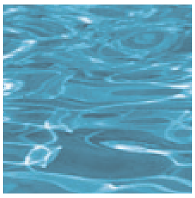
Appendix A

Waikanae Treatment Plant Upgrade Technical Memorandum



Waikanae Water Treatment Plant Technical Memorandum

1 Context

The water supply project requires upgrading of the existing Waikanae WTP for two reasons:

- some of the options being investigated will require treatment of raw water qualities that are different from what the existing treatment process can cope with,
- in all cases the plant will require an increase in capacity (to a nominal working figure of 32,000 m^3/day).

However, there are also asset management allowances totalling $10.5 million in the LTCCP in the period 2012/13/14 associated with renewals of the Waikanae WTP asset.

In our concept design of the upgrading that is necessary for the KWSP, we have not included work related to asset management (i.e. renewals), unless there is an overlap between such work and that needed for the KWSP. Where this occurs, we have assessed what proportion of the costs should be attributable to the KWSP.

A workshop was held with Council operational staff and asset managers on 28 April to discuss the current issues with the operation of the plant and some preliminary concepts for upgrading the process to meet the objectives of both the water supply project and the upgrade project. The workshop opened with Council's operational staff giving their views on treatment technologies and operation philosophies. In summary, these views are:

- While there is a willingness to consider new technologies, any technology must be well proven both from a design and performance point of view, as well as operationally. Proof of good operation needs to be determined from discussions with operational personnel who actually operate the technology.
- Full automation of the plant would only be acceptable if the plant can also be easily made to run in manual mode, to ensure that all operators maintain the skills and ability to run the plant manually in the event of a system failure (e.g. the PLC).

These views are borne from Council's experiences over the years with new and emerging technologies, as well as the fact the Waikanae WTP is the only source of water for WPR and if it failed the community would run out of water.

The upgrading concepts described in Section 3 are our proposed designs to meet the design objectives outlined in Section 2. Based on our experience we consider that the proposed designs are feasible, practical, and are likely to be the best value solution. However, other concepts may well be feasible, suit operational preferences better, and be of similar or better value. This will be considered further at the preliminary design stage.

2 Design Objectives

2.1 Treatment

The criteria for the water quality value developed as part of the MCA process in Stage 2 of the project were:

#	Criteria	Criteria Scale	Explanation
1.1	Public health: risk associated with not meeting the Drinking-water Standards for NZ (DWSNZ)	Almost zero	The risk of the water supply not meeting the requirements of the DWSNZ is almost zero.
		Low	There is a low risk, due the nature of the raw water source, that the water supply may not meet all of the requirements of the DWSNZ all of the time.
1.2	Taste, Odour and Aesthetics (excluding hardness): risks associated with water not being acceptable to most consumers	Almost zero	The risk of taste, odour and aesthetic problems with the water supply is almost zero.
		Low	There is a low risk of the taste, odour and aesthetic quality of the water supply not being acceptable to most consumers.
		Possible	The quality of the water may be such that taste and odour thresholds may be exceeded or the aesthetic quality of the water may not be acceptable to most consumers.
1.3	Hardness: level of hardness in water supply	Matches existing river supply	The hardness of the water supply is similar to the existing river supply (around 30 mg/L - higher value means more likely to get scale deposition).
		Less than 100 mg/L	The hardness of the water supply will be higher than that from the river supply but less than that from the existing Waikanae borefield.
		Greater than 100 mg/L	The hardness of the water supply will be similar to that from the existing Waikanae borefield.

The consultation with the community to date has clearly demonstrated the importance of the quality of the treated water. Given this importance, the treatment objectives should therefore be targeted at meeting the highest criteria in the table above. In summary these are:

- Meeting DWSNZ: The risk of the water supply not meeting the requirements of the DWSNZ is almost zero.
- Taste, Odour and Aesthetics (excluding hardness): The risk of taste, odour and aesthetic problems not being acceptable to most consumers is almost zero.
- Hardness: The hardness of the water supply is similar to the existing river supply (around 30 - 50 mg/L).

2.2 Capacity

The predicted 2060 peak day demand including headroom is 32,000 m^3/day. To allow for the transition from the current 23,000 m^3/day consented capacity to the 2060 demand, certain aspects of the upgrading work could be staged if it was economically attractive to do so.

3 Process Issues and Upgrading Concepts

3.1 Raw Water / Future Sources

The final mix of raw water sources to the plant will depend upon the option finally selected. The following assumptions have been made in order to develop the upgrading concepts:

- The Waikanae River will continue to be the primary raw water source.
- 4 log removal of protozoa is understood to be required based on Cryptosporidium monitoring of the Waikanae River.
- If a dam option is selected, iron and manganese will be controlled at source by use of dam destratification.
- If raw water storage in the form of a dam or pond is implemented, there will be increased risk of algal blooms, thereby increasing the risk of algal toxins and taste & odour events occurring. This issue remains a significant risk for the existing plant which needs to be addressed regardless of whether raw water storage is implemented – the inclusion of raw water storage increases the risk.
- If groundwater from the existing or extended Waikanae Borefield to be treated:
  - The high TDS and hardness, if dilution by river water is inadequate, will be treated by a nanofiltration (NF)
  - Following NF the bore water will be dosed with potassium permanganate to precipitate the manganese, and then either be blended with the river water influent at the plant inlet or alternatively bypassed directly to the filters, primarily to remove the precipitated manganese.

