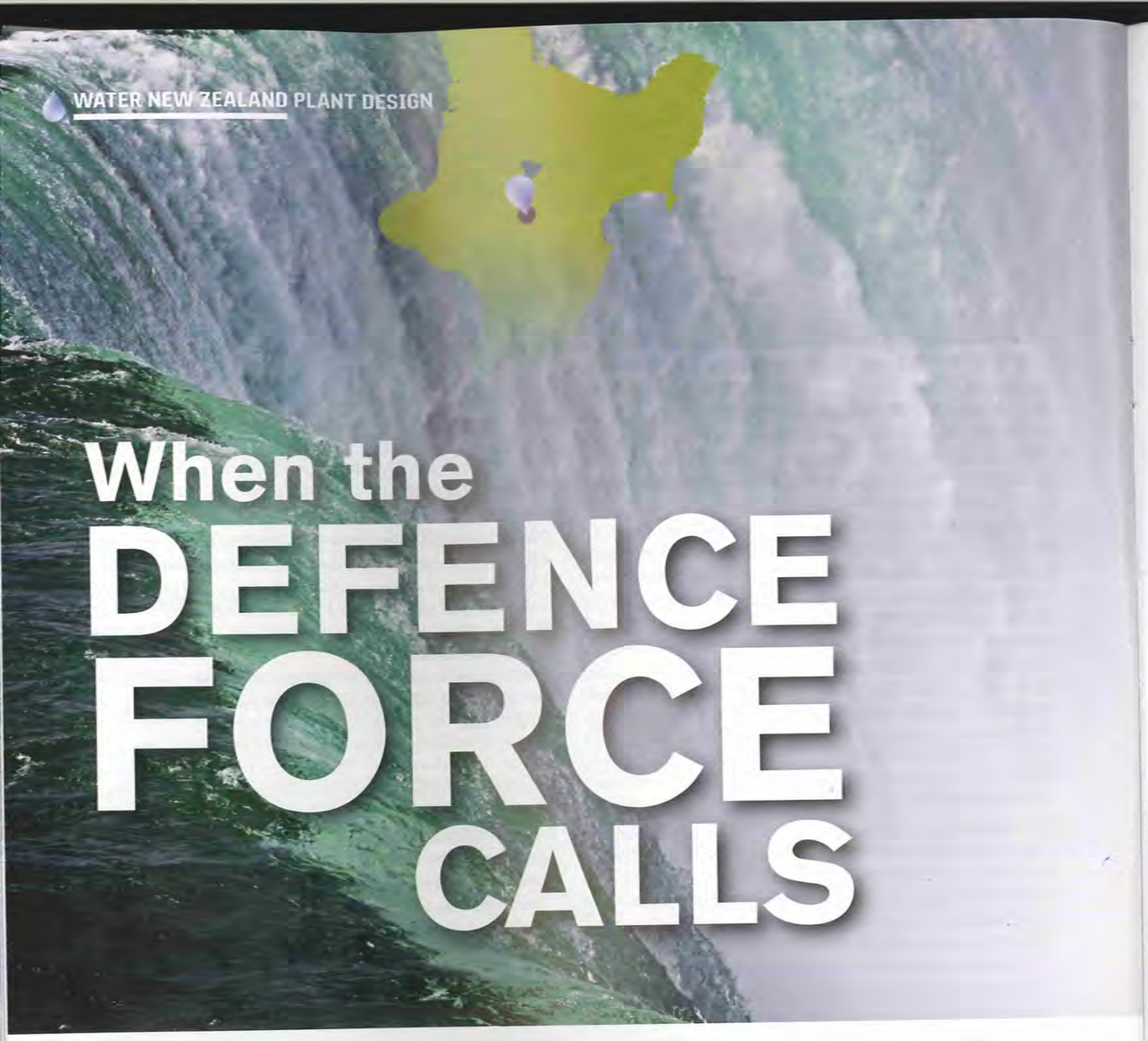

When the DEFENCE FORCE CALLS

Warren McKenzie, environmental engineer and Rob Docherty, technical director Water Infrastructure, Pattle Delamore Partners, discuss the design of a new treatment plant.

The New Zealand Defence Force (NZDF) owns and operates a Wastewater Treatment Plant (WWTP) at Waiouru, which was originally built in 1957. The WWTP treats wastewater generated from the NZDF military base and from commercial and residential sources within the township and serves a total population of around 3000. Pattle Delamore Partners (PDP) has assisted NZDF in the upgrade of the WWTP throughout the consenting, investigation, design, construction and operation of the plant.

