of approximately $2m between the grand total book value show above and the book value shown in Table 24. This is because some assets are not linked to equipment records in the asset management database (approx $1.4m), and because deactivation is in progress for some assets (approx $260k).

Appendix 6 – Condition inspection forms

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Pipe condition inspection form (refer #1118704)

File B/08/04/04	Date:	W/O:	Attach photographs
Name of pipe:			
Size/coating/lining/wall material:			
Joint type:			
Location/depth:			
Length of pipe exposed/inspected:			
Approx water table depth:			
Pipe bedding material:			
Adjacent soil type (circle appropriate): clay - sand - gravels - rock - peat			
Typical coating condition			Grade
Localised coating damage (size/extent):			
Typical pipe wall condition			Grade
Localised internal/external pits or single pin hole (size/extent):			
Typical lining condition			Grade
Localised lining damage (size/extent):			
Typical pipe joint condition			Grade
Pipe joint bolts condition:			
Pipe joint wrap/coating condition:			
Other observations:			

Condition Grading Table

Grade	Classification	Action	Description
1	Very good	No action required	New or near new condition. Some wear or discolouration but no evidence of damage.
2	Good	No action required	Deterioration or minor damage that may affect long term performance.
3	Moderate	Consider specialist assessment	Clearly needs some attention but is still working.
4	Poor	Get specialist assessment	Either not working or is working poorly because of significant damage or deterioration.
5	Very poor	Replace or repair	Needs urgent attention.
N/A	Not applicable	No action required	Does not exist with this pipe.

Return form to Assets and Compliance for processing (see over)

Processing by Maintenance Planner, Assets and Compliance		
1.	Scan form and save to eDocs file (B/08/04/04).	
2.	Link eDocs copy of this form to the SAP work order.	
3.	Determine overall condition rating (the worst rating out of individual ratings for coating, wall, lining, joint).	
4.	Update SAP equipment condition with overall condition rating.	
5.	Forward eDocs link to Team Leader Engineering and Projects for assessment.	

Processed by: ______________________

Date: ______________________

Water, air, earth and energy – elements in Greater Wellington's logo that combine to create and sustain life. Greater Wellington promotes **Quality for Life** by ensuring our environment is protected while meeting the economic, social and cultural needs of the community

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