Wellington Metropolitan Water Supply Development

FOR FURTHER INFORMATION

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30 April 2008

Contents

1. Introduction

As the recently published history of the Wellington water supply indicates (www.gw.govt.nz/section67.cfm), the system has largely been built as a series of major increments, starting with the Lower Karori dam in 1878. The Stuart Macaskill lakes and treatment plant at Te Marua were completed over 20 years ago and the last major investment was the water treatment plant at Wainuiomata 15 years ago. It is now time for the next major increment and decisions are needed on what we do next to avoid a shortage of water in a really adverse drought situation.

Over the 2007/08 summer the El Nina weather pattern resulted in higher than normal temperatures and prolonged periods without rain. The effect was reduced river flows, a reduced aquifer level and an increased reliance on the Stuart Macaskill storage lakes. As lake levels fell it became necessary to introduce a domestic sprinkler and irrigation ban for the first time in over 20 years. Further restrictions would have been necessary if sustained rain had not fallen at the end of March. This summer was not a very severe drought, but it illustrated the vulnerability of our reliance on run-of-river water sources, where shortage of source water was a bigger problem than the level of demand.

Fortunately, for most of the year, Wellington has a more than adequate supply of water available for treating. However, more untreated water needs to be available from December to March to meet peak demand from the growing population and provide increased security of supply, particularly in drought situations. Modelling of demand shows that we are no longer meeting the adopted security standard of 2% shortfall (1 in 50 year drought) for the current population of 379,000 and projections indicate that this situation will worsen at an increasing rate without additional new water sources or a corresponding reduction in demand.

Short-term developments are needed now to restore the security of supply. Three short-term options have been identified that together will reinstate the 2% shortfall and maintain it for the next 4 years. A fourth option (the Upper Hutt aquifer) with the other three is capable of supplying sufficient additional water for a population of at least 425,000. Beyond that population a storage dam would be required. However water demand reduction from either conservation initiatives or population growth lower than forecast would defer the need for a storage dam. Two development scenarios have been identified and independent economic analysis has been undertaken to consider the options on a similar basis. From a resident’s point of view the interest in likely to be in what the financial impact of any scenario will be on a household rather than the total development cost.

The demand side options to reduce per capita water demand will be fully considered in the separate Regional Water Strategy. This development report examines the options available for water supply increase to reinstate the security of supply whilst retaining the flexibility necessary to incorporate demand management initiatives.

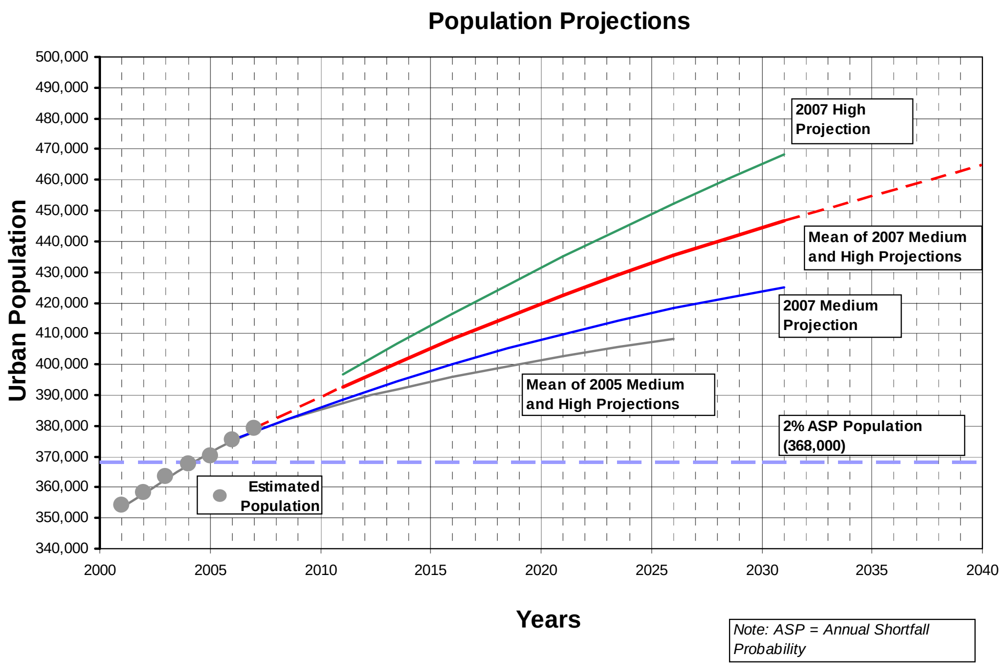
2. Background

Greater Wellington Regional Council (GWRC), in consultation with its city customers, adopted a security of supply standard some years ago. The standard is to have no more than one year in every 50 years when we are unable to meet the peak demand for water, or more correctly, a 2% probability of a shortfall in any one year (annual shortfall probability). This standard is conservative, but then the consequences of water shortage can be severe. Also, as the severity of a drought cannot be determined until after it is over, it is prudent to put conservative demand reduction measures in place during a potential drought – as found necessary during the recent summer. As a comparison, Watercare Services in Auckland raised its security of supply standard from 1 in 50 years to 1 in 200 years following a severe drought in 1994.

Over the last few years, population growth in metropolitan Wellington has been much greater than expected. Our earlier modelling work indicated the water supply system could sustain a population of 377,000. In 1997, it was predicted this population would be reached in about 2020. Our new and more sophisticated model indicates there is only sufficient water for a population of 368,000 under 1 in 50 year drought conditions. What the new climate change module will show when completed is still unknown.

In December 2007 Statistics New Zealand released a revised urban population estimate of 379,000 for the four metropolitan cities (Lower Hutt, Porirua, Upper Hutt and Wellington) as at June 2007. On this basis the probability of a shortfall has increased to 2.9% or one shortfall every 35 years on average. Our stated level of service cannot now be met.

GWRC has adopted the mean of the medium and high population projections from Statistics New Zealand as the population projection for water planning purposes. This is a balance between what is likely to happen and a more cautious approach, which recognises the time needed to have new infrastructure approved and constructed. It has also proven to be a close approximation of the actual trend over the last few years).



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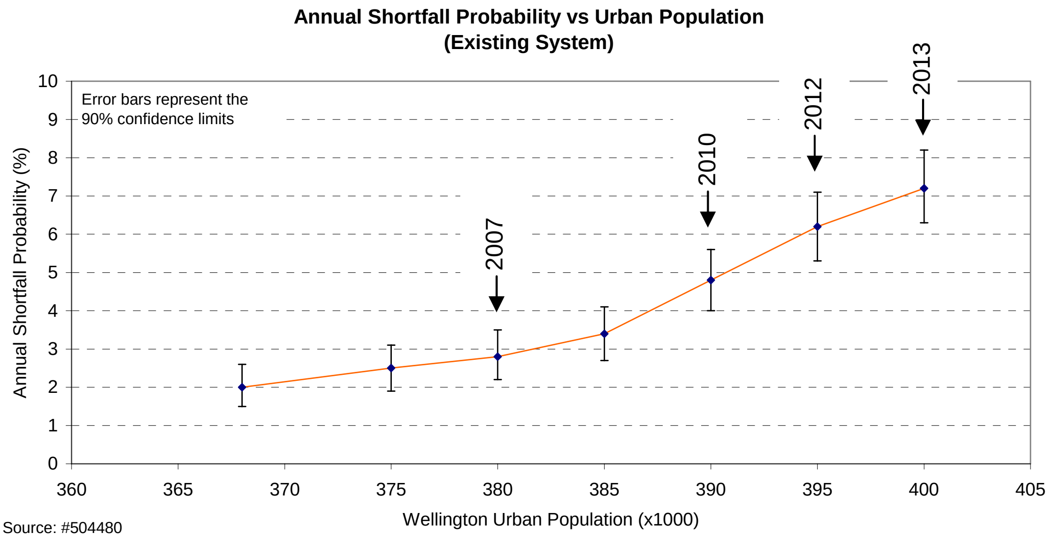
As the previous graph shows, Statistics New Zealand has substantially changed their population projections in just the last two years.

With continued population growth, the annual probability of a shortfall will rise at an increasing rate unless some action is taken to increase the supply of water or reduce demand. Using GWRC's population projection from Statistics New Zealand figures, the probability of a shortfall is shown in the following graph to be almost 5% in about 2010 and over 7% by 2013.



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Four years ago it became apparent that enhancements to the water supply system would be needed much sooner than 2020, so a series of detailed investigations were started. Provision for the detailed investigations was made in the GWRC 2006/07 Long-Term Council Community Plan. This followed preliminary investigation work reported to GWRC through the Council's Utility Services Committee (Report 05.359). A media release of 20 September 2005 alerted the public to the preliminary work and ongoing investigations.

A target of supplying a population of 450,000 was adopted, though there is nothing magical in this figure. GWRC's population projection identifies that the population will be 450,000 in about 2032. Given the long lead-time for planning and constructing some types of water supply infrastructure, it is prudent to plan for at least this level of population.

Initial investigations into water supply options were wide ranging and by mid 2005 these had been narrowed down to a few short and long-term options that can be used to provide a future water supply strategy. Details of these options are outlined in the report. Raising the maximum water level of the Stuart Macaskill Lakes at Te Marua is a late addition to the list of possible options. Options discarded include several dam sites that were not suitable and a desalination plant. The latter was discarded because of high capital and operating costs, and energy usage in particular. Demand reduction initiatives have also been identified but these are not discussed in detailed in this report, since they will be thoroughly considered by the Regional Water Strategy.

Two strategic scenarios utilising the possible options been developed and analysed and these are described in the report.

3. Short-term water supply options

3.1 Introduction

Options that can be implemented in the short term are necessary to reinstate the probability of a water supply shortfall in any one year from the current level of 2.9% to the target probability of 2%. Three options have been identified that together reinstate this target, and maintain it through to a population of 395,000, which is expected to occur in 2012 based on recent population projections. The fourth option (Upper Hutt aquifer development) provides a future water supply for significant years of population growth from 2012.