3.2 Process Flow Diagrams

Process flow diagrams (PFDs) are included in Appendix ?? showing the existing and proposed process steps. For the proposed upgrading, the PFDs also indicate whether the particular process changes is part of the renewals scope or the project scope.

3.3 Intake

3.3.1 Existing

Table 1 – Existing Intake Configuration

Type	Passive channel side wall 12mm slot (estimated) wedgewire screen, manually raked, with channel top flood level intake with webforge-type grating 20mm slot size (estimated)

3.3.2 Issues

Renewals Scope

Screen cleaning –screens require manual raking – screen cleaning is manual, labour intensive and has associated H&S issues.

Improved access is already planned to overcome the health & safety issues associated with the long access ladder without hoops, lack of barriers, and working over moving water.

Project Scope

The existing intake screen has relatively coarse openings (about 12 mm), which will entrain fish. Although this is not an issue currently, new consents will have to be sought as part of the water supply project, and exclusion of fish may well be a mitigation measure that is required. Typically a 1 to 3 mm slot size is needed to minimise impacts on aquatic life.

3.3.3 Upgrading Concept

New wedgewire screening to exclude fish, and install new airburst system to remove increased debris that will build up on the screen because of finer screen openings.

Improvements to address any residual H&S issues.

Because the screening and airburst system is related to the project, the costs have been allocated to the project scope.

For the river recharge option the extent to which the existing intake can abstract more flow at very low river levels needs to be confirmed by hydraulic analysis. This will need to take into account the flow control gate that is already planned for installation by Council.

3.4 Raw Water Pump Station

3.4.1 Existing

Table 2 – Raw Water Pumps

Type	Duty/standby vertical turbine pumps (Kelly Lewis). 90 kW DC motors with thyristor drives
Capacity	Each pump rated at 400 L/s at 16.5 m head

The existing pump station comprises:

- a wetwell (4.50m x 2.15m internal dimensions in plan) linked to the screened intake by a culvert under the channel feeding the intake screen. One third of the wetwell is covered by a low level concrete slab with access hatches. The other two thirds of the wetwell are covered by a vertical shaft.
- a reinforced concrete vertical shaft (2.88m x 1.80m internal dimensions in plan) rising from the wetwell to the pump station building.
- a building (4.28m x 4.10m internal dimensions in plan) on top of the vertical shaft, where the existing pump motors and valve trains are located.

The existing plan area of both the wet well and the shaft are relatively small, due to the vertical turbine pumps being compact in plan. Similarly the building at the top of the riser is compact with little spare room for any additional plant.

3.4.2 Issues

Spares for pumps not available – replacement impellers not available.

Motors and drives are old technology, but reported to be serviceable.

Need crane to lift motors/pumps through roof.

The wetwell is confined – need to check feasibility of fitting replacement pumps without civil modifications.

3.4.3 Upgrading Concept

On the basis that the pumps are rated at 400 L/s (34,600 m^3/day), even though the consent limit is for 23,000 m^3/day, we have assumed that all upgrading costs are related to renewals.

Scope of the upgrading is:

- Replace raw water pumps, with new pumps.
- Add VSDs and locate in pump station building.
- Modify wetwell and pump station building to suit (including addition of lifting beam/equipment)
- Run new cabling to pump station from existing switchboard.

Options that are likely to be feasible for replacing the raw water pumps, and would be considered further in preliminary design, are:

1. Replace existing pumps with three submersible pumps in duty/assist/standby configuration. Each pump would be selected to pump up to 200 L/s within their preferred operating range. The third pump would be located in the wetwell area which is not covered by the vertical shaft. Increasing the plan area of both the shaft and pump building to cover the full wetwell would be considered in conjunction with this option.

2. Replace existing pumps with two submersible pumps in duty/assist configuration. Each pump would be selected to pump up to 200 L/s within their preferred operating range. However, each pump would be capable of pumping 400 L/s in the infrequent event of full demand being required at the same time as a pump being out for service. This higher discharge rate would be outside of the pumps preferred operating range, so long term operation above 200 L/s would not be recommended as excess wear would occur. The manufacturer would need to guarantee the pump as suitable for short term operation at 400 L/s.

