MAKING NEW PLACES FROM OLD SPACES THE WAIKANAE WTP AND RRWGW UPGRADE

P. Garrity – Cardno
H. Meyer and D. Bassett – Kapiti Coast District Council

ABSTRACT

In May 2015 Kapiti Coast District Council (KCDC) completed the first stage of the Kapiti Water Supply Project (KWSP) to ensure that the water demands of the Waikanae, Paraparaumu, and Raumati (WPR) communities are met for the next fifty years. A new resource consent has enabled water to be taken from the Waikanae River during lower river flows than previously permitted. This is achieved by offsetting the water abstracted from the river with a direct and equal discharge to the river of ground water abstracted from the Waikanae borefield. This concept is known as the River Recharge with Groundwater (RRwGW) scheme.

As part of achieving the scheme objectives the existing WTP required renewing and upgrading. To do this a number of old spaces within the forty year old plant were engineered into places providing modern water treatment operations. To create the innovative RRwGW scheme, design and construction works were undertaken to convert and expand the existing groundwater supply and to normalise the groundwater through land contact before it enters the Waikanae River surface water.

This significant project to the Kapiti Coast community was implemented between June 2012, when detailed design commenced, and June 2015, when construction was completed. This was done successfully despite the challenges of doing so on a fully operational plant and the need to operate the supply from the groundwater source throughout the two summers that fell within the construction period.

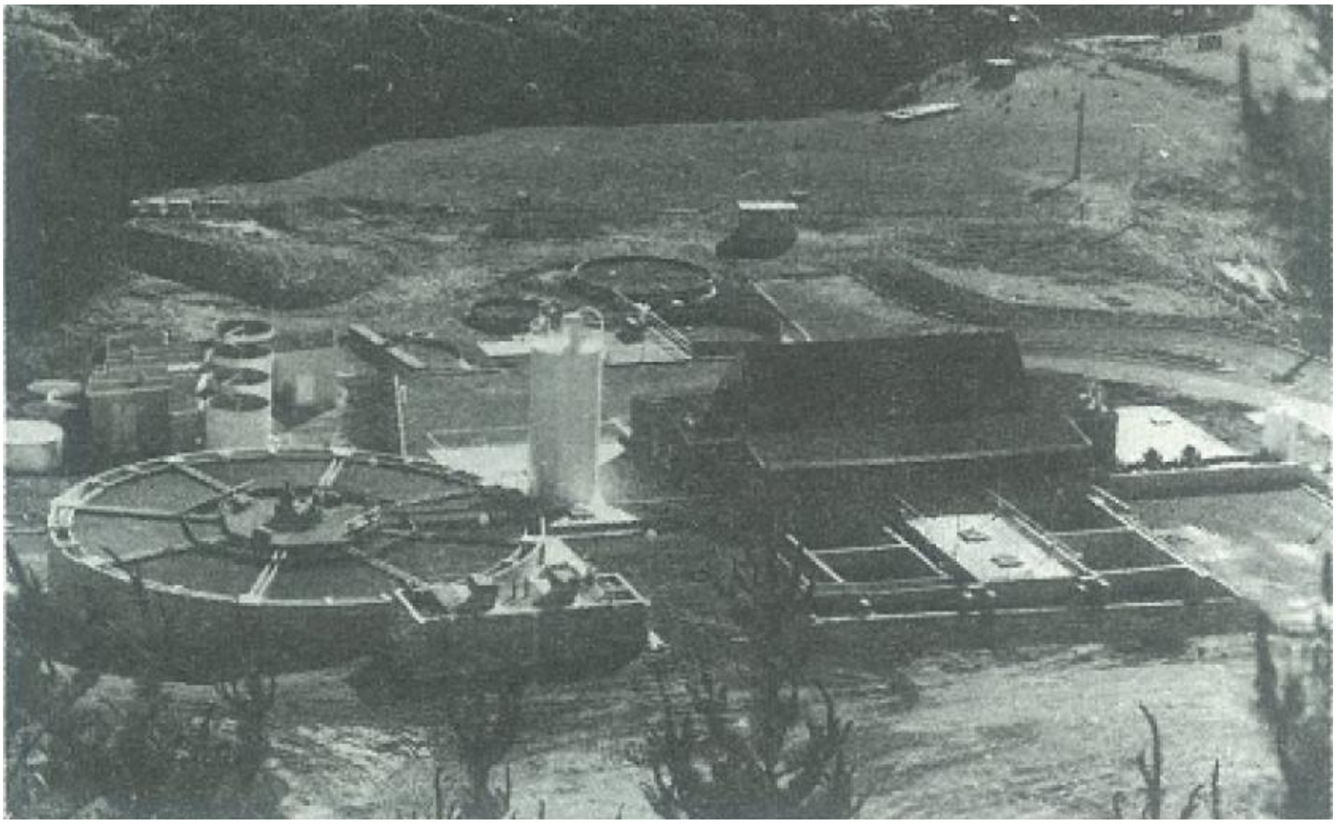
KEYWORDS

Water Treatment, Renewal, Groundwater, River Recharge

1 INTRODUCTION

On the 20th March 1977 the Wellington Regional Water Board opened the Waikanae Water Treatment Plant supplying the communities of Waikanae and Paraparaumu with a potable water source from the Waikanae River. The approximately 25MLD treatment plant was a conventional process including a raw water intake and pumping station in the Waikanae River, alum and lime dosing, a radial clarifier, dual media rapid gravity filtration, chlorination, fluoridation, Clearwater chlorine contact and pumping to two remote reservoirs and an on-site residuals management plant with a centrifuge for solids dewatering. Generous provision was made for future potential upgrades.