Each option has some degree of risk (whether engineering, consenting or political) and no option can be assumed to be guaranteed. If any of the three 'reinstatement' options are unable to be implemented, then the Upper Hutt aquifer will be essential to reinstate the security of supply. Each option is described below.

3.2 Raising the water level of the Stuart Macaskill Lakes

The concept assessment has identified that it should be possible to raise the level of both lakes in the order of 1.3 m without costly earthworks or major alterations to the existing structures and without compromising the existing design or safety of the lakes. A feasibility study is under way to confirm the concept, provide preliminary design details, and review the cost estimate.

The effect would be to increase the total storage capacity of 3,330 million litres (ML) by an additional 400 ML, a 13% increase in usable volume. Modelling work has identified that an additional 400 ML of storage at Te Marua would supply the summer peak water demand of an additional 10,000 population.

Some modification of the inlet and overflow weirs, spillways and intake tower chamber walls would be needed but this work is not substantial. One of the main considerations of raising the level of the lakes is to ensure there is adequate freeboard above the new top level of each lake to prevent overtopping by seiche waves generated by a large seismic event. It is proposed to achieve this by installing a nominal 1.3 m high concrete barrier or raising the embankment crest around parts of the perimeter of both lakes where the impact and risk from seiche waves is more than minor.

With careful management, the work on each lake could be carried out without significantly affecting their operation. This will minimise the impact on water supply storage security whilst the level of the lakes is increased.

Since the work required to increase the level of the lakes is within the regional park designation of the Upper Hutt District Plan, a resource consent under the district plan should not be required. A building consent issued by GWRC, with Environment Waikato acting as its agent, is likely to be required for alterations to the dam structure.

A very preliminary cost estimate (as at September 2007) to raise the level of both lakes by 1.3 m is $3.9 million to $5 million. It is estimated that the design, consenting and construction could be completed in 2 years.

3.3 Reducing the minimum water flow at the Kaitoke weir

The current Kaitoke water take consent requires a minimum residual flow of 600 litres/second downstream of the Kaitoke weir. This requirement restricts the amount of water that can be taken at Kaitoke and the water stored in the Stuart Macaskill Lakes is used as far as possible to make up the shortfall. The quantity of stored water used daily determines the period that the lakes can supplement this shortfall. In February 2008 up to 60 million litres per day (MLD) were pumped from the lakes, which was well over 50% of the water treated daily by the Te Marua plant. By reducing the residual flow at Kaitoke, more water would be available for treatment.

Scientific studies show that reducing the residual flow to 400 litres/second would have manageable impacts and effecting this change requires only a simple adjustment to the weir control system and requires no capital investment. However it would require a change to the resource consent.

For approximately 40 years until the Regional Freshwater Plan was introduced in 1999, there was no requirement for any residual flow. Studies have shown that there has been no permanent damage to the ecology as a result. Approximately 500 m downstream of the Kaitoke weir the Hutt River is joined by the Pakuratahi River, which significantly increases the total flow.

Since the Hutt River is already used extensively for water supply, stakeholders are concerned that reducing the residual flow could be detrimental to the river ecology. Key stakeholders see the main issues as:

(1) Possible restriction of fish passage through the Hutt River Gorge between Te Marua and Kaitoke.

(2) Reduction of trout habitat below Birchville, the main fishing reach.

(3) Possible exacerbation of recent algal blooms.

(4) Reduction in macro-invertebrate populations, an important source of fish food.

Each of these issues has been studied and reported on. These reports are currently being peer reviewed and all areas of concern worked through. GWRC staff members and consultants have worked closely with key stakeholders for a period of two years. A collaborative approach has been adopted in an effort to achieve an agreed methodology and avoid disagreement over the scientific methods used.

Because there are a number of factors influencing the river flow, in addition to the abstraction of water at Kaitoke, a low flow management plan for the Hutt River below Birchville has been suggested to the key stakeholders. This would involve a range of demand management, system management and ecosystem monitoring actions being initiated at various river flow trigger levels.

The proposal is that action will be taken to maximise the use of sources other than the Hutt River when the river drops below the flow required to maintain the desirable minimum habitat. The health of the river ecology will be monitored to establish whether any degradation has occurred and GWRC may request the four city customers to use advertising and water use restrictions to reduce demand.

Once the outcomes of the scientific work have been agreed and the majority of the technical issues resolved, a resource consent application will be lodged with GWRC's Environment Management Division.

3.4 Constructing a new water reservoir in Wellington City

In 2003 a large new reservoir (35 ML) was proposed for Wellington City to be jointly funded by Capital and Coast District Health Board (C&CDHB), Wellington City Council (WCC) and GWRC. The reservoir was to provide emergency water storage for Wellington Hospital, together with replacing water storage lost to WCC when the old Bell Road Reservoir is decommissioned, plus additional storage for the GWRC metropolitan water supply system in the right location to assist with high peak demand.

The proposal gave each party access to an agreed volume of water at a cost between $3 and $4.3 million each, with C&CDHB to also fund a dedicated and more secure supply pipeline to the hospital for an additional $1.1 to $1.35 million. A site in the town belt above the Prince of Wales Park was chosen.

At the time the Ngauranga Reservoir was completed and the Karori Reservoir closed, it was recognised that a second new reservoir would also be needed, with a completion date about 2010. This reservoir would provide added capacity to cope with short-term peak demands in the Wellington CBD zone. A shared reservoir with WCC and potentially C&CDHB will fulfil this need.

The Capital Quake exercise in 2007 clearly identified that without a reliable source of water Wellington Hospital would very quickly become unable to continue to provide services in an emergency such as a large seismic event. From a community perspective GWRC is keen to ensure that the hospital is able to continue to function following a major emergency event.

Almost five years after the initial proposal C&CDHB has not yet committed funding to the project. Now that GWRC's 1 in 50 year design standard for water supply can no longer be met, it is important that additional capacity is provided soon to reduce the risk of a supply shortfall. In addition, WCC wishes to make progress on replacing its old Bell Road Reservoir.

In the absence of a funding commitment from C&CDHB, it will be necessary for GWRC to proceed with WCC to plan the joint development of a reservoir, possibly with the ability to accommodate C&CDHB at a later stage. The cost to both GWRC and WCC would increase depending on the size of reservoir built and C&CDHB's future involvement. Provision has been made in GWRC's 2008/2009 proposed Annual Plan for some of the funding required.

A possible scenario is that the reservoir would be owned by WCC; with GWRC purchasing a long-term property right that give access to an agreed water storage capacity for its share of the construction cost. Whilst efforts continue to include the input of C&CDHB, the details of this alternative will be explored with WCC with a view to commencing planning and design in the 2008/09 financial year for completion by the end of 2011.

3.5 Developing the Upper Hutt aquifer

The Upper Hutt groundwater zone extends from approximately the northern end of Totara Park to the Taita Gorge. It is a shallow unconfined aquifer (i.e. not secure like the Waiwhetu aquifer in the Lower Hutt valley) that is currently used by a small number of organisations for commercial purposes and irrigation. It has been used by the Coca Cola Corporation in the past and until recently the major user was South Pacific Tyres, which used aquifer water for cooling purposes.

Drilling investigations to determine the capacity of the aquifer were previously conducted at Trentham Memorial Park in 1971 and Trentham Army Camp in 1986. However, at that time development for public water supply was focused on the Waiwhetu aquifer further south. No further investigation of the Upper Hutt aquifer occurred until 2005, when a review of the existing information indicated that a viable source of water for public supply could exist. This was confirmed by exploratory drilling and testing undertaken in the Wallaceville area in 2007.

The deposits of gravel and silt that make up the aquifer are known to be very variable, which creates a risk that any well drilled may yield only low volumes of water. Whilst this did not occur with the test wells drilled, the actual number of wells required for development of the aquifer would be dependent on the flow rates obtained.

The aquifer has limited storage and is recharged by infiltration from the Hutt River and rainfall in the hills to the east of Upper Hutt and on the Upper Hutt flats. Modelling has shown that water abstraction of 16 MLD to 24 MLD is practicable, but if water is abstracted over an extended period it increasingly comes from the Hutt River rather than storage. For example, after 90 days of abstraction at 24 MLD, approximately 90% of the water comes from the river. More detailed studies of these impacts and the potential effect on river ecology will be undertaken before initiating discussions with key stakeholders.

The only other impact identified is a possible reduction of stream flow and water quality in the spring fed stream in Trentham Memorial Park (Mawaihakona Stream). Monitoring during well testing did not show any noticeable impact.

It is proposed that the Upper Hutt aquifer would normally only be used during the summer months (with the exception of a small flow to keep the system and water treatment plant in good operating condition) and as a standby water supply.

Preliminary modelling indicates that 16 MLD will meet the peak water demand of an additional 30,000 population. At this flow rate the Upper Hutt aquifer, together with all other short-term measures identified, will increase the sustainable population to 425,000. At 24 MLD the sustainable population would be approximately 440,000.

The Upper Hutt aquifer development would consist of 6 to 8 wells in a distributed wellfield, with interconnecting underground pipework to a water treatment plant and booster pumping station. Treated water would be discharged into the Kaitoke to Karori water main. Following a major seismic event the aquifer could be used to supply parts of Upper Hutt City.

To fully utilise the Upper Hutt aquifer, it will be necessary to increase the capacity of the Kaitoke to Karori main by adding new or upgraded pumping stations at some stage in the future. This is currently being modelled to identify under what conditions and where increased capacity will be required.

Since this is an unconfined aquifer, there is the potential risk of contamination from historically contaminated sites, leaking fuel storage tanks, or from future spills of chemicals or other substances. Whilst the testing carried out did not reveal any contamination at the time, it remains a risk. As a consequence the water treatment proposed would be capable of coping with possible future contamination.

The preliminary estimated cost of the development (as at September 2007) is approximately $15 million for a 16 MLD capacity and $19 million for a 24 MLD capacity. This estimate does not include the cost of any new or upgraded pumping stations needed in the future to increase distribution capacity, which could cost up to a further $5 million.