3. Replace existing pumps with similar vertical turbine pumps. This relies on suitable pumps being sourced.

Initial investigations indicate that the following pump options are unlikely to be practicable:

(a) Borehole pumps are unlikely to be practicable as the minimum water depth wetwell is shown as 1.4 m and most borehole pumps will require a larger depth.

(b) Draft tube type pumps are unlikely to be practicable as the smallest pumps of this type appear to have a minimum best efficiency point of around 400 L/s. The system curve is also fairly flat. As a result, at the existing average flow of 180 L/s, draft tube pumps would be operating outside their preferred operating range. This could result in vibration and/or cavitation causing excess wear and premature failure.

(c) Three submersible pumps are unlikely to be practicably accessed via the existing vertical shaft. While it may be possible to squeeze three pumps into this area, the ports into the wetwell would not line up with the pumps and it is likely to prove difficult to alter these ports while keeping the existing pumps in service.

3.5 Borefield Pre-Treatment

3.5.1 Existing & Issues

The pre-treatment for the borefield water is potassium permanganate dosing and an aeration tower located on the rapid mix/flocculation.

For details of potassium permanganate refer to section 3.12.

Aeration/stripping – check if blended bore/river coagulated water pH is appropriate – air stripping of CO_2 may not be advantageous to process. Need tor review of performance of aeration process.

3.5.2 Upgrading Concept

For details of potassium permanganate refer to section 3.12.

Allow for refurbishment/replacement of aerator under renewals budget.

3.6 Coagulation and Flocculation

3.6.1 Existing

For coagulation refer to section 3.6.

Table 3 - Existing Flocculation

Type	Two duty mechanical flocculators with VSDs. Some hydraulic flocculation from baffling
Dimensions	3.65 width x 10.6 length x 3.3 depth
Volume	128 m^3
Nominal retention time at 32,000 m^3/day	5.8 minutes

3.6.2 Issues

Renewals Scope

PACl poor mixing – added at single point over 3.65m wide weir. Alum mixing OK.

No standby flocculator.

Project Scope

None, unless DAF added.

3.6.3 Upgrading Concept

Assume the following improvements are renewals: Improve PACl mixing and add standby flocculator drive.

3.7 Clarification

3.7.1 Existing

Table 4 - Existing Clarifier

Type	Accentrifloc style clarifier – central mechanically mixed flocculation zone, octagonal baffle curtain, radial sludge scraper to central hopper.
Plan Dimensions	24.5 m diameter with 11m internal octagonal flocculation zone
Flocculation	4 flocculators with VSDs
Depth (sidewall)	5m
Area (clarification)	367 m^2
Hydraulic loading at 23,000 m^3/day	2.6 m/h

3.7.2 Issues

The loading rate at 23,000 m^3/day is approaching the limit for this type of clarifier (about 3 m/hour). However, performance is poor with high levels of floc carryover onto filters, even at typical flows and deteriorating at flows greater than 17,000 m^3/day.

The clarifier is a single process unit with no redundancy in the event of a mechanical failure (e.g. failure of bearing on scraper mechanism in 2005). Also need redundancy in order to complete routine maintenance (e.g. on the rake).

Operational experiences with the bore water has shown that up to 1m^3/day of very fine sand, particularly on bore-start up, is removed in the clarifier. This has caused extensive abrasion/erosion in the blowdown with the knife-gate valve and the blowdown pipe needing to be replaced.

If wastewater is to be recycled, good performance from clarifier becomes more critical.

If an option involving groundwater that does not require increased clarifier throughput is feasible (e.g. ASR), direct filtration of bore water or low turbidity river water could provide flexibility to complete maintenance on clarifier, although there could be some issues with control of quality.

3.7.3 Upgrading Concept

Except for any option that doesn't require increased clarifier throughput, we consider that a second clarification process unit is necessary as part of the upgrading. Because the performance of the existing clarifier deteriorates at flows greater than 17,000 m^3/day, and the lack of redundancy, we have assumed all costs relating to a second clarification unit are renewals-related.

The two options proposed are:

1. Second clarifier, of either a reactor clarifier type, or a upflow sludge blanket type.

2. Dissolved air flotation (DAF) unit.

The second clarifier is in many ways the preferred option as it allows for the coagulation/ flocculation process to be optimised for that process, and it does not introduce a second clarification process into the plant.

Council's Water and Wastewater Treatment Manager has a preference for a reactor clarifier similar to the existing unit, as it has performed adequately for the past 30 years.

Upflow sludge blanket type clarifiers are used at about 90% of treatment plants in New Zealand (excluding the direct filtration plants), and have a good record of being able to cope with highly variable raw waters and consistently produce an effluent of less than 2 NTU, and typically less than 1 NTU. A well-optimised upflow sludge blanket type clarifier will cope with reasonably elevated algae levels (e.g. all the Watercare Services WTPs that are on dam sources). There will be increased solids carryover under high algal loads, but we would expect the deep bed filters would cope with the moderate algal loads anticipated.