The upgrade of the plant included a new dual tank Sequencing Batch Reactor (SBR), alum dosing for phosphorus removal, UV treatment, improved sludge handling facilities and the refurbishment of many of the existing treatment processes. The overall construction cost was about $3.5 million. The plant discharges into the Waitangi Stream which is a small alpine stream which enters the Whangaehu River a few kilometres downstream.

Detailed design

PDP started the design in October 2012. The process design was assisted by utilising Biowin wastewater treatment modelling software.

The process design was undertaken in parallel with detailed design and site investigation given the tight timeframe required to meet key consent dates. Information was fed from the process design and site investigations to the detailed design team and the design progressed quickly with design documentation completed in February 2013.

A key part of the project was to incorporate as much of the existing treatment plant infrastructure as possible and in particular utilise the existing trickling filters as these were accepted by local Maori representatives as providing spiritual cleansing of the wastewater.

Flow data

The historical WWTP wastewater flow data comprised "hand kept" records (spanning some 10 years) which were essential in sizing unit processes.

Some significant flows have been encountered at the Waiouru WWTP due to stormwater inflow and groundwater infiltration (I and I) in the township. The average daily flow for the plant is around 800m³/d but flows have been recorded in excess of 5000m³/d. These large flows required the incorporation of overflow points at particular locations through the treatment process, the SBR tanks being one such point where bypassing will occur when inflow exceeds 1600m³/d. Following plant commissioning in early 2014 no flow in excess of 1600m³/d has been experienced.

Characterisation of loads entering the WWTP is of particular importance. Post-screen flows were characterised for their contaminant loads to provide valuable process sizing information. The low BOD:N ratio required supplementing of the incoming SBR flow with an artificial carbon source to enhance denitrification and enable a high percentage removal of nitrogen in the SBR.

Designing the plant for cold weather was also a challenge, with recorded air temperatures of -6°C being common and wastewater temperatures often being less than 10°C. Heat transfer theory was applied, resulting in the insulation of pipework and the provision for heating of some chemicals. Stagnant flow in pipework was avoided and some unit processes have been programmed for periodic pulsed operation to prevent freezing.

Nitrification inhibition

Some difficulties were experienced in early 2014 just two and a half months after commissioning with poor treatment being achieved by the SBR tanks. After some investigation, it was discovered that a local contractor had been contracted to provide portaloos for a temporary military exercise and he was regularly discharging portaloo contents into the sewer network. The products used in these portaloos for odour control are antimicrobial and were having an adverse effect on SBR treatment. While these portaloo discharges may have been acceptable in small quantities, during army exercises 75 to 100 portaloos were being emptied every three days into the plant's relatively small 800m³/d inflow.

The portaloo discharges inhibited nitrification in SBR 1. SBR 2 was then used to reseed the affected SBR tank with activated sludge. SBR 1 fully recovered in seven to 10 days following reseeding and ammoniacal nitrogen concentrations returned to normal (< 5mg/L). The ability to reseed an affected tank has proven very useful and this is one of the advantages of a dual SBR system and an allowance should be made in any design to enable the operator to transfer activated sludge between process tanks.

To prevent future recurrence of the portaloo discharges, the portaloo contractor is now required to use a wastewater treatment friendly product that relies on enzymes for odour control. No issues have been experienced at the plant since this new product was introduced.

PLANT EQUIPMENT

The upgraded plant includes (new treatment processes bolded):

- Inlet works, with grit chamber and step screen
- Primary clarifier
- **SBR Lift Pumpstation with 40L/s capacity.**
- **2 x 800m³ SBR tanks (400m³ live volume per cycle) with diffused aeration, submersible mixers, sludge wasting pumps, floating decants and monitoring probes.** Shown in Figure 1.
- **Caustic dosing to increase alkalinity prior to nitrification in SBRs (alkalinity deficient wastewater).**
- **Carbon dosing to assist denitrification (due to an inadequate C:N ratio).**
- Trickling filters (2 of, working in parallel).
- **A recirculation pumpstation with 25L/s capacity (to keep the trickling filters wet during SBR idle phases).**
- **Alum dosing prior to secondary clarifier.**
- Secondary clarifier.
- **Ultraviolet treatment.** Shown in Figure 2.
- **Improved sludge handling facilities with a geobag dewatering system.**

Figure 1

Figure 2

REMOTE OPERATION USING SCADA

PDP has been providing operational assistance to NZDF since the plant was commissioned in early 2014. Operational assistance is provided remotely (using a SCADA connection) and monthly site visits undertaken in order to provide training to the existing plant operator.