Over the ensuing years a number of significant modifications were made to the plant including the introduction of polyaluminium chloride dosing, powdered activated carbon dosing, ultraviolet disinfection, and sludge disposal to sewer. Upgrades to instrumentation, control, and security systems were on-going to keep up with developing technologies as were various optimisations made by the experienced operational staff to improve the process performance.



Photograph 1: Waikanae Water Treatment Plant. Completed March 1977 (Source New Zealand Engineering Vol 33 No. 1 1978)

A major development occurred in July 2005 when the Kapiti Coast District Council (KCDC) completed the Waikanae Borefield project. The objective of this project was to reticulate newly drilled groundwater wells to the Waikanae Water Treatment Plant and thereby provide an alternative raw water source for the district during river low flow periods. The project involved the installation of more than 8km of pipework through residential and semi-rural areas, including crossing State Highway 1 and the North Island Main Trunk Railway Line; and civil, mechanical and electrical works for groundwater reticulation. In addition a permanganate dosing facility was built at the Waikanae Water Treatment Plant for pre-treatment of iron and manganese. This secondary source helped to sustain the water supply during summer low flows in the Waikanae River but doing so presented challenges to the Council staff due to the different aesthetic characteristics of the groundwater compared to the river water.

Photograph 2: Kb4 Bore Headworks on the Waikanae Borefield. Completed July 2005

In May 2015 a new milestone for the water supply was achieved. Kapiti Coast District Council celebrated the opening of the first stage of the Kapiti Water Supply Project (KWSP). This project has brought together the two historic pillars of the Kapiti Water Supply in a new and innovative way to ensure that the water demands of the Waikanae, Paraparaumu, and Raumati (WPR) communities are met for the next fifty years. A new resource consent granted in 2013 enabled water to be taken from the Waikanae River during lower river flows than previously permitted. This is achieved by offsetting the water abstracted from the river with a direct and equal discharge to the river of groundwater abstracted from the bores. This concept is known as the River Recharge with Groundwater (RRwGW) scheme.

Photograph3: Upgraded Operations Building, Completed May 2015

To create the RRwGW scheme, engineering works were undertaken to convert and expand the existing bore water supply and to divert and normalise the groundwater by land contact before it enters the Waikanae River surface water. This has been designed and constructed within the environmental and cultural frame work laid down within the resource consent application and conditions.

As part of achieving the RRwGW scheme objectives the existing WTP required renewing and upgrading as it remains central to the treatment of raw river water and the delivery of potable water to the WPR communities. As part of the WTP upgrade a number of old spaces within the forty year old plant were engineered into places providing modern water treatment operations. These areas have included the raw water intake, the raw water pumping station, the powdered activated carbon, alum, PACl, polymer and lime chemical dosing facilities, and the clearwater pumping station. Transformational upgrades were also completed to the main operations building and the plant’s electrical, control, and software systems.

Given the expansive scope of this project this paper sets about to provide a brief overview of some of the key elements of the construction of this project with descriptions of some of the challenges and innovations that occurred.

2 UPGRADES AT THE WATER TREATMENT PLANT

2.1 RAW WATER INTAKE

The upgrade to the raw water intake aimed to modify it to comply with the new consent conditions and, at the same time, endeavoured to improve its operation.

Photograph 4: Upgraded Raw Water Intake

2.1.1 UPGRADED RAW WATER INTAKE

The scope of the upgrade included:

- Replacement of the vertical screen panels and horizontal 'storm' screen panels with 2mm wedgewire.
- Installation of a new 2mm vertical screen. This involved saw cutting to remove part of the existing flume floor then bolting a pre-fabricated stainless steel support frame to the intake structure. The new vertical 2mm wedgewire screen was attached to the support frame over the new penetrations to allow screened raw water to flow into the pump chamber below. The support frame was shaped to minimize disruption to the hydraulics in the intake flume.
- Replacement of the current flume control gate with a new hydraulically operated gate system based on a horizontal hinged arrangement attached to the side of the existing flume channel.
- Installation of an air-burst cleaning system for the two vertical screens including an air compressor, air receiver, air feed pipe, solenoid operated butterfly valves and sparge manifold with discharge holes. The new air receiver and compressor were housed remotely within the new PAC building. A control panel for manual operation of the system was installed above on the raw water pumping station platform.
- Construction of a penetration in the gate to allow a minimum of 200L/s to pass through the flume at all times and a plunge pool downstream of the flume control gate to support fish passage
- Installation of water level monitoring within the flume.

2.1.2 INNOVATIONS WITH THE RAW WATER INTAKE UPGRADE

The following were some of the challenges and the innovations used to overcome them during the upgrade:

Challenge	**Innovation**
The period of low base flows in the river extended only until the end of April each year. After that work in the river was difficult.	Site measurement and installation of new components were undertaken over two consecutive Summers. This allowed a period of design development, approval and testing to occur with the contract prior to installation.
There were very few examples available of vertical wedgewire screens with air sparge systems on which	The system was fully fabricated before transporting to site and underwent off site testing in a tank to prove

to base the design.	the concept.
There were very few examples available of hydraulically actuated horizontally hinged flow control gates on which to base the design.	The system was fully fabricated before transporting to site and underwent off site testing to prove the concept.
The existing intake structure leaked more and in more locations than anticipated and contained significant amounts of sediment and gravel.	Divers provided structural investigations and gravel removal at short notice. Leakage repairs were undertaken internally in the confined space and externally by the Contractor.