Provided there were no lengthy delays in obtaining resource consents, the Upper Hutt aquifer could be constructed and operational by 2012 and meet the water supply needs of a growing population for at least 10 years. This would provide sufficient time to design, consent and construct a dam, or to implement demand reduction initiatives.

4. Long-term water supply options

4.1 Introduction

The short-term options for augmenting the water supply and the options to reduce demand do not remove the need to plan for a long-term solution to water supply. They do, however, delay its construction and possibly for a substantial number of years. If the population continues to increase at the currently projected level there will come a time when the increasing level of risk can only be reduced through an additional water source. However if the projected level of population reduces in the future, the need for this new water source will be deferred further.

There are a number of options that provide a long-term water supply solution, including river sources, desalination, third storage lake at Te Marua, to a dam. Future water sources investigations completed in 2005 identified water storage using a dam as the preferred option for long-term water supply. Desalination and building a third storage lake at Te Marua were set aside because of high capital and operating costs or physical limitations. River sources were discounted because of hydrology limitations and/or cost.

4.2 Background

The future water sources investigations examined a number of potential dam sites and narrowed the choice down to sites in each of the Pakuratahi, Wainuiomata and Whakatikei catchments. All three areas are GWRC owned land designated for water catchment or future water catchment.

The concept of building a dam at these sites is not new. The Whakatikei site was identified as a water supply option in 1927 and all three sites were considered around 1980 as potential water sources. Further investigations into these three sites (known as the Live Storage Assessment (LSA) project) were completed in the second half of 2007.

The design parameter chosen was for a dam to be able to provide water for 450,000 people with a 2% chance of a shortfall in any year. Short-term improvements to the water supply were expected at the time to be capable of meeting the needs of a population of 390,000. That required a dam to meet the water supply needs of an additional 60,000 people. A peak day demand of 36 MLD was established as the design supply yield for investigation purposes.

4.3 General

4.3.1 Survey information

Survey data for each site was collected using a modern aerial technique that enabled the ground topography of each dam site and inundation area to be measured with a high level of accuracy, despite dense vegetation cover. This data would have been extremely difficult to obtain to this accuracy by traditional survey methods.

4.3.2 Hydrology

The total storage volume for each dam site includes water below the lowest take-off level and provision for flushing flows, downstream residual flow, climate change within that catchment, 100 years of sedimentation, plus an allowance for modelling inaccuracy and other variables.

The assessment of catchment yield for the Whakatikei and Pakuratahi Rivers was greatly assisted by the availability of high quality data collected at hydrological station sites since the 1970s. Relatively good data was also available for the Wainuiomata and Orongorongo Rivers.

4.3.3 Seismic information

GNS Science studies indicate there are no active faults through any of the dam sites, although all sites are in highly seismic areas due to their proximity to either the Wellington or Wairarapa faults. The Whakatikei dam site is close to the Moonshine fault, for which there is limited data available on its time of last movement or recurrence interval.

4.3.4 Geotechnical constraints

Geological information shows there are no known major geotechnical constraints to the development of a dam at any of the three sites. More detailed investigations of a preferred site will be undertaken, but given the relatively uniform nature of Wellington’s geology, unexpected geological constraints are unlikely to be encountered.

4.3.5 Dam engineering

A roller compacted concrete dam (a form of concrete gravity dam) was selected as the preliminary dam type, although other dam types have not been discounted at this stage. By coincidence all dams are 43 m in height to achieve a water supply yield of 36 MLD. The Whakatikei has a lower concrete volume (less than 50% of the others) because of the narrow gorge at the dam site.

Suitable dam types can be designed for each site to resist earthquake induced ground shaking and to meet best practice dam break criteria. Whilst inundation of urban areas is possible should a dam fail, the probability of failure is extremely low.

4.3.6 Construction impacts

There would be significant temporary adverse environmental effects from construction activities at all the sites. Effects would predominantly be from constructing access roads, dams, pipelines, and vegetation clearance for the reservoir. Impacts would include reduced downstream water quality, some sediment deposition, increased local traffic, changed landscape values, reduced recreational access, increased noise, and increased dust. Impacts would need to be carefully managed, including the diversion of clean water around construction areas, containment and treatment of contaminated stormwater runoff, and minimising disturbed areas.

The Whakatikei option would result in some unavoidable disruption to residents and traffic in Moonshine and Bulls Run Roads during road upgrading and pipeline laying.

4.3.7 Security of supply

Of the range of issues affecting security of the water supply, movement of the Wellington fault is by far the most significant and important event. The current wholesale water distribution system is expected to suffer catastrophic disruption following the rupture of the Wellington fault, because of the trunk mains crossing the Wellington fault at six locations. The probability of a Wellington fault event within the next 30 years is estimated at 12%. Whilst work is under way to improve the overall resilience of the system, repair of these mains at fault crossings is expected to be very difficult and lengthy, requiring extensive material, labour and plant resources.

The construction of a new water source provides a unique opportunity to reduce the vulnerability of the water supply system.

4.3.8 Designation and consents

Although the sites are owned by GWRC and designated as water supply catchments, currently none of the three site options has an existing designation for a dam or a reservoir. Therefore a change to the designation in the district plan would be required for the catchment chosen. Multiple consents for the selected dam site and off-site works would be required from GWRC.

4.3.9 Stakeholder consultation

As part of the investigations, preliminary discussions were held with key stakeholders and initial impressions gained for each site. This included initial contact with Iwi to gain some appreciation of the cultural significance of each site, and a series of meetings with Fish and Game New Zealand to discuss trout spawning studies. Further detailed consultation will be necessary for the chosen site should a storage dam be chosen as the preferred strategic development scenario.

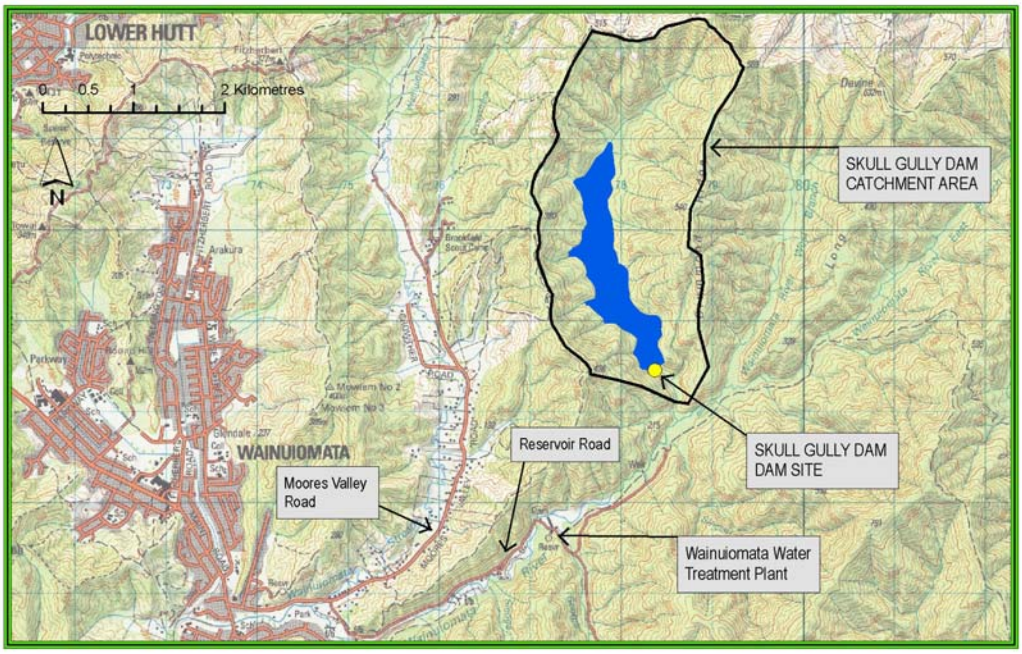
4.3.10 Dam and catchment statistics

	Wainuiomata (Skull Gully)	Pakuratahi	Whakatikei
Water storage volume	5,900 ML	6,400 ML	8,400ML
Dam height	43 m	43 m	43 m
Dam concrete volume	73,400 m^3	67,000 m^3	32,100 m^3
Reservoir surface area	44 ha	48 ha	68 ha
Approximate length of reservoir	2 km	2.5 km	4 km
Catchment area	596 ha	3,750 ha	4,413 ha
Optimum water supply yield	70 MLD	135 MLD	97 MLD
Increase in dam height for 50% increase in design supply yield	6.0 m	3.5 m	5.5 m

4.4 Wainuiomata dam

4.4.1 Catchment and infrastructure

A dam site was chosen in the area known as Skull Gully, which lies within the 15,000 ha Wainuiomata/Orongorongo water collection and conservation area. The land is owned by GWRC and designated for water supply purposes. Public access to the land is managed. The potential dam site has a catchment area of approximately 600 ha and is approximately 600 m upstream of the Skull Gully stream confluence with the Wainuiomata River. The dam would be upstream of the existing Wainuiomata River intake. A 43 m high dam would provide a reservoir of approximately 5,900 ML extending 2 km upstream of the dam, with the inundation area covering land occupied by unmodified podocarp/broadleaf forest.



Because of the small catchment area, the reservoir would also be supplied by gravity from the Orongorongo River via the existing Orongorongo intake pipeline and a new 3 km pipeline to the dam. The dam would supply the existing Wainuiomata Water Treatment Plant by gravity and reverse flow through the dam inlet pipeline.

The water treatment plant currently has spare capacity but would need to be upgraded from 60 to 75 MLD to meet the additional water supply required during summer peak demand. The water stored in the dam would enable the plant to operate at the higher supply output during dry summers. The distribution system would require a new booster pumping station on the existing pipeline from the plant on or near the Hutt Road.

The existing access road from the treatment plant to near the Skull Gully stream confluence would be upgraded with a new access road constructed from near the confluence to the dam. New bridges across the Wainuiomata River and two other streams would also be required. At this stage it has been assumed that all construction aggregate would be sourced from outside the catchment area.

By increasing the height of the dam from 43 to 49 m the design supply yield would be increased by 50% to 54 MLD and sustain an additional population of 30,000. The Skull Gully catchment (augmented by water from the Orongorongo River) has an optimum water supply yield of 70 MLD and is easily capable of this increase.