The justification for considering DAF is the likely increase in algae blooms for the dam and storage pond options, as well as the river recharge option. In the latter option, the abstraction from the river will have to extend into periods of low river flows compared with currently, when algae blooms are likely to be more developed and algae cells are in greater concentrations in the abstracted water.

DAF is generally recognised as being the preferred treatment process for raw waters with high algae concentrations, and is more widely used in Australia than in New Zealand for this reason. A disadvantage of DAF is its energy use (primarily for the saturator), but this could be at least partly be addressed by using the existing clarifier to meet base demand and only using the DAF for the higher demand periods.

In the summer of 2005/06 an algal bloom in the river was of sufficient concern that the river source was discontinued and the supply switched to the borefield source for two to three weeks in the second half of January and early February 2006. Public health concerns were heightened because earlier that summer (November 2005), the deaths of at least five dogs on the Hutt River had been linked to algae blooms and cyanotoxin poisoning[1]. Testing of the Waikanae River and the treated water for microcystin LR was undertaken during the event, and the river water source was reinstated on 5 February after results showed the source was well below 50% of the MAV[2].

If DAF was the selected option, then either a second coagulation/flocculation train could be added, which would have some advantages for redundancy; or the present coagulation/ flocculation train could be adapted to serve both clarification processes. Primarily this would involve modifications to allow the poly to be dosed after the flows have been split, so that a lower dose rate can be applied for the DAF process.

For the purposes of developing cost estimates we have assumed an upflow sludge blanket clarifier with a scraper to accommodate removal of the grit from the bores.

[1] *New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters*, Ministry for the Environment.

[2] Email from Water & Wastewater Treatment Manager (Manfredo Hintze) to the DHB (Rebecca Fox), dated 14 February 2006.

3.8 Filtration

3.8.1 Existing

Table 5 - Existing Filtration

Number of Filters	4
Plan Dimensions	5.18 x 5.78m
Area of each filter	30 m^2
Hydraulic Loading at 23,000 m^3/day (assuming all filters in service)	8 m/h
Hydraulic Loading at 23,000 m^3/day (assuming one filters in backwash)	10.7 m/h
Media	305mm sand plus 1220mm anthracite
Backwash	Air scour followed by fluidised water backwash
Air Scour Rate	60 m/hr (based on WTP brochure)
Backwash Rate	24 m/hr, 50 m/r to restratify the bed (based on WTP brochure)

3.8.2 Issues

Renewals Scope

The current filter area and loading rates are considered appropriate for 23,000 m^3/day, and perform adequately up to about 26,000 m^3/day. The media configuration was forward thinking for its time, and would still be considered to be a good configuration for achieving high filtration efficiency. The filtration process is generally performing well, making up for the shortcomings in the clarification performance.

The backwashing process is currently being automated.

We consider that the filter-to-waste needs improved control for transition from filter-to-waste to filter-to-supply, although the operators’ experience with the transition is that it does not spike above 0.08 NTU.

There is no redundancy on the backwash pump (although it may be possible to use backflow from Kakariki Reservoir, this has not been tried).

The blowers are being replaced. Three blower units have been purchased – centrifugal rather than Roots-type – need to check capacity suitable for any filter upgrade.

Project Scope

Allowance needs to be made to construct one or two more filters for expansion up to 32,000 m^3/day (two filters have been assumed in the cost estimates).

3.8.3 Upgrading Concept

Either refurbish existing or change to BAC.

The one or two new filters would need to match the design selected for the upgrading. The installation of these filters could be delayed until about 2020.

Refurbish Existing (Renewals scope, except for new filters)

For source water options that don't increase the frequency and/or severity of algal blooms (ASR, and Extended Borefield & Treatment (Option C)) the lower cost option is to undertake a basic refurbishment of the existing filters in general accordance with their original design.

A basic refurbishment would include:

- replacement of the nozzles
- cleaning of the underdrainage system
- replacement of the media
- replacement of the air relief valves
- remedial work to, or replacement of, the four steel inlet flow splitting boxes.

Change to BAC Filtration (Renewals scope, except for new filters)

Conversion of the filters to biologically activated carbon (BAC) filtration would provide a reduced reliance on PAC for taste and odour control. BAC has a very low opex cost, and hence this conversion would provide a reduction in plant operating costs.

BAC filtration will also achieve nitrification, converting the ammonia in the bore water to nitrate, reducing the chlorine demand and reducing the risk of chloramine tastes from the chlorination of ammonia.

A good example of a BAC filter process that is working well is that at the Waikato WTP (Watercare Services). Another good example is the New Plymouth WTP (New Plymouth District Council) filters, which while not BAC, have the same control system as BAC.