2.2 RAW WATER PUMPING STATION

The upgrade of the raw water pumping station aimed to replace the pumps, motors, drives, and any related components with current equipment.

Photograph 5: Upgraded Raw Water Pumping Station

2.2.1 UPGRADED RAW WATER PUMPING STATION

The scope of the upgrade included:

- Replacing the existing 90kW Kelly Lewis vertical turbine pumps with DC motors on thyristor variable speed drives with two new 90kW Gould's vertical turbine pumps with AC motors on variable speed drives. The drives were located remotely of the new PAC building. The new pumps were fitted with anti-vortex plates to avoid cavitation in low river levels.
- Replacing the check valves with anti-slam dual flap check valves and removing the surge tank.
- Replacing the leaky gibault joints and repairing corrosion on the pipes around the joints.
- Installing a new level sensor in the wet well to provide the operators with a better overview of the river intake state.
- Removal of the raw water intake building and gantry crane without replacement.

- Remediating structural condition issues with the building and bridge.
- Installing a barrier to discourage external access up the ladder.

2.2.2 INNOVATIONS WITH THE RAW WATER PUMPING STATION UPGRADE

The following were some of the challenges and the innovations used to overcome them during the upgrade:

Challenge	Innovation
Designing a detachable roof to the existing building to satisfy all health and safety requirements.	The building and gantry were removed altogether. This was made possible by the protection rating of the AC motors suitable for exposed outdoor conditions. The pumps and pump motors had almost always been removed by crane not the gantry.
Removing the building presented some new health and safety risks at the platform and to the deterioration of the asset.	New safety railing was installed around all newly exposed fall heights and new grating was installed at floor level to manage trip hazards. All pumps and pipes were painted to provide weather proofing and in a colour to blend in to the surrounding environment.
Implementation of water meters resulted in lower flow minimums than anticipated. The single stage pumps have a very flat flow versus head relationship in the low end of their control curve.	Variable torque control is being investigated as a means of providing improved control definition throughout the flow range.

2.3 CHEMICAL COAGULATION SYSTEMS AND RAPID MIX TANK

Two coagulants are used at the Waikanae WTP. These are polyaluminium chloride (PACl) and aluminium sulphate (alum). PACl is the coagulant used for the majority of the time but alum is used during periods of high raw water turbidity. When alum is being dosed, pre-lime is also dosed. Polyelectrolyte is dosed with both coagulants. The existing coagulant chemical regime has been maintained with the upgrade however coagulation control was currently manual and reactive. The upgrade of the coagulation systems aimed to improve the coagulation control system so that it is automated and predictive (feed forward), replace the chemical dosing systems with new technology and improve mixing in the rapid mix tank.

2.3.1 UPGRADED CHEMICAL COAGULATION SYSTEMS

The scope of the upgrade included:

- Installing an s::can unit measuring a raw water sample taken from the raw water pumps. The com:pass algorithm was incorporated for processing the data and calculating the coagulant dose.
- Installing a raw water turbidity meter measuring a sample taken from the raw water pumps.
- Replacement of the pumped dosing systems for PACl, Alum and Polymer .
- Installation of level sensors in the PACl and Alum storage tanks for SCADA monitoring.
- Installing stators on the rapid mix tank walls to improve the influence of mixing.
- Relocating the alum and PACl coagulant dosing points to the tip of the first mixer.
- Relocating the polyelectrolyte dosing point to the tip of the second mixer.
- Modifications to the site SCADA for controlling the dose pump flow rates and for trending the dose rates.

Photograph 6: Upgraded Poly Aluminum Chloride Dosing System

2.3.2 INNOVATIONS WITH THE CHEMICAL COAGULATION SYSTEMS UPGRADE

The following were some of the challenges with the coagulation system upgrade and the innovations used to overcome them:

Challenge	Innovation
The process control algorithm for the managing the PACl to Alum changeover was unique and required development.	The s::can unit was installed in advance of the main construction contract. Options based on PACl dose changeover and raw water turbidity changeover were assessed. Although it was initially intended to use turbidity changeover once installed, control based on PACl dose was found effective due to the earlier introduction of PAC in the process train than previously, increasing turbidity.
The original concept for the rapid mix tank upgrade involved extensive structural changes with static mixing rather than mechanical mixing.	The design team determined from experience that the rapid mixing could be significantly improved at minimal cost compare with the previously recommended upgrade.

2.4 POWDERED ACTIVATED CARBON STORAGE AND DOSING

Powdered activated carbon (PAC) is used continuously at the Waikanae WTP to remove taste and odour causing compounds such as geosmin and 2-MIB from the raw water, by adsorbing these organics within the porous structure of the PAC. The PAC is then removed in the clarification and filtration processes. With the new water take consent, water may be taken from the Waikanae River at lower flows than what it was historically extracted. This may result in water being taken which contains higher concentrations of taste and odour causing compounds. In the future it is estimated that the PAC dose rate may have to increase to cope with major taste and odour events. The aim of the powdered activated carbon dosing upgrade was to improve the capacity, reliability, and control of PAC dosing to cope with these scenarios and, at the same time improve the working environment for the operators.