4.4.2 Terrestrial ecology

Skull Gully is considered to be the most ecologically significant of the three catchments being investigated. This is based on the expanse of unmodified lowland podocarp forest in the catchment that sets the forest apart from much of the forested land remaining across the lower North Island. The site is part of a “mainland island” project where part of the catchment is fenced and an intensive pest control programme is under way to enhance the ecological health of the forest, including restoration of native birdlife.

Skull Gully and the adjoining catchments provide high quality habitat for rare and threatened bird species. The area has the highest densities of bird species on GWRC land, including threatened yellow crowned parakeet, kereru and long tailed cuckoo. Tree climbing geckos and forest dwelling skinks are also likely to inhabit the catchment. This forest is ecologically significant, both regionally and nationally.

The potential for edge effects and weed infestation would be present and would need to be managed following the establishment of the reservoir. There would be a loss of forest, impacts on adjacent forests, loss of wetland habitat with consequent loss of habitat for native birds, lizards and invertebrates.

4.4.3 Aquatic ecology

Water quality is considered to be high at the Skull Gully site and the ecology of the streambed is considered to be pristine. The dam would reduce the extent of the existing fish habitat, block the upstream or downstream migration of native fish species and degrade the quality of habitat downstream of the dam by modifying the flow regime. Skull Gully was considered to have the most valued habitat. However, since the decommissioned Morton dam and Wainuiomata lower dam (both on the Wainuiomata River) have already modified the fish population so that it consists mainly of non-migrating species, the additional potential adverse effects from a dam at Skull Gully are lower than for the other two sites.

4.4.4 Security of supply

Although relatively remote from the Wellington fault line, movement of the fault is an extreme risk for the Skull Gully option, and very high for other seismic events, such as movement of the Wairarapa fault. This is because the supply pipeline from the Wainuiomata Water Treatment Plant to Wellington crosses the Wellington fault line at Petone and Thorndon. In addition, there is expected to be pipeline rupture because of subsidence along the Petone foreshore, resulting in difficult repair conditions.

The impact of landslides from the steep and unstable Orongorongo Valley hillsides is very high. The impact of climate change is also considered to be high, because heavier rain events will lead to increased instability of these hillsides. Recent experience has shown that repair of the supply pipe from the Orongorongo Valley is difficult under normal circumstances. The Skull Gully dam option was found to provide the lowest improvement in the security of water supply of the three dam sites.

4.4.5 Planning

The Lower Hutt City District Plan provides a high level of protection to the habitat and natural values of Skull Gully, as does the GWRC Regional Freshwater Plan. A high degree of uncertainty exists over obtaining a resource consent for Skull Gully or a change to either plan.

4.4.6 Recreation

The Wainuiomata catchment, as an active water supply catchment, is a restricted area with public access managed for specific activities.

4.5 Pakuratahi dam

4.5.1 Catchment and infrastructure

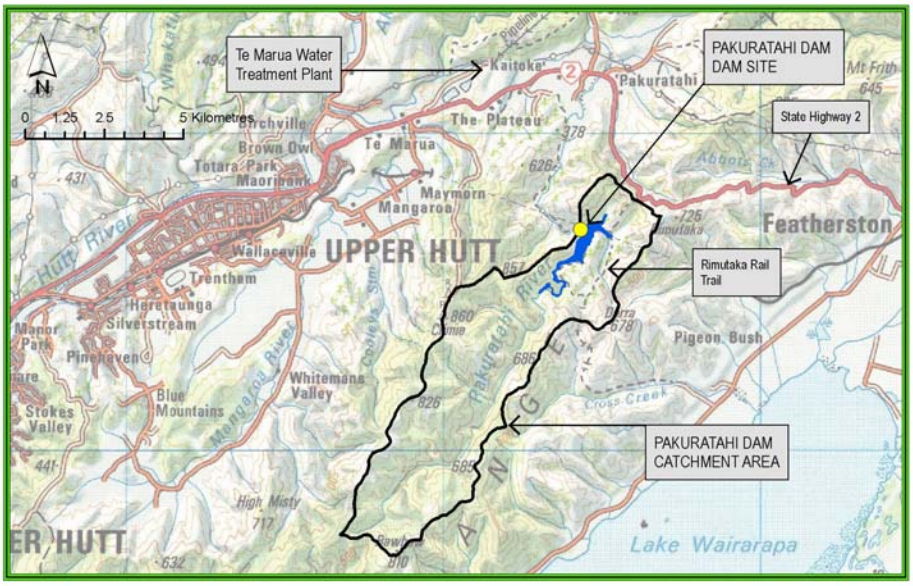
The potential dam site is on the Pakuratahi River at Ladle Bend approximately 6 km upstream of where State Highway 2 crosses the river at Kaitoke. The dam site catchment of 3,750 ha is on the western side of the Rimutaka Ranges on GWRC owned land designated as a future water supply catchment.

A 43 m high dam would be constructed in the narrow gorge resulting in a 6,400 ML reservoir extending approximately 2.5 km upstream and inundating land which is predominately plantation pine forest and some regenerating or unmodified podocarp/beech forest. Aggregate for construction of the dam has been assumed to be sourced from within the inundation area.

The existing 5.4 km logging truck route from State Highway 2 near Muldoon’s Corner on the Rimutaka Hill Road to the dam would be upgraded for construction and operational vehicle access.

A new 9.4 km pipeline with a capacity of 40 MLD would be required to supply water by gravity from the dam to the existing Te Marua Water Treatment Plant. The Te Marua Water Treatment Plant would be upgraded from its current 140 MLD nominal capacity to 180 MLD, to be capable of treating the peak water supply demand. New booster pumping stations would be required at Silverstream and near Tawa. The capacity of the existing Haywards Pumping Station would need to be increased.

By increasing the height of the dam from 43 to 46.5 m the design supply yield would be increased by 50% to 54 MLD and sustain an additional population of 30,000. The catchment has an optimum water supply yield of 135 MLD, which far exceeds this increased requirement.



4.5.2 Rimutaka rail formation and trail

The historic Rimutaka Rail Trail (until 1955 part of the Upper Hutt to Wairarapa railway) passes through the inundation area. The Rimutaka rail formation constructed during the 1870s is registered under the *Historic Places Act 1993* and is a rare example of early railway engineering. Rail features on the Rimutaka rail formation are listed in the Upper Hutt District Plan. The proposed dam would straddle and inundate the historic Ladle Bend Bridge and some 1.5 km of the 18 km of historic rail formation. The pipeline from the dam would disturb up to a further 6 km of historic rail formation, though this would be reinstated. The existing walking/cycling track on the rail trail would need to be relocated to bypass the dam and reservoir.

4.5.3 Terrestrial ecology

Investigations indicate that the effect of the proposed Pakuratahi dam and reservoir on terrestrial values would be the least of the three options being considered by the GWRC, despite the loss of a regionally significant manuka fen wetland.

The affected reach of the Pakuratahi catchment has relatively low natural values because of the presence of a large area of pine forest over much of the area that would be inundated by the reservoir. While the reservoir would affect a short section of the valley that is covered in unmodified podocarp/beech-broadleaf forest, the proportion of forest vegetation affected is considered to be minor and is the least of the three sites. However, it is acknowledged that vegetation associated with the riparian margins along this particular reach of the valley would be lost and the degree of naturalness would be significantly diminished. Threatened kereru, kaka and New Zealand falcon are recorded in the beech forest.

The potential for edge effects and weed infestation would be present and would need to be managed following the establishment of the reservoir. There would be some loss of forest and an impact on adjacent forests, loss of wetland habitat, and loss of habitat for native birds, lizards and invertebrates.

4.5.4 Aquatic ecology

Water quality is considered to be moderate to high at the Pakuratahi site and the ecology of the stream bed is considered to be pristine. The dam would reduce the extent of existing fish habitat, block the upstream or downstream migration of native fish species and degrade the quality of habitat downstream of the dam by modifying the flow regime.

The impact of all potential adverse effects at Pakuratahi is rated as high but less than Whakatikei because of lower numbers of native fish. Both rivers have value primarily as Hutt River trout spawning tributaries rather than as angling areas.

The change in tributary flow contributions to the Hutt River is not considered significant at low flows. Whilst the dam will cut off the supply of sediment to the river downstream, the percentage sediment reduction in the Hutt River is expected to be only minor.

4.5.5 Security of supply

The impact of a Wellington fault movement on water supply from the Pakuratahi site was considered to be very high. The pipeline from Pakuratahi crosses the fault line before reaching the Te Marua Water Treatment Plant and the supply pipeline from the plant crosses the fault line after leaving the plant and again at Silverstream.

The risk from increased reliance on the Te Marua Water Treatment Plant, flooding and other seismic events such as movement of the Wairarapa fault are also considered to be high.

4.5.6 Planning

The Upper Hutt District Plan gives the Pakuratahi area a high degree of protection because of the heritage values associated with the old Rimutaka railway formation. It is likely that the Historic Places Trust would oppose an application to build a dam at the preferred location. Obtaining a resource consent for a dam at Pakuratahi would have a high degree of uncertainty.