Conversion would require:

- Backwash – The filters were reported to historically suffer from mudballing, which is a symptom of poor backwashing, but currently not reported to be an issue. Modern best practice for filtration is to use a combined simultaneous air/water backwash. This causes a mechanism known as collapse pulsing where air pockets form and collapse in the filter bed and provides a much more effective cleaning mechanism. If BAC filtration is to be implemented due to the increased biological activity, and the need for a chlorine free backwash (which does aid maintaining filter bed condition), a combined air water scour would be considered a prerequisite.
- Raise sills for increased media depth.
- Replace floor to allow for combined air water backwash.
- Chlorine free backwash water – needs new backwash tank – location options include the existing car park, or buried at the end of the filters, or beside existing clearwater tank (refer section 3.10). If possible filter-to-waste will be used to fill the backwash tank. It could possibly be pumped to tank, which would give more location options. New backwash pumps needed.

Table 6 - BAC Filter Upgrade

EBCT	10 minutes
Backwash Rate (preliminary)	45 m/h
Backwash Rate	375 L/s
Backwash Tank Volume (2 x BW volume)	400 m^3 (12m dia x 4m H or 10x10x4.4)
Air scour rate	50 m/h
Blower Duty	1,500 m^3/h
Blower Duty (preliminary)	50 kPa
GAC Grading (preliminary)	1-2 mm
Sand Grading	0.5-1.0 mm
Depth media to washout sill	1000 mm
GAC	1500 mm
Sand	300 mm
Underdrain (Triton wedgewire style)	150 mm
Total (floor (grout existing underdrains) to washout sill)	2950 mm

3.9 UV Disinfection

3.9.1 Existing

Table 7 - UV Disinfection

Type	Trojan UVSwift Medium Pressure (duty only)
Rated flow	400 L/s
Inlet/Outlet Diameter	600mm

3.9.2 Issues

Single unit – no standby.

Hydraulics – unlikely to work at increased capacity required. Needs to be tested. Desirable to eliminate axial pump. Possibly eliminate weir upstream of UV to achieve this.

3.9.3 Upgrading Concept

The UV system as it is currently configured allows bacterial compliance in terms of DWSNZ to be achieved with only UV disinfection. This has allowed the chlorine dose to be lowered to 0.7 mg/L as it leaves the WTP, thereby reducing taste and odour complaints. There are three options that are worthy of consideration:

1. Decommission UV; as it is not required for protozoa compliance, and rely on chlorination for bacterial compliance. The optimisation of the coagulation control process, and the addition of the BAC process, should reduce taste & odour problems associated with chlorination.

2. Retain UV for primary bacterial compliance (and also for the additional protozoa credits), but provide standby for bacterial compliance by automating a changeover to chlorine compliance when UV is not producing the dose of 40 mJ/cm^2 necessary for bacterial compliance. We note that if the rising mains could form part of the chlorine contact time, it is likely that the chlorine dose would not have to be increased.
3. Install a standby UV unit.

We recommend Option 1 above if BAC is implemented (as part of renewals scope), or Option 2 above if the basic filter refurbishment is implemented (also as part of renewals scope).

3.10 Clearwater/Chlorine Contact Tank

3.10.1 Existing

Table 8 - Chlorine Contact Tank

Dimensions	12.8 x 14.6 x 4.5 m (approx depth)
Volume – Maximum	840 m^3

3.10.2 Issues (Renewals scope)

The existing tank will not achieve 30 mins on site (but if UV is used for bacterial compliance (duty plus standby) this is not an issue). Reportedly no connections before Kakariki reservoir, but Waikanae Downs is the first take-off before Paraparaumu reservoirs. Chlorine contact time may be able to be achieved prior to consumers, but this needs to be checked.

No redundancy/ability to remove lime solids – 200 mm reported to have accumulated in tank. The operators believe that the cyclone system that was installed on the lime system a few years ago has reduced the amount of solids entering the tank significantly.

Some filter media evident in weir box.

3.10.3 Upgrading Concept (Renewals scope)

The improvement options are:

- Duplicate tank (high cost).
- Use lime saturator to eliminate lime solids (expensive option).
- Improve access to tank, use divers and Hydrovac to clean.
- Investigate/upgrade scours.

Preferred concept is to construct a dedicated backwash tank that could serve as an interim clearwater tank, clean out lime insolubles and make modifications to existing clearwater tank, and then commission it as the dedicated backwash tank.

Modifications to the existing tank to include:

- Improved access to tank for cleaning and modifications to allow for easier removal of future accumulations of lime insolubles
- Consider installing a dividing wall to provide the ability to isolate one part of the tank at a time for maintenance and cleaning. Note that this would require significant rearrangement of the existing pumps.