Photograph 7: Upgraded Powdered Activated Carbon Dosing System

2.4.1 UPGRADED POWDERED ACTIVATED CARBON STORAGE AND DOSING

The scope of the upgrade included:

- Constructing a building for PAC storage, make-up and dosing, with an internal height of 6.0m required for handling bulk bags of PAC into the storage hoppers.
- Installing an overhead travelling crane and hoist for handling bulk bags of PAC.
- Installing duty/standby PAC storage hoppers including a dust extraction system.
- Installing duty/standby volumetric feeders, wetting cones and eductor systems for entraining the PAC into the delivery flow.
- Providing new PAC dosing points, up front in the process on the raw water delivery line.
- Installing a ventilation system for the building.
- Providing site services to/from the new building including power, process water, process air and stormwater.
- New local PLC and local control panel.
- Decommissioning the existing PAC dosing facility.

2.4.2 INNOVATIONS WITH THE POWDERED ACTIVATED CARBON STORAGE AND DOSING UPGRADE

The following were some of the challenges with the PAC upgrade and the innovations used to overcome them:

Challenge	Innovation
KCDC's regular supplier of PAC did not have reference on their MSDS that their PAC product was not spontaneously combustible. This would have required compliance with HSNO classification 4.2C for the storage of PAC.	Through a process of research and then assessment by the supplier the PAC MSDS was able to be modified to classify their product as not spontaneously combustible. Notwithstanding this a Hazardous Area Assessment was undertaken to assess the risk of dust explosion. All equipment was installed as either ex-rated or alternatively was located outside the risk areas.
The MCC room housing the variable speed drives for the raw water pumps was installed adjacent to the PAC storage room.	A 240min fire wall was constructed between the MCC room and the PAC storage and dosing room.
PAC is a 'dirty' substance to handle.	Iris valves were used for the transfer of the bulk bags into the hopper. Black was the chosen colour for all painted surfaces.

2.5 LIME MAKE-UP AND DOSING

The Waikanae WTP utilises lime dosing for pH Correction before the Rapid Mix Tank (pre-lime) and before the Clearwater Tank (post-lime). Pre-lime is dosed only if alum is being used as the coagulant which occurs during raw water events with elevated turbidity. Post-lime is dosed continuously to maintain a treated water pH target of 8.0. The aim of the upgrade was to reproduce the lime batch make-up system that had been developed by the operators over a number of years but improve the operations and system redundancy.

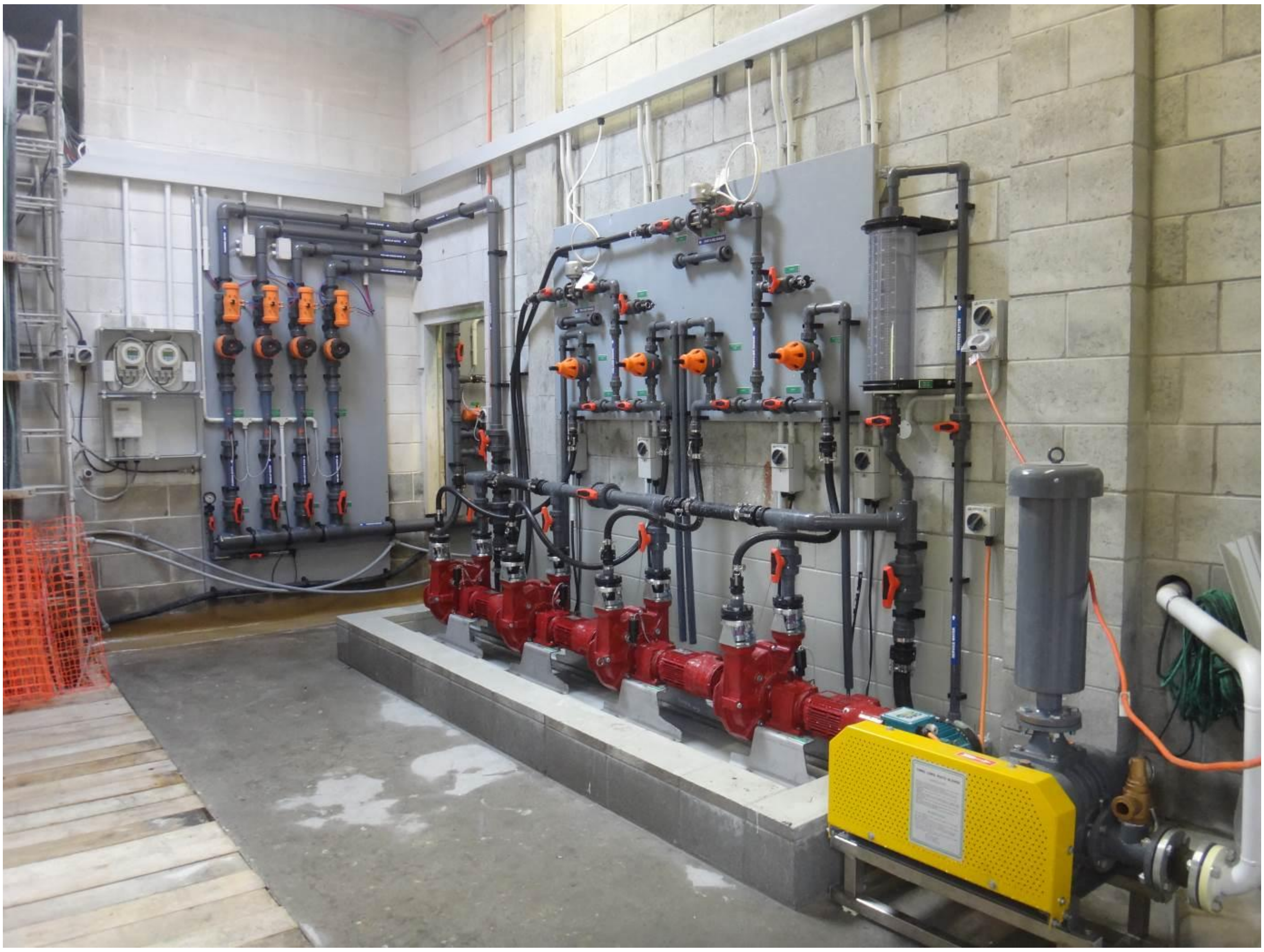
2.5.1 UPGRADED LIME MAKE-UP AND DOSING SYSTEM