4.5.7 Recreation

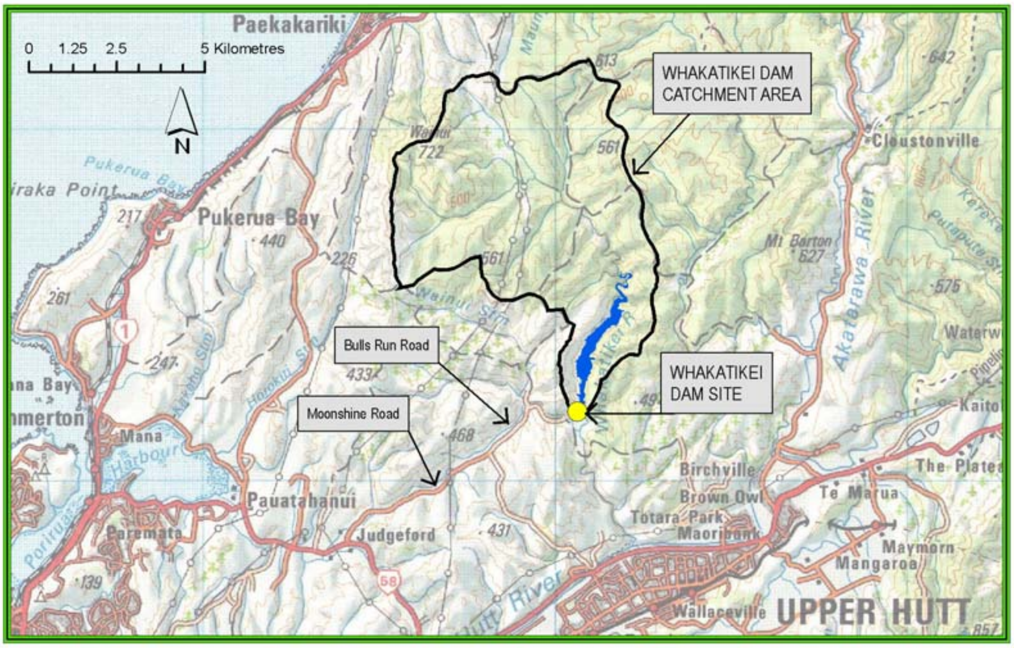
The Rimutaka Rail Trail is a safe, wide and gently graded walkway and cycleway, with an estimated visitor use of over 30,000 people per year. This open access would make it difficult to restrict or prevent use of the reservoir lake for recreational purposes. Whilst vehicle access is currently restricted, vehicle access from State Highway 2 would be possible should a dam and reservoir be constructed at Ladle Bend.

4.6 Whakatikei dam

4.6.1 Catchment and infrastructure

The potential Whakatikei dam site has a catchment of approximately 4,400 ha and is at the lower end of a gorge, approximately 5 km upstream from the confluence of the Whakatikei and Hutt Rivers. The land is owned by GWRC, is designated as a water catchment and forms part of the Akatarawa forest. A

43 m high dam would provide a storage reservoir of 8,400 ML, extending 4 km upstream of the dam, and inundate an area currently occupied by pine plantation forest and podocarp/beech forest.



A new 40 MLD water treatment plant would be constructed near the Whakatikei River end of Bulls Run Road and gravity fed from the dam. A new pumping station would supply a new 8.6 km pipeline along Bulls Run and Moonshine Roads to connect with the existing Te Marua to Wellington pipeline near Judgeford. A new booster pumping station would be required near Tawa.

Bulls Run and Moonshine Roads would be upgraded for dam construction traffic, installation of the new pipeline and subsequent plant operational traffic. A 1 km long access track from the dam through the gorge would be developed for dam construction and inundation area clearance.

Aggregate for construction of the dam and associated works is assumed to be available from within the inundation area or a river terrace on GWRC land. A new upstream bridge may be required if aggregate is sourced upstream of the dam.

By increasing the height of the dam from 43 to 48.5 m the design supply yield would increase by 50% to 54MLD and sustain an additional population of 30,000. The catchment has an optimum water supply yield of 97MLD, which again far exceeds the design requirement. This yield could be increased further by water from the Akatarawa River west through a new intake and tunnel into the catchment.

4.6.2 Terrestrial ecology

The Whakatikei site is considered to have moderate to high ecological values in view of the variety of indigenous vegetation types within the affected area and the contiguous nature of this regenerating forest cover. The area contains a wide range of habitat for native birds, including threatened parakeets and kererü, as well as lizards and invertebrates. The degree of naturalness immediately upstream of the dam site and towards the head of the reservoir is considered to be high. The loss of tawa dominated forest associated with river terraces is considered to be significant because of its limited distribution in the Whakatikei catchment and the adjacent Akatarawa catchment. The same applies to the extensive raupo/sedge wetlands.

The potential for edge effects and weed infestation would be present and would need to be managed following the establishment of the reservoir. There will be the loss of forest, impacts on adjacent forests, loss of wetland habitat with consequent loss of habitat for native birds, lizards and invertebrates.

4.6.3 Aquatic ecology

Water quality is considered to be high at the Whakatikei site and the ecology of the stream bed is considered to be pristine. The Whakatikei catchment supports the highest diversity of species of all three catchments. However, the most significant communities of native fish were found to exist below the dam site. The dam would reduce the extent of existing fish habitat, block the upstream or downstream migration of native fish species and degrade the quality of habitat downstream of the dam by modifying the flow regime.

The impact of all potential adverse effects is considered to be high at Whakatikei. The Whakatikei River has value as a Hutt River trout spawning tributary rather than an angling area. A spawning survey by Cawthron Institute showed the Whakatikei River was likely to provide better potential for spawning than Pakuratahi.

The change in tributary flow contributions to the Hutt River at low flow is not considered significant. Whilst the dam will cut off the supply of sediment to the river downstream, the percentage sediment reduction in the Hutt River is expected to be only minor.

4.6.4 Security of supply

The Whakatikei dam, treatment plant and supply pipeline would be the only facility located on the western side of the Wellington fault. A new facility in this location should reduce the supply risks to Porirua City and the northern and western suburbs of Wellington City after a Wellington fault rupture, because the pipeline does not cross the fault.

Previous work suggests it would take at least 30 days to restore water supply to Wellington City following a movement of the Wellington fault. The Whakatikei option is expected to greatly reduce the time needed to restore water supply to Porirua City and the northern and western suburbs of Wellington City. Since the Whakatikei option provides a water source much closer to the Wellington Central Business District this should also reduce the time taken to reinstate the water supply after a Wellington fault movement.

Whakatikei is the only site of the longer-term options that requires a new water treatment plant (rather than upgrade of existing treatment facilities). This would increase the number of normally operating GWRC treatment plants from four to five (assuming the Upper Hutt aquifer is developed), hence further increasing the security of water treatment. The Whakatikei site was also considered to provide a greater degree of security of supply than the other two dam sites for all types of security events reviewed.

4.6.5 Planning

The policy framework in the regional and district plans presents only a moderate degree of uncertainty in obtaining a designation change and resource consents for the Whakatikei site. Ancillary activities - such as construction, new water treatment plant and pumping station, and infrastructure upgrades - involve less significant environmental impacts than the other sites considered and generally straightforward consent regimes.

4.6.6 Recreation

The Akatarawa forest has a moderate level of outdoor recreation, including tramping, hunting, horse riding, mountain biking, trail biking and four wheel driving (via organisations such as ARAC). Since there are few tracks in the vicinity of the proposed dam and reservoir site, access other than by organised ARAC groups is not frequent at present.

If this site is developed, road access to the dam and reservoir may increase casual access to limited areas in the future resulting in agreed or unwanted recreational use of the lake. New tracks may need to be developed around parts of the lake to preserve access to other areas of the Akatarawa forest currently used by members of 4 wheel drive clubs such as ARAC.

4.7 Cost estimate and construction programme

A risk based cost estimate was developed taking into account all elements of the work required at each site. This generated a range of costs with associated probabilities. For budgeting purposes, the 95 percentile estimate has been adopted, which means there is only a 5% chance that the estimate will be exceeded. The 95 percentile estimate (excluding GST) for each dam site as at September 2007 are shown below:

	Wainuiomata (Skull Gully)	Pakuratahi	Whakatikei
Cost estimate 95 percentile	$84 million *	$150 million *	$142 million *
Additional cost for 50% increase in water supply yield (dam only)	$6.6 million	$3.7 million	$1.0 million

* These figures include all costs associated with the dam, reservoir vegetation clearance, raw water pipelines, water treatment, pumping and distribution upgrades required.

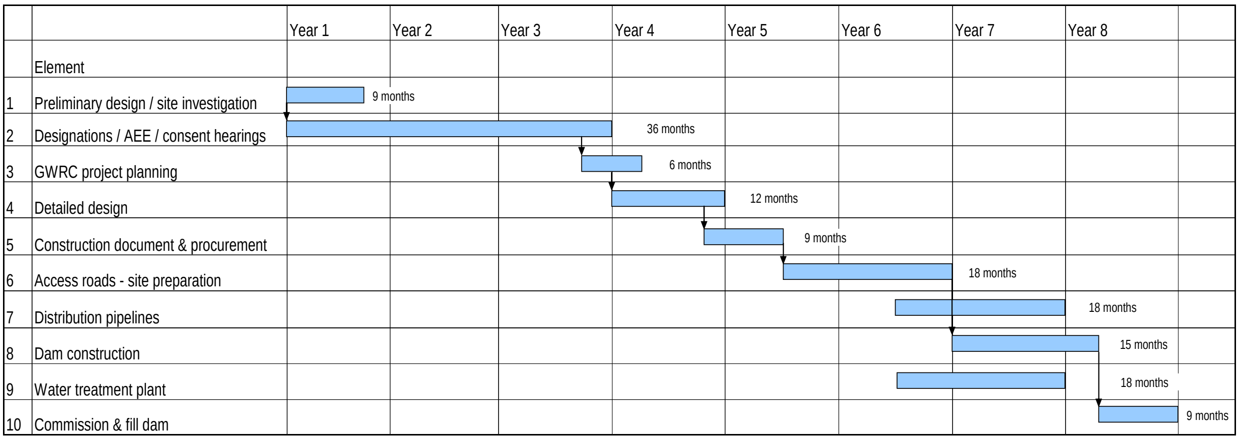
Operating costs

A comparative assessment of the operating cost for each site over a 50-year period showed that water supplied from dams at Skull Gully and Pakuratahi would be similar in cost, whilst the Whakatikei option was approximately 15%

more expensive. This is because Whakatikei involves an additional water treatment plant that would be used mainly for meeting peak demand, with associated higher treatment and pumping costs.

Construction programme

An indicative timeline for consultation, consents, tendering, design, construction and commissioning is presented below. This timeline applies in general to all three options, although not all options have identical work elements. From the decision to proceed, it should be expected that it would take at least 8 years to complete the project.