A SCADA link is used by PDP staff from the Auckland and Tauranga offices to remotely access key information from the plant such as flows, dissolved oxygen, pH, temperature, valve positions, equipment status and tank wastewater levels. The development of the SCADA system was discussed in some detail within the construction contract documents and with the contractor's programmer throughout construction to ensure it provides the correct level of detail in an "easy to use" format.

The SCADA link also provides monitoring trends which are invaluable for troubleshooting purposes. A well performing SCADA link is a key requirement in providing operational assistance to any technologically advanced WWTP. Screenshots of the SCADA system are shown in Figures 3 and 4.

Figure 3

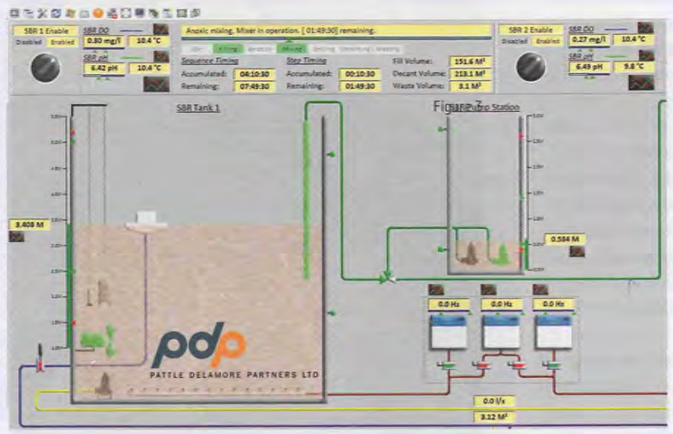

Figure 4

Temperature

Wastewater temperatures declined to 8°C during/after snowfall in mid-July 2014. While it would be normal to expect a drop off in nitrogen removal at these temperatures, interestingly no negative effects were seen on the nitrification and denitrification ability of the SBRs.

Onsite sampling

Troubleshooting of performance difficulties in a WWTP can prove difficult, particularly given the seven-day turnaround time of any effluent sample sent to a laboratory for analysis. To overcome this, PDP staff and the plant operators utilise a colorimeter allowing real-time measurement of ammoniacal nitrogen, nitrate, nitrite, dissolved reactive phosphorus (DRP) and suspended solids (SS). This has proved to be an invaluable tool for the operator as it allows him to make proactive adjustments to the plant control. The colorimeter results were compared against a laboratory sample and were remarkably similar for the nitrogen species and within acceptable limits for DRP and SS.

Plant performance

Median effluent results for the plant over the last 12 months (May 2014 to April 2015 inclusive) are shown in Table 1. The plant is showing comfortable compliance with all parameters.

Nitrogen removal can be improved by increasing the carbon dosing rate which reduces residual nitrate concentrations. However, this has operational cost implications and for this reason nitrogen concentrations are maintained at a comfortable level of compliance.

Conclusion

PDP has worked alongside NZDF throughout the full project lifecycle of the Waiouru Sewage Treatment Plant Upgrade which was commissioned in early 2014.

The new plant has significantly reduced the discharge of nitrogen, phosphorus, faecal coliforms, BOD and suspended solids to the Waitangi Stream. PDP's work has included consenting, detailed design, contract management, operational assistance and operator training which has provided NZDF with a highly functioning WWTP that will serve Waiouru. **WNZ**

Table 1

WAIOURU SEWAGE TREATMENT PLANT: EFFLUENT DISCHARGE COMPLIANCE

PARAMETER	UNIT	MEDIAN	CONSENT LIMIT
Biochemical Oxygen Demand	mg/L	2	20
Ammoniacal Nitrogen	NH_4- N mg/L	0.54	5
Total Nitrogen	mg/L	7.7	12
Soluble Inorganic Nitrogen	mg/L	6.5	10
Total Suspended Solids	mg/L	13	25
Total Phosphorus	mg/L	0.74	0.9
Dissolved Reactive Phosphorus	mg/L	0.04	0.7
E Coli	MPN/100 mL	1	1000
Faecal Coliforms	CFU/100 mL	1	2000