The scope of the upgrade included:

- A new makeup system including two batching units each comprising:
    - A automated silo rotary valve.
    - Gain-in-weight batch hopper with load cells and actuated dumping mechanism.
    - Makeup tank with agitator and ultrasonic level monitor.
    - Makeup water pipework and actuated valves.
    - Actuated valves to provide alternation between the two makeup systems.
    - A grit pump and hydrocyclone.
    - New bunded area (common).
    - New dust extract system (common).
    - New local PLC and local control panel (common).

- A new dosing system comprising:
    - Two positive displacement (peristaltic) pre-lime dosing pumps (duty/standby).
    - Two positive displacement (peristaltic) post-lime dosing pumps (duty/standby).
    - Magflow meters on each dosing pipe to monitor flow and detect no-flow condition.

- A flushing system including:
    - New service water pipework and actuated valves to enable fully automatic back-flushing through dosing suction pipework into makeup tanks and forward flushing through dosing pumps to drain.



Photograph 8: Upgraded Lime Dosing System

2.5.2 INNOVATIONS WITH THE LIME SYSTEM UPGRADE

The following were some of the challenges with the lime upgrade and the innovations used to overcome them:

Challenge	Innovation
The existing lime dosing system had been developed over a number of years and from experience by the operations staff. There was an expectation that this system would be reproduced but additionally improved upon.	The design was a collaborative approach between KCDC operations staff, Cardno, Downer and its chemical and electrical subcontractors. A willingness to achieve the desired outcome was the pervading attitude.
During the upgrade the existing lime room needed to be refurbished and this meant the WTP had to be operated without lime.	Two temporary caustic dosing systems were installed one each for the pre and post pH correction dosing functions. These functioned very successfully.
The quality of lime includes a relatively high level of grit.	The end result was one hydrocyclone per make-up system with an automated grit dump
During flood flows experienced during commissioning it was found that the flushing sequence would result in loss of stable pH control because of flush frequency.	Control sequencing was modified to remove the flushing process when operating on pre-lime dosing.

2.6 TREATED WATER PUMPING STATION

The treated water pumping system is comprised of a single treated water pump chamber from which water is pumped to both the Paraparaumu and Waikanae water supplies using vertical turbine pumps ranging in size from 75kW to 132kw. The aim of the upgrade was to replace two of the pumps based on age with the remainder of the pumps to be replaced progressively in the future.

Photograph 9: Upgraded Treated Water Pump Station

2.6.1 UPGRADED TREATED WATER PUMPING STATION

The scope of the upgrade included:

- Replacement of the 75kW pump on the Paraparaumu pump manifold with a 55kW Gould's vertical turbine pump
- Replacement of the 90kW on the Waikanae pump manifold with a 90kW Gould's vertical turbine pump.
- Installation of new soft starters for all the pumps.
- Replacement of the existing swing check valves for the replaced pumps with 'surgebuster' surge suppression type.
- Installation of digital pressure gauges on each of the manifolds
- Installation of vibration sensor on all pumps
- Installation of level instruments and solenoid valves on the air lines of both surge vessels to enable automatic filling.
- Construction of an acoustic fence to reduce noise levels to adjacent properties.

2.6.2 INNOVATIONS WITH THE UPGRADED TREATED WATER PUMPING STATION

The following were some of the challenges with the treated water upgrade and the innovations used to overcome them.

Challenge	**Innovation**
Previous recommendations had proposed putting the	An investigation was made of the system curves and operations of each of the pump sets. It was determined

small pumps for upgrade on variable speed drives.	that the additional costs of installing variable speed drives for some or all of the pumps was not warranted and new soft starters were installed for all pumps.
The lead time on the pumps was approximately 1 year	The soft starters that were installed in the new MCC were sized for running the existing pumps until such time as the pumps were available for replacement.

2.7 OPERATIONS BUILDING

The main aim of the upgrade was to create an area within the existing building for the new electrical MCC. At the same time the opportunity was taken to improve the facilities for operations staff especially the lunch and meeting room which was able to be expanded into the decommissioned electrical area. At the same time a seismic model was built of the existing and upgraded building and some minor additional structural works were undertaken to increase the seismic resistance of the building.

Photograph 10: Upgraded Operations Building

2.7.1 UPGRADED OPERATIONS BUILDING

The scope of the upgrade included:

- For the new electrical equipment area:
    - Constructing a first floor within the workshop/backwash valve room with a structural steel frame and concrete floor with ample penetrations for cables. The construction required opening up the existing ground slab to provide a foundation for the columns of the new frame.
    - Replacement of the roller door by one with lower height and enclosing the glassed end of the building with solid cladding.
    - Provision of two outward opening egress doors for the electrical room.
- For the control equipment area:
    - Relocating the PLC and servers to the new MCC equipment area. This opened up a new records room.
- For the operator lunch/meeting room and office spaces:

- Removing the existing electrical MCC's and extending the meeting/lunch room into this area.
- Constructing office space and an outdoor deck on the area above the canopy on the west face of the Main Building.