4.8 Multi-criteria analysis

A multi-criteria analysis of the three sites was carried out in 2007 by GWRC Councillors, customer water supply managers and GWRC managers in three separate workshops. Multi-criteria analysis is a technique for decision making that utilises the judgement of a group of knowledgeable people. MWH NZ Ltd, an international consulting company experienced in this type of analysis, performed the role of independent facilitator.

The analysis involved identifying the attributes seen to be important in determining a dam site and the relative weighting of those attributes; raising the group's knowledge of each dam site (including the issues relevant to each attribute identified); discussing the issues; and then scoring each attribute to achieve an overall score for each dam site.

Each of the three workshops separately decided what attributes it believed were important and what the relative weightings of these attributes should be. Each workshop separately assessed and scored the three sites against each attribute. Despite having different sets of attributes and weightings, all three workshops reached the same clear preference for the Whakatikei dam option over the other two dam sites.

The findings recorded and reported by MWH for each of the workshops, including the attributes identified and their weighting, is provided in Appendix 1 of this report.

5. Development scenarios

Two development scenarios have been analysed using the short-term and long-term options identified to increase the metropolitan water supply. The timing of implementation of each option in the scenario has been set to maintain the target of 2% probability of a water supply shortfall using our current modelling and Statistics New Zealand's population data.

These scenarios require three short-term supply options to be implemented by 2012 and assume no demand reduction initiatives are in place (the timing and level of savings achieved from any demand management initiatives will help defer the need for a dam but may not affect the need for the short-term options). The Whakatikei dam has been used in these scenarios as the median cost dam option.

Development scenario 1

- Implement short-term projects as follows:
    - Raise level of Stuart Macaskill lakes (2008 to 2011)
    - Reduce minimum flow at Kaitoke weir (in 2009)
    - Build CBD reservoir (2008 to 2011)
- Construct Upper Hutt aquifer wellfield and treatment plant (2009 to 2012).
- Construct Whakatikei dam (2014 to 2022).

Development scenario 2

- Implement short-term projects as for Scenario 1
- Construct Whakatikei dam (2009 to 2017).

Note that if any short-term option fails to obtain consent or approval under Scenario 2, then it will be necessary to proceed with the Upper Hutt aquifer to maintain security of supply, which may slightly defer the timing for development of the dam.

6. Economic analysis

6.1 Background

The two development scenarios have been analysed by Brown, Copeland and Company Ltd to establish the Net Present Value (NPV) of each of these scenarios. An estimate of the impact each would have on the average residential property rate is also presented.

6.2 General assumptions

- Domestic water consumption figures are derived from information supplied by the territorial authorities and presented in *Wellington Water Management Plan – Technical Document.*

- The Upper Hutt aquifer produces up to 16 MLD over the three month summer period only, sufficient to supply approximately 30,000 people.
- The Whakatikei dam has a usable storage volume of 5,000 ML, sufficient to provide water to approximately 60,000 people.

6.3 Scenario Analysis

6.3.1 Scenario Costs

The capital costs of the development scenarios are shown in the table below. The cost of the 3 short-term options is common to both scenarios and is therefore not included in the capital cost.

Development Scenarios		Capital Cost	Ranking
No	Options/Sequence		
1	UH aquifer, dam	$157M	2
2	Dam	$142	1

6.3.2 Results of NPV analysis

The NPV analysis of expenditure was carried out using a discount rate of 7%. The analysis was also carried out at discount rates of 5% and 9% to test the sensitivity of the result. The cost of the three common short-term options was excluded, together with potential distribution upgrade since the full extent needed and its timing is uncertain at this stage.

The results of the Brown Copeland NPV analysis are shown in the following table.

Development Scenarios		Present Value (PV)			Ranking		
No	Options/Sequence	5%	7%	9%	at 5%	at 7%	at 9%
1	UH aquifer, dam	$87M	$70M	$57M	1	1	1
2	Dam	$105	$94M	$84M	2	2	2

Although Scenario 2 (dam) has the least capital cost, Scenario 1 has a substantially lower cost when judged by conventional economic criteria, i.e. it has the lowest Present Value because the larger expenditure items are further into the future. The results clearly show that it is not sensitive to changes in the discount rate over the period involved. Demand reductions from any initiatives implemented by the 4 cities, or a reduced population level, would defer the need for a dam and further improve the Present Value of Scenario 1.

6.3.3 Impact on average residential rates

The attached graph shows the average impact on residential rates for these two development scenarios over the period 2008 to 2041. This period covers the major costs involved, but there is no allowance for depreciation. After 2041 the rate increase will reduce as earlier capital expenditure is paid off.

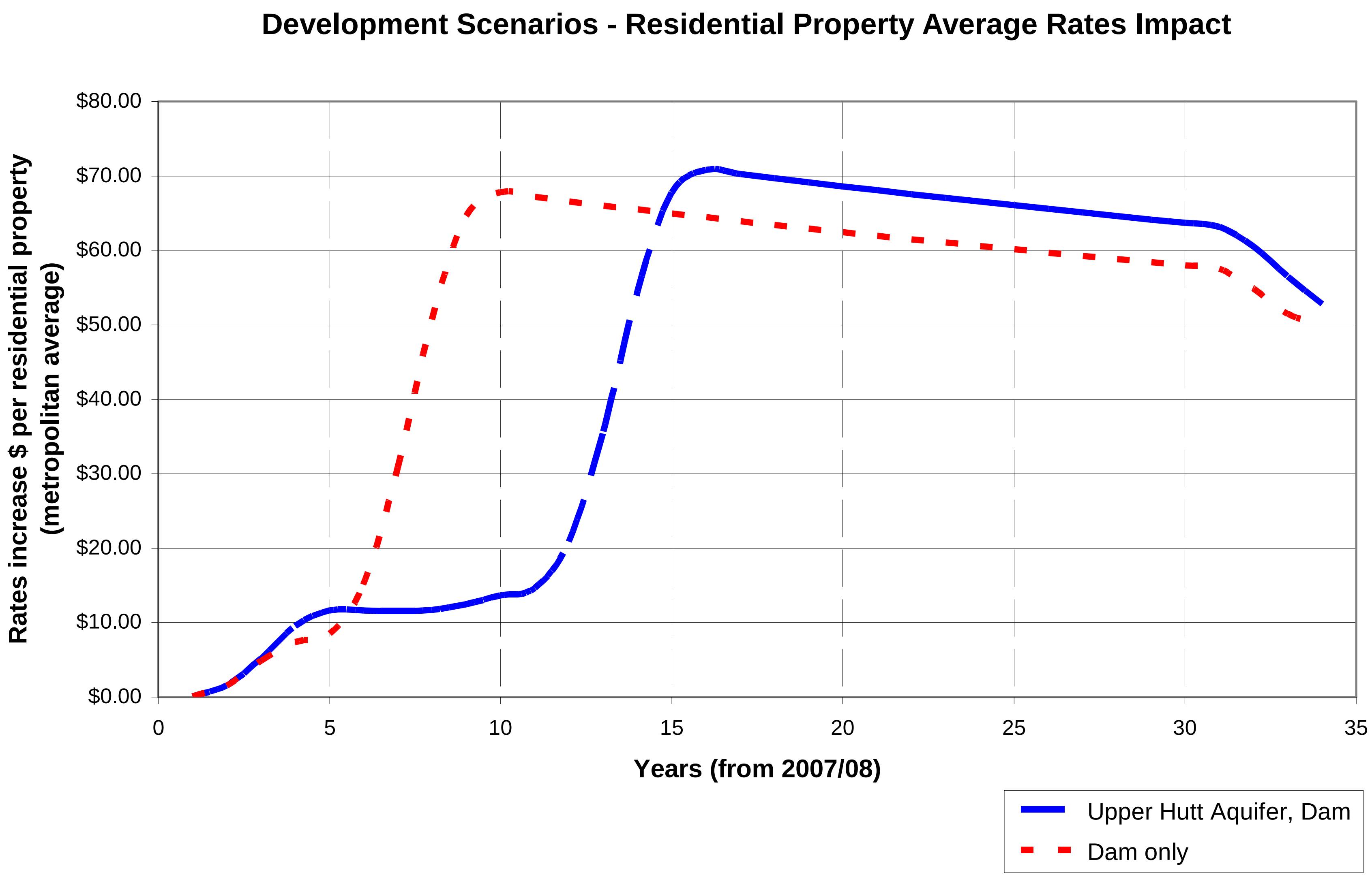
Rate increases have been calculated assuming borrowing over 30 years at an interest rate of 8.15%. All costs are in September 2007 values.

6.3.4 Comparison of cost per million litres of storage

Analysis of the capital cost of various options within the strategic development scenarios indicates the following:

Development Option	Storage Volume (ML)	Capital Cost	Cost / ML Stored
Upper Hutt aquifer	Assumed 16 MLD X 90 days X 50% = 720	$15M	$20,000
Whakatikei Dam	5,000	$142M	$28,000
Raising Stuart Macaskill Lakes	400	$4.5M	$11,000
CBD Reservoir (1)	10	$4.5M	$450,000

(1) The CBD reservoir provides covered storage of treated water close to the point of use and provides different benefits and therefore should not be directly compared with other development options. 10 ML is assumed to be available to GWRC.



Development Scenarios - Residential Property Average Rates Impact
Rates increase $ per residential property (metropolitan average)
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
0
5
10
15
20
25
30
35
Years (from 2007/08)
Upper Hutt Aquifer, Dam
Dam only

7. Discussion

7.1 Consumer expectations

Consumer research indicates there is low awareness of the risk of a water shortage in the Wellington area. On the contrary, there is a belief that there are ample supplies of water. A high percentage of the residents expect there will be sufficient water to meet their needs. About half indicated they are making some effort to conserve water.

Consumers expect a water strategy to include initiatives for both demand management and supply increase. The Regional Water Strategy that has been initiated by GWRC together with all councils in the Wellington region will provide the forum to review, discuss and develop a strategy (including conservation strategies) for water resources and their use.

This water supply development report is focussed on supply increase, both to quickly reinstate the current drop in security of supply from the 1 in 50 year shortfall target, and to provide options for further development to maintain security with population growth. Although the analysis of the options has assumed no savings from demand reductions, the development of a dam could be deferred many years by the introduction of demand management through the Regional Water Strategy.