3.11 Treated Water (High Lift) Pumps

3.11.1 Existing

Table 9 – Treated Water Pumps

Type	Vertical turbine
Number/ Configuration and Capacity	3 pumps supply Waikanae (1 duty, 1 duty assist, 1 standby); 20,000 m^3/day 3 pumps supply Paraparaumu (1 duty, 1 duty assist, 1 standby); 20,000 m^3/day

3.11.2 Issues (Renewals scope)

The existing treated water turbine pumps are being refurbished one by one and, even though they are all original, perform satisfactorily. The pumps are fixed speed, which reduces the operational flexibility somewhat.

3.11.3 Upgrading Concept (Renewals scope)

Check mechanical and energy performance of existing pumps and see if replacement is warranted. Note that replacement with anything other than turbine pumps will create need for modifications to clearwater tank.

Consider advantages and costs of adding VSDs to some or all of the pumpsets.

3.12 Potassium Permanganate Dosing

3.12.1 Existing

Table 10 - Potassium Permanganate Dosing

Type	Received in 50kg drums, made up as 1.3% (w/v) solution.
Storage	Two 3000 L tanks with Lightnin mixers

3.12.2 Upgrading Concept

Minor improvements to be done as part of renewals scope.

3.13 Coagulant Dosing

3.13.1 Existing

Table 11 - Coagulant Dosing

PACl	PACl used for raw water turbidity up to 5 NTU. Stored in 2 x 25 m^3 tanks
Aluminium sulphate	Alum (with pre-lime) used for raw water turbidity greater than 5 NTU. Stored in 2 x 42.3 m^3 tanks

3.13.2Issues (Renewals scope)

Control is currently manual and reactive; that is, at times treated water quality deterioration happens before any correction to dosing occurs, particularly during floods and changing raw water quality.

Although the alum pumps are original, they are still working well. Delay replacement until not economic to repair.

Dose pump area unbunded.

3.13.3Upgrading Concept (Renewals scope)

Options used for coagulation control in water treatment are manual, streaming current and feed-forward.

Manual Control

Manual control is feasible on stable sources with limited/slow changes in raw water quality. Due to the variable quality of the Waikanae River and the fact that as growth increases demand there will be greater use of the supplementary source, the risks associated with manual control will increase. Any failures in coagulation control potentially compromise the quality of the final treated water.

Streaming Current

A streaming current instrument measures the relative charge in the coagulated water, and in theory if the same charge conditions are maintained, control of the coagulant dose will be maintained.

Streaming current control has become well established in the automated control of coagulant dosing over the last 15 years. It has been successfully implemented at many sites but is reliant on a high degree of operator commitment, time and skill to maintain control. There are also many sites where the streaming current control has been discontinued due to issues with its control reliability.

Issues with streaming current control are:

- The instrument cannot be calibrated against any set standard, and as the instrument drifts and looses sensitivity it is reliant on the operator being able to re-optimise the process. There can be times where it may be difficult to diagnose why control is not being maintained.
- Streaming current is very sensitive to pH and if excellent pH control is not maintained the streaming current control will be unworkable.
- Streaming current does not respond well to plant shut down/restart.
- The low alkalinity conditions that are a characteristic of the Waikanae River water can be a challenge for streaming current instruments.
- Large changes in water quality can be challenging for stream current control.
- Variable plant flow and therefore lag time to the instrument can change the instrument response.

Feed-forward Control

Feed-forward control relies on measuring the raw water quality, and using the measured parameters to predict the required coagulant dose using a parametric formula.

Organic matter in the raw water typically has the largest impact on coagulant dose, and turbidity or inorganic suspended solids a secondary impact. Effective coagulant control therefore requires measurement of organic matter, and the ability to further analyse organics into the various fractions enables more accurate and robust control when used in an appropriate algorithm.

For feed-forward dose control to be viable, reliability in the water quality measurement is critical. In the past commercially available instrumentation has not had sufficient accuracy and reliability. However, there are now UV scanning spectrophotometers available and in use which are able to provide a large amount of data characterising the raw water quality and have been proven to provide very reliable data. The s::can scanning spectrophotometer is the instrument in widest use in New Zealand and Australia.

The instrument scans through a range of wavelengths, and from this can derive parameters such as dissolved organic carbon, UV absorption (254 nm commonly) and nitrate. Parameters can be corrected for cross sensitivities and parameters are compensated for suspended solids interference. The spectral output can also be used to determine concentrations of other parameters if calibration factors can be determined and also for control functions such as coagulant control.

Using the outputs from the s::can it is possible to develop equations to predict the coagulant dose rate. Over the last five years the use of this instrument for feed forward control has been developed and implemented at a number of sites in New Zealand. Examples are Te Marua, Wainuiomata (similar source variability to the Waikanae River), Kapuni (Hawera), and New Plymouth The level of control and reliability achieved has been very good. We have successfully implemented control previously using the processed s::can outputs an equations residing in the site PLC. As an alternative, a proprietary coagulation control algorithm has been developed in association with s::can and is marketed under the name com::pass. For this application we would recommend the use of the com::pass algorithm, taking advantage of the research and development that has gone into the development, with less site customisation to be necessary and more robust control expected.