- For the operator and visitor ablutions:
  - Increasing the size of the male change/shower toilet area including two WC compartments and one shower compartment. Providing lockers and a change area.
  - Providing a unisex accessible toilet and shower compartment including lockers and bench for potential female staff.
- For the laboratory:
  - Removing the redundant control panel and making modifications to provide more storage space.
  - Providing a new laboratory bench.
- For the entry:
  - Installing a timber slat screen around the diesel generator and diesel tank.
  - Adjusting the stairs to entry level including a timber deck.
  - Adjusting and replanting the planter edge.
  - Providing a disabled access.
- For the building envelope and site works:
  - Replacing sealant between precast concrete panels.
  - Providing a water proofing system to the exterior concrete at ground level over the filter gallery.
  - Removing historic buried diesel tanks that had been decommissioned a number of years previous.
  - Resurfacing the full plant site in asphalt.
  - Providing a chemical tanker unloading bund.

2.7.2 INNOVATIONS WITH THE OPERATIONS BUILDING UPGRADE

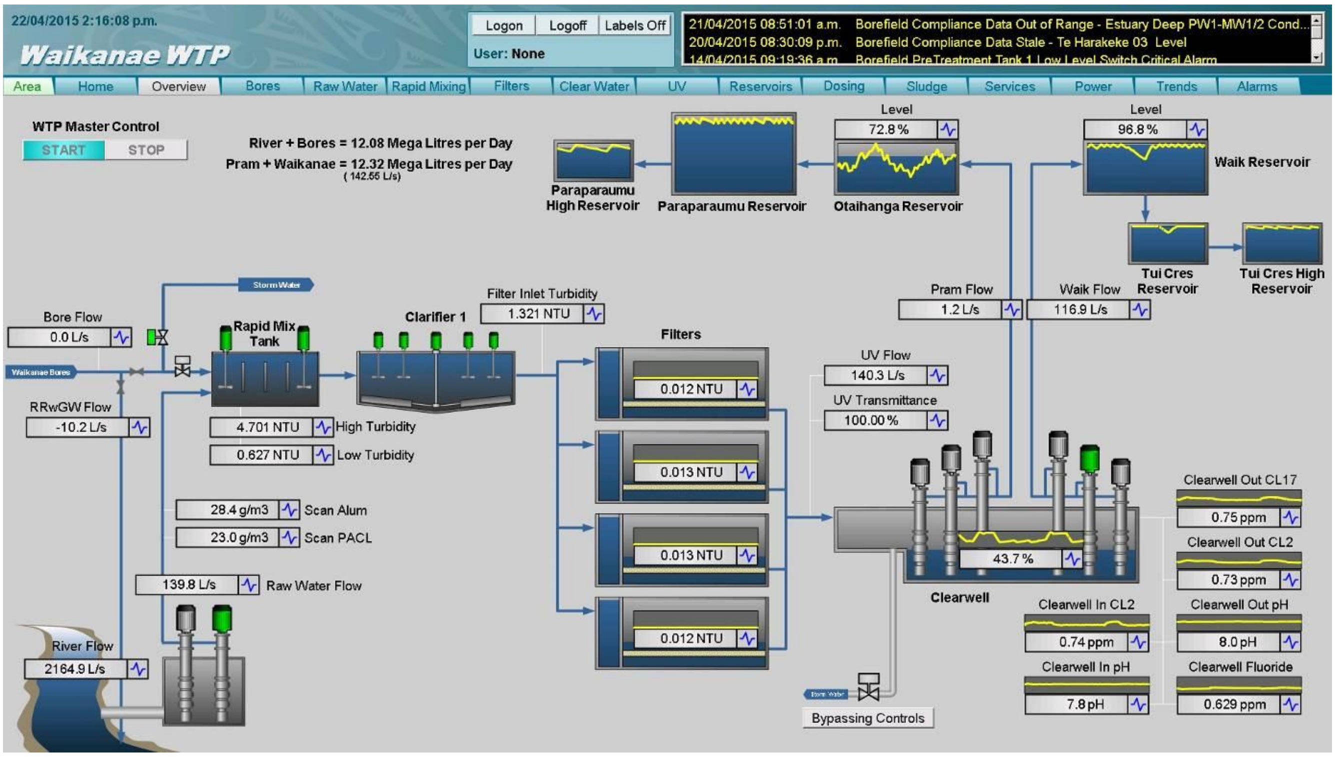
The following were some of the challenges with the building upgrade and the innovations used to overcome them.

Challenge	**Innovation**
The building was approaching 40 years old and was requiring renovation.	The building upgrade was treated as an architectural project and the facility was renovated to give a contemporary feel. The building is now a popular place for holding water infrastructure meetings.
During the upgrade the building had to remain operational.	The old electrical room could not be decommissioned and the new meeting room completed until the plant was able to run off the new MCC. MCC decommissioning was a major milestone in being able to achieve building upgrade completion.
During the upgrade the operators had to relocate out of the building.	Temporary facilities were provided for the operators for a period of approximately 8 months. Computer equipment and linkages to SCADA were provided for the operators in these facilities. All project meetings were held in these facilities.
The building had a number of deferred maintenance items that became apparent during the building upgrade.	The project team worked together to ensure each item was addressed. The replacement of window units and waterproof membranes meant that building consent amendments were required during the construction process. The overall objective was to achieve a

	building upgrade that all could be proud of.

2.8 ELECTRICAL AND CONTROL SYSTEMS

The aim of the upgrade was to replace the obsolete electrical systems for the entire plant and to upgrade the SCADA software.