7.2 Short-term water supply options

7.2.1 Raising the water level of the Stuart Macaskill Lakes

Raising the Stuart Macaskill Lakes increases the storage capacity by 400 ML or 13% of usable volume at a cost of $3.9 to $5.0 million. This is cost effective compared with other storage options and, subject to detailed study, it should be relatively straightforward to implement. From a sustainability perspective, it makes better use of an existing resource. The cost is still subject to revision after the actual design work is completed.

7.2.2 Reducing the minimum water flow at the Kaitoke weir

Reducing the minimum flow at the Kaitoke weir from 600 litres per second to 400 litres per second can be achieved very easily by altering the controls at the weir. Effectively, this could be carried out in a matter of hours at no capital cost. There are some manageable environmental impacts though, and there are costs associated with applying for a resource consent and a subsequent hearing. While this project appears to be promising, its outcome would remain uncertain until a resource consent is issued and the associated conditions were known.

7.2.3 Building a new reservoir in Wellington City

Building a new reservoir in Wellington in conjunction with the WCC and potentially C&CDHB offers benefits to all parties. This project has already been provided for in GWRC's capital works programme for some time. When the closure of Karori Reservoir was planned, it was recognised that two replacements reservoirs would be required. The first of these has already been built at Ngauranga and the storage available to GWRC in a Wellington CBD reservoir fulfils the function of the second reservoir.

Collectively, these three short-term projects can provide for a population of 395,000 without breaching a 1 in 50 year drought standard. Current projections indicate that a population of 395,000 will be reached in 2012.

7.2.4 Developing the Upper Hutt aquifer

Development of the Upper Hutt aquifer is relatively straightforward. However, there is the need to obtain resource consents, and an element of uncertainty will always exist until these have been granted. Following this, additional bores would be drilled and underground pipelines laid to a water treatment plant and pumping station, which would probably be located in an industrial area. Although the aquifer is classed as unconfined (i.e. not secure), the water is of good quality and will only require minimal treatment to comply with the *Drinking Water Standards for New Zealand*. For reasons of potential contamination risk though, a high level of treatment would be employed.

The Upper Hutt aquifer would provide an additional water treatment plant, increasing the number of operational plants from three to four, and therefore reducing the risk resulting from the failure of any one plant. A water treatment plant in Upper Hutt City also assists with security of supply to Upper Hutt following a major seismic event or supply issue from Te Marua.

Development of the Upper Hutt aquifer at $15 to $19 million is a cost-effective way of providing security of supply over at least 10 years with current population projections. Further expenditure estimated at $5 million may be necessary in the future to provide increased distribution capacity to areas of population growth.

7.3 Long-term water supply options

7.3.1 Wainuiomata dam

A dam in Skull Gully near the Wainuiomata Water Treatment Plant can be filled by gravity from the Orongorongo River using an extension to the existing pipeline that provides water to the water treatment plant. For drought purposes, the Wainuiomata dam offers the same benefits as dams at the other two sites. Unfortunately, the pipeline from the Wainuiomata Water Treatment Plant to Wellington is vulnerable in many places to a major seismic event. It is also expected that the supply pipeline from the weir on the Orongorongo River would suffer during a major earthquake. An area of about 70 ha of pristine native bush would be cleared for the reservoir behind the dam. This is significant in environmental terms and must be considered against the remaining 4,000 ha of pristine forest in the same water catchment. At $84 million, a Wainuiomata dam and infrastructure is the lowest cost of the three dam developments.

7.3.2 Pakuratahi dam

A dam on the Pakuratahi River could supply water to an expanded Te Marua Water Treatment Plant. From an environmental perspective, this is possibly the best of the three dam sites. Recreation could be considered on the lake created behind the dam as it would be accessible from State Highway 2 near the top of the Rimutaka Hill. Of the three dam sites, this is the only lake that would be readily accessible. One of the drawbacks of the site is the dam would cut across the Rimutaka Rail Trail, which is part of the old railway formation to the Wairarapa. Gentle grades on this trail mean it is particularly attractive to many walkers and cyclists. A track could be built to bypass the dam, but in order to maintain the same gradient it would be long. Of the three dam sites and their associated infrastructure, it is the most expensive at $150 million.

7.3.3 Whakatikei dam

Several kilometres upstream of the confluence of the Whakatikei and Hutt Rivers there is a deep gorge which is very suitable for the construction of a dam. A major advantage is that it is west of the Wellington fault line. Following a movement of the fault line, few repairs would be expected and water could flow again to Porirua City and the northern and western parts of Wellington City relatively quickly. Environmentally, the impact of the reservoir behind the dam will be less than the Wainuiomata site but more than the Pakuratahi site. There will be an impact from construction of a new water pipeline from a new water treatment plant just downstream of the dam to near State Highway 58 at Judgeford, also some road improvements would be required for construction of the pipeline on Moonshine and Bulls Run Road.

Upstream of the dam, some plantation forestry areas would be cleared and some regenerating native bush would be removed. The dam, water treatment plant and pipeline, at $142 million, are slightly less expensive than the Pakuratahi development.

7.3.4 Dam option selection

In order to judge the best dam site, three separate multi-criteria analysis workshops were held with GWRC managers, water supply infrastructure senior managers of the four cities and Greater Wellington Regional Councillors of the previous triennium.

All three workshops favoured development of the Whakatikei site by a comfortable margin over the other dam sites.

The workshops considered Pakuratahi and Wainuiomata developments to be relatively close to each other in terms of the evaluation process.

7.4 Economic analysis of development scenarios

Two development scenarios were identified for economic analysis. Both scenarios include the 3 short-term options needed to reinstate the 2% annual shortfall in supply target (1 in 50 year shortfall), followed by either a dam, or the Upper Hutt aquifer and a dam. Both scenarios maintain this level of security for at least a population of 450,000 and beyond if demand management initiatives are introduced.

Economic analysis showed the dam-only scenario (scenario 2) to have the lowest capital cost, but the Upper Hutt aquifer/dam scenario (scenario 1) to have the lowest present value by a clear margin.

8. Conclusions

There is an urgent need to return to the agreed security standard of 2% probability of a shortfall (1 in 50 year drought). This need was clearly demonstrated over the 2008 summer when water restrictions were introduced for the first time in over 20 years. Three short-term projects have been identified that together achieve that aim and maintain it to 2012:

- Raising the level of the Stuart Macaskill lakes
- Reducing minimum flow at Kaitoke weir
- Building the Wellington city CBD reservoir

Each option has some degree of risk which may prevent it proceeding. If any of these projects is not able to be built then development of the Upper Hutt aquifer will be necessary to reinstate the security standard, and for this reason development should proceed in parallel.

Security of supply for the future is solved by building a dam, particularly if the dam is increased in height to provide a 50% increase in stored volume. Of the three dam sites investigated in detail, the Whakatikei site has been clearly identified as the preferred option.

If it is considered reasonable to accept the increased risk of a shortfall whilst proceeding immediately with a construction of a dam, then this focuses on the long-term solution at least capital cost. Some reduction in the drought risk would be achieved by proceeding with 3 of the short-term options. Since a dam has a lead time of 8 to 10 years, planning would need to take place concurrent with implementation of the short-term options.

However this does not provide the flexibility necessary to take advantage of savings in water consumption that will result from demand management initiatives through the Regional Water Strategy. Significant savings have the effect of deferring the need for a dam further into the future.

In addition there have been unexpected upward revisions to the population projections by Statistics New Zealand. Projections over the next few years could just as easily show the population not increasing as fast as the present projections suggest, hence also deferring the need for a dam.

Development of the Upper Hutt aquifer will provide sufficient additional water for at least 10 years at the current population projection, provided the 3 short-term options are also implemented. With demand reductions and possible future population projection reductions the aquifer would continue to provide sufficient water for much longer before a dam was required.

In present value dollar terms, development of the Upper Hutt aquifer followed by a dam has the lower present value, reduced impact on rates and gives flexibility for changing water demands.

9. Recommendations

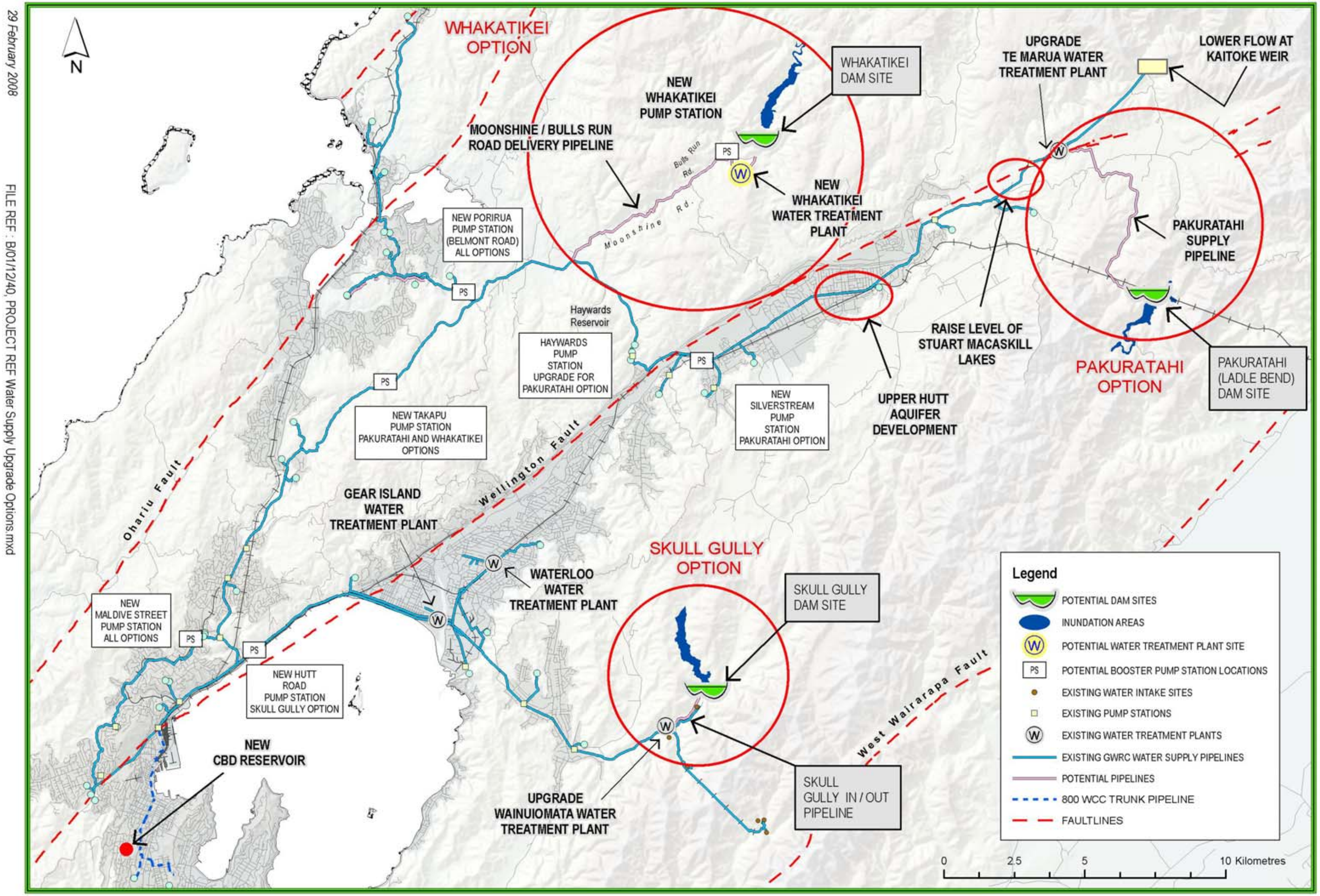
- Proceed with the first three short-term options, i.e.:
  - Raising the level of the Stuart Macaskill lakes
  - Reducing minimum flow at Kaitoke weir
  - Building the Wellington City CBD reservoir