In conclusion, we recommend upgrading to feed-forward control using an s::can UV scanning spectrophotometer.

Other upgrading work:

- Bund dosing pumps.
- Allow for replacement of PACl tanks.

3.14 Poly Dosing

3.14.1 Existing

Table 12 - Poly Dosing

Type	LT22, manually made up in 2000 L tank to 0.4% solution
Mixing/storage	Two 2000 L tanks, each with mixer

3.14.2 Issues (Renewals scope)

Long retention time in dose tanks – (7 days?) – poly solutions tend to reduce in effectiveness if they are stored for too long. Operators note that the detention time in the dosing tanks has not been found to be an issue.

Manually batched – may be OK.

Dosing pumps due for replacement.

3.14.3 Upgrading Concept (Renewals scope)

Consider auto batching system, although the operators consider that the batching time for poly make up is not too onerous.

Replace dosing pumps.

3.15 Lime Dosing

3.15.1 Existing

Table 13 - Lime Dosing System

Type	Stored in bulk silo (dry) and dosed by volumetric feeder
Storage Capacity	30 tonne (10 tonne delivery every 1 to 3 months)

3.15.2 Issues (Renewals scope)

Insolubles – grit and insoluble material from the lime dosing settles in the clearwater tank, causing a maintenance issue here as well as potentially downstream, but this issue is now thought to be mainly a historical problem since the cyclone was installed.

Health & safety/house keeping – dust widespread in dosing area.

Bunding/drainage to suitable point.

No redundancy – recommend duplication of feeder.

3.15.3 Upgrading Concept (Renewals scope)

New duty + standby lime system (i.e. replace existing feeder/batching/dosing system).

3.16 Powdered Activated Carbon (PAC) Dosing

3.16.1 Existing

Table 14 - PAC System

Type	Manual loading of 25 kg bags. Dry feeder into slurry tank.

3.16.2 Issues

Dust and manual handling. Limited redundancy.

3.16.3 Upgrading Concept

If installing BAC – refurbish existing (Project scope).

If don't install BAC – change to 1 tonne bag system with complete duty/standby (Renewals scope).

3.17 Chlorine Dosing

3.17.1 Existing

Table 15 - Chlorine Dosing

Type	Vacuum gas dosing system
Storage	2 x 920 kg drums
Dose – Typical	0.7 mg/L (with UV providing bacterial compliance)

3.17.2 Issues

No major issues noted – plant generally in good order and fit for purpose.

3.17.3 Upgrading Concept (Renewals scope)

Add load cells.

Check gas leak alarms and upgrade if necessary.

3.18 Fluoride Dosing

3.18.1 Existing

Table 16 - Fluoride Dosing

Chemical	Sodium silicofluoride

3.18.2 Issues

The draft 2010/2011 Annual Plan has sought feedback from the community on ceasing the fluoridation of the WPR supply. This has created some political uncertainty regarding the future of the fluoride dosing.

The existing system works adequately, but is likely to need some renewal work.

3.18.3 Upgrading Concept (Renewals)

To be determined once future of fluoridation is known.

3.19 Ozone Dosing

For the dam and storage pond options, and also river recharge, there are risks of increased algal concentrations, and the associated taste & odour and cyanotoxin issues. Changing to BAC filtration, with the ability to also dose with PAC in major events, is expected to be able to deal with these risks. However, there is a small risk that BAC+PAC will not be able to cope all the time, and given the importance the community places on treated water quality, we recommend that future provision should be made for ozone dosing prior to filtration to manage algal tastes & odours and toxins. Space for the associated equipment and contact tank should therefore be allowed for in the site layout.

3.20 Sludge/ Waste Water/ Residuals

3.20.1 Existing

Table 17 – Backwash Holding Tanks

Type	Fill and draw floating decanter
Dimensions	2 No. x 9.75m dia x 3.2m sidewall 2.9m (?)
Volume	2 x 220m^3 (plus cone)

Table 18 - Sludge Thickener

Type	Centre feed, mechanical rake and scrapper, sludge to sewer and supernatant recycled to head of the plant
Dimensions	9.75m diameter x 3.2m sidewall 2.9m water depth
Area	75 m^2
Capacity @1.5 m/h	110 m^3/h

Grit and heavy sludge from the grit tank is trucked to landfill.

3.20.2 Issues (Renewals scope)

While the existing sludge/waste water area of the plant is workable, much of the original design has been modified over the years, and additional piping and equipment has been installed in an ad-hoc manner. The area needs to tidied up and rationalised.

The grit holding tank is reaching the end of its life.

There is the opportunity to reduce the volume of waste discharged (estimated as being 500 – 800 m^3/day). It represents a lost raw water resource. In addition there are issues with the capacity of the downstream waste water pump station and reticulation, that suggest reducing the volume of wastes discharged would offer additional benefits.