Photograph 11: Waikanae Water Supply Overview Updated SCADA Screen

2.8.1 UPGRADED ELECTRICAL AND CONTROL SYSTEMS

The scope of the electrical and controls upgrade included:

- Supply and installation of a new MCC1 in the new electrical room. MCC1 was split into two sections MCC1A and MCC1B connected by a bus tie to ensure electrical redundancy. Allowance has been made in MCC1 for future upgrade stages.
- Reinstatement of the standby generator electrical and control cables to MCC1.
- Supply and installation of MCC3 for the raw water pumps adjacent to the PAC building. MCC3 has dual supply.
- Supply and installation of new distribution boards for building services.
- Design and construction of local control panels for coagulation chemicals, Lime and PAC.
- Relocating the main PLC in to the new electrical room.
- Converting existing SCADA elements to Intouch ArchestrA format, developing code and screens for new elements.
- Supply and install new PLC for lime control.
- Supply and install new PLC for PAC control.
- Installation of new computer server.
- Installation of new data and phone connections. Extension of existing security systems.
- Commissioning.

2.8.2 INNOVATIONS WITH THE ELECTRICAL AND CONTROL SYSTEMS UPGRADE

The following were some of the challenges with the electrical and controls upgrade and the innovations used to overcome them.

Challenge	Innovation
The existing electrical and control cabling was not well labelled and much electrical cabling was redundant.	Extensive exercises in cable tracing both by the electrical engineers during design and by the electrician during construction were undertaken.
The design of the electrical room need to allow for cable penetrations.	Bottom entry panels were used for MCC1. The structural floor design was such that it had some flexibility on the locations of penetrations without reducing structural strength. Penetrations were made in the floor after marking out based on the built panel. An extensive cable ladder system was installed beneath the electrical room floor.
The plant had to be kept live during changeover with shutdowns being no longer than 8hrs.	A second PLC was built using KCDC held spares. This was installed in the new electrical room and initially made to run the old PLC software. Equipment and controls were migrated item by item with two PLCs running in parallel. The existing PLC was decommissioned. The new software was introduced after full migration had occurred.
The old MCC needed to be kept live until all equipment had been migrated. The raw water pump DC drives needed to be kept operative until near the end of the contract due to the long lead times on the new pumps.	Once mains power was transferred to MCC1 the existing electrical panels were fed through MCC1. The raw water pump drives were relocated to a temporary position outside of the electrical room to allow the old MCC to be decommissioned. Decommissioning of the drives occurred once the new pumps were installed and running off MCC3.

3 BOREFIELD AUGMENTATION AND RIVER RECHARGE WITH GROUNDWATER CONSTRUCTION

3.1 BORE HEADWORKS

In 2005 six bores were connected to the groundwater delivery system to the Waikanae WTP. These were known as bores K13, K10, Kb4, K4, K5 and K6. The aim of the upgrade was to make-up for the capacity that was lost when one of the existing bores, K13, had to be decommissioned as part of the new resource consent.

3.1.1 BORE HEADWORKS UPGRADE

The scope of the bore upgrade included:

- Decommissioning of existing bore K13.
- Raising the level of the existing bore K10 headworks to be above ground.
- Relocation of a surge protection vessel from K13 to K10.
- Installation of bore pumping and wellhead works at new bores Kb7, K12 and N2.
- New buried high voltage lines to bore N2 and new transformers at Kb7, K12, and N2.
- New low voltage local control panels including variable speed drives at bores N2 and Kb12. Relocation of the local panel from K13 to Kb7.
- New fibre optic system for communications linking bores K12 and Kb7 to existing bore K6.
- New radio system at bore N2 with a radio transmission tower at a remote location called Nikau ridge for communications.

Photograph 12: New Bore Kb7 Installation

3.1.2 INNOVATIONS WITH THE BORE HEADWORKS UPGRADE

The following were some of the challenges with the bore headworks upgrade and the innovations used to overcome them.

Challenge	Innovation
The remoteness of bore N2 and the acquisition by NZTA for the Mackay's to Peka Peka expressway of the property required for access to bore site N2.	Excellent consultation was maintained by KCDC and Cardno to ensure access, power and future pipeline easement agreements were negotiated with all private property owners including the M2PP project.
At the time of awarding the contract the communications system had not been finalised.	A turnkey design and construct contract was run as a variation to the contract. It was awarded to KCDC's nominated communications system provider to ensure this would not hinder the project from completion.
The pressure vessel relocated from K10 had been designed verified under the old loadings code NZS4203.	The vessel had to have its design verification reviewed for compliance against AS/NZS1170 prior to vessel certification in its new location.
The capacity of bores Kb7 and K12 was last tested in 2005.	These bores were pump tested as part of the contract and the information used to confirm the final selection of the pumps. The full available range of the VSD was required to cover the single pump, multiple pump, and future pumping scenarios.

3.2 BORE PIPELINES

Pipelines ranging in diameter from 250NB to 450NB, constructed in uPVC pipe materials were installed as part of the 2005 borefield project. These were mostly constructed in the residential areas of Waikanae. The aim of the pipelines upgrade was to extend the pipelines to reticulate the new bores Kb7, K12 and N2 in to the existing network. This pipelines were mostly through rural areas and rural roads.