  This will require including the project to raise the level of the Stuart Macaskill Lakes in the 2008/09 capital works programme;

- Proceed with development of the Upper Hutt aquifer and treatment plant;

- Confirm Whakatikei as the preferred site for a water storage dam to be built when a dam is needed;

- Carry out appropriate consultation with the cities about the options identified above, followed by public consultation on the aquifer and a dam in the next Long Term Council Community Plan.



WATER SUPPLY UPGRADE OPTIONS

APPENDIX 1

Results of Multi-Criteria Analysis Workshops

Workshop 1 – GWRC Managers

Attachment 1 to Report 08.244
Page 35 of 40

Workshop Attributes and Weightings

The attributes and relative weighting identified by the GWRC staff at the Stage 1 workshop were as follows:

Attribute	Relative Weight	Percentage Weight
Wellington Fault Vulnerability	9	13.4%
Capital Cost	9	13.4%
Security of Supply	7	10.4%
Consentability	7	10.4%
Terrestrial Ecology	6	9.0%
Aquatic Ecology	6	9.0%
Cultural Heritage	6	9.0%
Tangata Whenua Issues	6	9.0%
Social Issues	6	9.0%
Operational Costs	3	4.5%
Construction Impacts	2	3.0%

Workshop Outcome

The scores assigned by the group from the workshop process are outlined in the table below:

Site	Terrestrial ecology	Aquatic ecology	Security of supply	Wellington fault vulnerability	Cultural heritage	Tangata whenua	Capital cost	Social	Consentability	Operational costs	Construction impacts	Overall score (with weightings applied)
Weighting	0.090	0.090	0.104	0.134	0.090	0.090	0.134	0.090	0.104	0.045	0.030	
Pakuratahi	3	2	3	4	5	2	5	5	5	2	2	3.716
Skull Gully	5	2	4	5	1	4	2	4	5	2	3	3.493
Whakatikei	3	3	1	1	1	1	3	2	3	2	2	2.000

Note: A higher score indicates higher impact, and therefore least preferred.

This indicates a priority of preference of the workshop group as follows:

Most Preferred **Whakatikei**
Next Preferred **Skull Gully**
Least Preferred **Pakuratahi**

Sensitivity Analysis

There is a significant difference in the weighted score between Whakatikei as the preferred option, and the other two sites. In order to change the preferred option there would need to be a substantial shift in the attribute weightings and/or option scores, or a major review of the attributes themselves.

A review of the individual scores between attributes indicates that there are consistently lower comparative scores for Whakatikei. The only exception to this is in respect of Capital Cost, in which Whakatikei scored in between the two other sites, and Aquatic Ecology, where Whakatikei scored behind the other two sites. This would indicate that the outcome would not be sensitive to a change in attribute weighting (given they are relative), and a significant change in multiple scores would be required to change the preference.

To achieve a change the order of preference an extreme, and most likely unrealistic, scenario (given the groups consensus on scoring and weighting) would be required. If the weighting of Capital Cost and Aquatic Ecology (the two “exceptions”) is increased to the maximum weighting and all other attributes are reduced to the minimum weighting, Skull Gully would become the preferred option (2.500), just ahead of Whakatikei (2.643). Pakuratahi would still be the least preferred option (3.536).

The introduction of new attributes may also have an impact on the preferred option. However, the workshop confirmed both its list of issues and attributes.

This consideration is rather academic however, as the group were clearly satisfied with the attributes they had used, and equally with the weightings applied.

Workshop 2 – Wholesale Water Supply Customer Representatives

Workshop Attributes and Weightings

The attributes and relative weighting chosen by the customer representatives at the Stage 1 workshop were as follows:

Attribute	Relative Weight	Percentage Weight
Security of Supply	9	17.0%
Capital Cost	8	15.1%
Future Proofing	7	13.2%
Operational Cost	7	13.2%
Sustainability	5	9.4%
Environmental – Terrestrial	5	9.4%
Environmental – Aquatic	5	9.4%
Social Issues	3	5.7%
Cultural Issues	2	3.8%
Consentability	2	3.8%

Workshop Outcome

The scores assigned by the group from the workshop process are outlined in the table below:

Site	Operational cost	Security of supply	Sustainability	Social	Consentability	Environmental – aquatic	Cultural	Capital Cost	Environmental – terrestrial	Future proofing	Overall score (with weightings applied)
Weighting	0.123	0.158	0.088	0.053	0.105	0.088	0.035	0.140	0.088	0.123	
Pakuratahi	2	3	3	5	5	3	5	3	2	3	3.175
Skull Gully	2	5	3	4	4	3	4	2	5	5	3.667
Whakatikei	2	1	2	2	3	4	2	3	3	2	2.351

Note: A higher score indicates higher impact, and therefore least preferred.

This indicates a priority of preference of the workshop group as follows:

Most Preferred	**Whakatikei**
Next Preferred	**Pakuratahi**
Least Preferred	**Skull Gully**

Sensitivity Analysis

As with the GW Managers workshop, the preference for Whakatikei following discussion and scoring was clearly evident. It would require a significant shift in either or both the scores and / or weightings in order for there to be a change in preference.

The only point of contention during scoring was in respect of the Environment - Aquatic attribute for Skull Gully. One member of the group wished to score this as a 2, whereas the general consensus was for a 3. When tested, it was found that the impact on the overall outcome from changing this score is negligible, only resulting in a change in the Skull Gully score from 3.667 to 3.579. The overall ranking remains the same.

As with the Managers workshop, the group was satisfied with their attributes and weightings, and satisfied with the outcome of the process in terms of the site rankings.

Workshop 3 – GWRC Councillors

Workshop Attributes and Weightings

The attributes and relative weighting identified by the Councillors at the Stage 1 Workshop were as follows:

Attribute	Relative Weight	Percentage Weight
Cost and Economics	10	13.5%
Environmental	10	13.5%
Security of Supply	9	12.2%
Operational Cost	8	10.8%
Social Issues / Public Values	8	10.8%
Consentability	7	9.5%
Operational Issues	7	9.5%
Future Proofing	6	8.1%
Construction Issues	5	6.8%
Associated opportunities/multiple use	4	5.4%

Workshop Outcome

The scores attributed by the group following the workshop process are outlined in the table below:

Site	Cost and economics	Environmental	Security of supply	Future proofing	Construction	Operational cost	Associated opportunities/multiple use	Social issues/public values	Consentability	Operational issues	Overall score (with weightings applied)
Weighting	0.133	0.133	0.120	0.080	0.067	0.107	0.053	0.107	0.107	0.093	
Pakuratahi	4	2	4	2	2	2	3	3	4	3	2.973
Skull Gully	2	5	5	2	3	2	3	4	5	2	3.413
Whakatikei	4	3	2	1	2	2	3	2	3	1	2.387

Note 1: A higher score indicates higher impact, and therefore least preferred.
Note 2: The scoring above is the final weighted score following adjustment of the weighting for consentability as determined during the workshop

This indicates a priority of preference of the workshop group as follows:

Most Preferred	**Whakatikei**
Next Preferred	**Pakuratahi**
Least Preferred	**Skull Gully**

Sensitivity Analysis

The scoring undertaken by the group was reached with general consensus.

During scoring of the future-proofing attribute, there was discussion as to whether the Skull Gully score should be 2 or 3. The score of 2 was the majority preference, but it was agreed to undertake some sensitivity analysis. Altering the score from a 2 to a 3 for this attribute at this site adjusts the score for Skull Gully from 3.413 to 3.493. This effectively makes Skull Gully less preferred, however doesn't change the relative ranking of the three sites. Given 2 was the majority preference, this score has therefore been retained for the purpose of the analysis.

There was discussion during the review of all attributes and scoring in respect of the relative weighting of the consentability attribute. It was agreed that consentability was a critical attribute, and therefore the group agreed to review its weighting from a 7 to an 8. The adjustment was made, which did not alter the outcome of the weighted scoring. The workshop agreed the revised weighting more accurately reflected their collective position having been provided with all relevant information throughout the workshop.

Even if the consentability attribute had been given maximum weighting, and all other attributes reduced to around a third of the assigned weights, the outcome would not have been altered.