3.20.3 Upgrading Concept (Renewals scope)

Recycle filter backwash water to the head of the plant, and thicken and dewater backwash and clarifier sludge. We consider that having a well performing clarifier is a sufficient barrier against the risks associated with recycling, as well as having the ability to divert to waste (i.e. to the WWTP via the sewer) in the event of a process upset.

3.20.4 Operational Comments

The Water and Wastewater Treatment Manager believes that the increased risks associated with recycling of backwash water and other wastes is not acceptable, unless the recycled stream is disinfected. This would be best addressed by having a dedicated UV unit for the recycled stream (subject to adequate UV transmittance in the stream). It would probably need to be a medium pressure unit.

Grit is a real issue in the WTP wastes, and any centrifuge must be demonstrably able to cope with grit.

3.21 Treatment for Hardness

3.21.1 Upgrading Concept

Because lime softening makes a limited impact on hardness, and we suspect that the TDS in the bore water is a significant contributor to taste issues, we are currently only considering nanofiltration (NF) as the treatment process for hardness.

The most economic solution for the brine wastes from the NF would be to send it to the WWTP. As long as the TDS concentration in the influent to an activated sludge process is increased slowly (i.e. not a shock loading) to allow the biomass to acclimatise, it normally does not cause process issues.

However, because of the constraints on the downstream pump stations and reticulation, a dedicated pumping main has been allowed for to carry the brine reject directly to the WWTP. Provisional brine volumes are 700 m^3/day for B&S (B), and 3,300 m^3/day for Borefield & Treatment. The NF plant would only run for a limited number of days per year – we have allowed on average for 15 days per year in 2015, increasing to 45 days in 2060.

3.21.2 Operational Comments

The Water and Wastewater Treatment Manager and the Asset Manager do not favour sending the brine waste to the WWTP, as there are constraints on the downstream pump stations and reticulation. There is a BIOWIN process model of the WWTP and this may be able to model the impacts on increased TDS on the process.

4 Electrical & Controls

4.1 Transformer

The existing plant has two 1000 kVA transformers, which is significantly more than required. Because tariffs are based on installed power, Council is paying a sizable premium for this additional capacity.

If NF was implemented, up to about 200 kVA of additional capacity over existing requirements would be needed.

4.2 MCC

The existing MCC is satisfactory for current and expected loads, but if VSDs are added to the high lift (treated water) pumps then it would require expansion.

Any expansion to the existing MCC would require building modifications.

If NF was implemented a separate dedicated MCC would be constructed in the NF building, fed from the main MCC.

4.3 Generator

The existing generator can run the entire plant, but does have a brief dip in output if the intake or high-lift pumps are started up.

No allowance has been made to upgrade the existing generator, on the understanding that it can provide sufficient output to meet a demand of 23,000 m^3/day with the existing treatment process, and that additional loads for any new processes could be temporarily shed in the event of a power outage. This assumption should be confirmed in preliminary design.

4.4 Control System

Remove existing mimic board, incorporating any residual functionality into the control system/SCADA.

The existing control system has ability to take more I/O.

Within the project scope we have allowed for an appropriate proportion of the costs for the incorporation of new treatment processes into the control system (both hardware and software).

5 Building

Under renewals scope allow for any necessary refurbishment of the building fabric and interior to prepare the building for its next 30 years.

6 Summary of Upgrading Concepts

6.1 Upgrading Common to All Options

The following is a summary of the renewals scope (R) and upgrading work for the project scope (P) that are common to all source options:

- Raw water pump station – new pumps and electrical system (R)
- Improved coagulation control/chemical dosing (R)
- New lime system (R)
- Miscellaneous improvements to chemical storage and handling (R)
- Add one or two new filters (P)
- Improvements to clearwater tank (R)
- Consider VSDs on treated water pumps (R)
- Sludge/waste water/residuals improvements (R)
- Building refurbishment (R)

6.2 Upgrading Specific to Options

Refer Table 19 where renewals scope is indicated by “R” and upgrading work for the project scope is indicated by “P”.

Table 19 - Upgrading Specific to Options

Option	Destrat-ification	Intake Screens & Airburst	Second Clarifier or DAF	Basic Filter Refurbishment + New PAC	BAC/ Refurbish PAC	UV (Decommission existing or install standby)	Nano-filtration
Dams	P	P	R		R	De-comm-ission (R)	
ASR			Direct filtration	R		Install standby (R)	
RRwGW		P	R		R	De-comm-ission (R)	
B&S (A)	P	P	R		R	De-comm-ission (R)	
B&S (B)	P	P	R		R	De-comm-ission (R)	P
Borefield & Treatment			Direct filtration	R		Install standby (R)	P

Andrew Watson
Technical Director - Water Supply
Direct Dial: +64-4-471 5514
Email: andrew.watson@beca.com