Photograph 13 Pipe Strings Prepared for Installation

3.2.1 UPGRADED BOREFIELD PIPELINES

The scope of the pipeline upgrade included:

- Construction of 1780m of pipeline in DN250 SDR11 PE100 from bore N2 along Ngarara Paper Road to Smithfield Road.
- Construction of 690m of pipeline in DN180/160 SDR11 PE100 from bore K12 along Smithfield Road to Ngarara Road collecting bore Kb7 along the way.
- Construction of 170m of pipeline in DN315 SDR11 PE100 from the Ngarara and Smithfield Road junction to the existing pipe terminus adjacent bore K6.
- Installation of air valves and scour valves at local high and low points respectively.
- Installation of a magnetic flow meter at the connection to the existing pipeline adjacent bore K6.

3.2.2 CHALLENGES WITH THE BOREFIELD PIPELINES UPGRADE

The following were some of the challenges with the bore pipeline upgrade and the innovations used to overcome them.

Challenge	**Innovation**
The terrain was challenging with alternating peat swamps and sand dunes.	The pipeline was entirely directional drilled and constructed in PE100. On only a couple of occasions were troubles encountered with buried trees in the peat. A specialized drill head was used when passing beneath transmission lines to ensure drill head location.
The previously selected route had potential to result in protracted property negotiations with private owners.	The finalized route was designed and constructed entirely in paper and formed roads. Access to the paper road corridor only was required which was excellently coordinated by the contractor.
The pipeline route had potential archaeological sites of	The directional drilling method reduced the locations

local iwi significance.	of disruption to discrete locations (the drill pits). Iwi representatives provided inspection at drill pit opening at locations that they deemed of potential cultural significance.
The pipeline had to cross the Mackay's to Peka Peka Expressway designated corridor which was being used as a haul road.	Designs were completed in consultation with the M2PP design team. The pipeline was enclosed in a sand filled steel duct. The corridor crossing excavation and reinstatement was completed over the course of weekend.

3.3 SWALE AND RIVER DISCHARGE

When arriving on site through the reticulation system the groundwater was delivered to the rapid mix tank via a permanganate pretreatment facility and an aeration tower. The aim of the swale and river discharge upgrade was to provide conditioning of the groundwater through land treatment prior to recharge of the Waikanae River as approved under the new resource consent.

3.3.1 UPGRADED SWALE AND RIVER DISCHARGE

The scope of the swale and river discharge upgrade included:

- Construction of a diversion chamber to allow flow to be directed either to the swale or to the water treatment plant.
- Construction of a meandering swale to condition a groundwater flow of up to 350L/s. The swale included inlet and outlet structures and intermittent rock weirs. The embankments were fully planted according to a landscape design.
- Construction of an open channel to convey the water from the swale site to adjacent the final discharge site on the bank of the Waikanae River.
- Construction of a discharge distribution chamber containing a manifold of five outlet pipes with flow spreader plates at the outlets.
- Construction of a natural rock cascade on the bank of the Waikanae River immediately downstream of the raw water intake.

Photograph 14: New River Recharge Swale and Discharge Structure

3.3.2 CHALLENGES WITH THE SWALE AND RIVER DISCHARGE UPGRADE

The following were some of the challenges with the swale and discharge upgrade and the innovations used to overcome them.

Challenge	Innovation
The concept for the physical infrastructure associated with the recharge system discharge was not fully developed prior to the lodgment of the resource consent application.	The concept and detailed designs for the swale and discharge were developed through a collaborative process between iwi, KCDC and Cardno.
Iwi required that no groundwater pass through the swale and into the River prior to an official blessing taking place.	The system was protected from regular groundwater maintenance flows. A special dawn commissioning ceremony was held with iwi the first time that water flowed through the swale.
The rock face beneath the river discharge was more weathered and friable than anticipated.	High density rock that had previously been imported into the Waikanae River to protect the intake structures was placed at the toe of the discharge to dissipate energy from the cascade while maintaining a natural appearance.
The wet ground conditions in the swale area made construction difficult.	The installation of subsurface flow cutoff drains made the site workable. Site clays and silts were able to be used to line the swale. Topsoil had to be imported because of its scarcity.

Photograph 15: New River Discharge Structure

4 CONCLUSIONS

On the 27th May 2015 staff and Councillors of the Kapiti Coast District Council and members of the local iwi opened the Kapiti Water Supply's new River Recharge Scheme. This project has set a new direction for water supply on the Kapiti Coast whilst continuing to utilise the existing water source assets that the community have been reliant on for the past 40 years.

The upgrades at the Waikanae Water Treatment Plant completed in this stage have been renewals and capacity and redundancy upgrades undertaken with the aim of providing updated water treatment process based on current technologies. In many cases the design solutions have been developed from incremental optimisations that were implemented by the treatment plant staff over the years. The upgrades have been constructed to good effect in places that have been made available with a new vision for the old spaces.

The river recharge concept is an innovative one and the engineering challenges to extend the borefield and to satisfy cultural and environmental principles have been overcome. It is anticipated that the River Recharge Scheme will improve the quality of potable water supplied to the Kapiti Coast community in times of low flows in the Waikanae River.

Photograph 16: Commemorative Plaque Unveiled at the Opening Ceremony

ACKNOWLEDGEMENTS

The authors wish to thank all those who were involved in this project who contributed to making it a success. These include the Kapiti Coast District Council project control team and their advisors, Te Ati Awa Ki Whakarongotai, the Kapiti Coast District Council WTP operations staff, the Cardno design team and all their subconsultants, and the Downer NZ construction team and all their subcontractors.

REFERENCES

Bishop, R.G. and Bayly, H. (1978) 'Wellington Regional Water Board' *New Zealand Engineering* 33 1 2-7

McCoy, M. and Garrity P.M (2012) 'Waikanae Water Treatment and River Recharge with Groundwater Upgrade Design Issues Report.