Capacity Assessment Report

DARGAVILLE WATER TREATMENT PLANT

FOR AWA ENVIRONMENTAL CONSULTANCY

June 21

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1. CONTENTS

2. INTRODUCTION

2.1 Purpose of Report

Awa Environmental Consultancy (Awa) have contracted Apex Environmental Limited (Apex) to review and evaluate the design flow capacity of the Dargaville Water Treatment Plant. The water treatment plant is an asset of the Kaipara District Council but is operated and maintained by Broadspectrum Ltd. Michael Fowlie is the Broadspectrum Treatment Supervisor and main operator of the Dargaville Water Treatment Plant.

The Dargaville Water Treatment Plant is gravity fed from a catchment within the Kaihu Forest approximately 30 kms north of the plant. It services the populations of Dargaville and Baylys Beach, as well as some industrial and commercial users, with approximately 2,880 m^3/d. The treatment plant is a conventional water treatment plant with raw water conditioning, clarification, filtration, chlorine gas disinfection, additional UV disinfection, and treated water storage.

This report focuses on the details and sizing of the individual unit processes and equipment of the plant, as well as the quality of treated water the plant is achieving, in order to evaluate the design capacity of the Dargaville Water Treatment Plant. All major findings of this design analysis and any recommendations are outlined in the report.

2.2 Location

The Dargaville Water Treatment Plant is located approximately at 200 – 210 Hokianga Road, Dargaville. This is around 3 minutes North of the Dargaville Town Centre. Apex Environmental's Engineer visited the Dargaville WTP site on 2 June 2021 to assess the existing plant and gather relevant information from site staff.

Figure 1: Location of Dargaville Water Treatment Plant

Figure 2: Close up of Dargaville Water Treatment Plant

2.3 Background

The Dargaville Water Treatment Plant (WTP) was first constructed in 1964 and the facility was expanded in 1966 to increase capacity. The plant is gravity fed from a catchment area of approximately 1,280 ha of the Kaihu Catchment Streams, which is located 32 km north of the plant. The plant has a consented water intake of 57 L/s and services a population of 4,500 in Dargaville, as well as a population of 230 in Baylys Beach, and several local industrial sites, such as Silver Fern Farms.

The raw water received at the Dargaville Water Treatment Plant is categorised as being low in turbidity and alkalinity, properties which both negatively affect the suspended particles' ability to coagulate and flocculate. Therefore, when raw water arrives at the Dargaville WTP, the addition of 47% alum is made in the slow mixing tanks to give the suspended particles time to coagulate prior to flocculation in the clarifiers. Soda ash is prepared as a 10% batch solution and also added to the mixing tanks to increase the pH and alkalinity of the raw water for optimal coagulation conditions. A 1% batch solution of Polyelectrolyte is finally added to aid in flocculation in the clarifiers.

Figure 3: Alum Batch Tanks

Figure 4: Soda Ash Batch Tank

Figure 5: Polyelectrolyte Storage Area

Following the addition of these chemicals in the mixing tanks, the raw water is equally split between two clarifiers for flocculation. The clarified water overflows into weirs at the top working level of the clarifiers and gravity fed to the filters. The settled sludge blanket is manually drained off and discarded approximately once a month, but in between this time the level is managed by continuously operating bleed valves which are run to waste.

Figure 6: Clarifier 1

There are four rapid sand filters which operate as two sets, each consisting of two filters. The operator completes a manual backwash of these filters every 72 hrs. The turbidity in the filters is monitored to ensure that if it exceeds 0.3 NTU at any time, an automatic backwash is completed.

Figure 7: Two of the four Rapid Sand Filters

The filtered water flows into a clear water tank beneath the plant which feeds either of the two duty/standby UV disinfection units. The water is then chlorinated using chlorine gas and is stored in two reservoirs which provide approximately 27 hrs contact time before the treated water enters the town's reticulation system.

Figure 8: Duty/Standby UV Reactors

Figure 9: Chlorine Storage Room

The Dargaville Water Treatment Plant operator is very passionate about this plant and takes great care and pride in running it. Despite the age of the facilities, the operator's passion for his role is evident in the high quality of the treated water and maintenance of the plant and equipment.

Figure 10: Clarity of water in the clarifiers

Figure 11: Clarity of water in the sand filters

3. TECHNICAL

3.1 Unit Processes

The Dargaville Water Treatment Plant is a conventional water treatment plant designed to treat 4,000 m³/d of raw water to New Zealand Drinking Water Standards (DWSNZ 2005) as depicted in Figure 12.

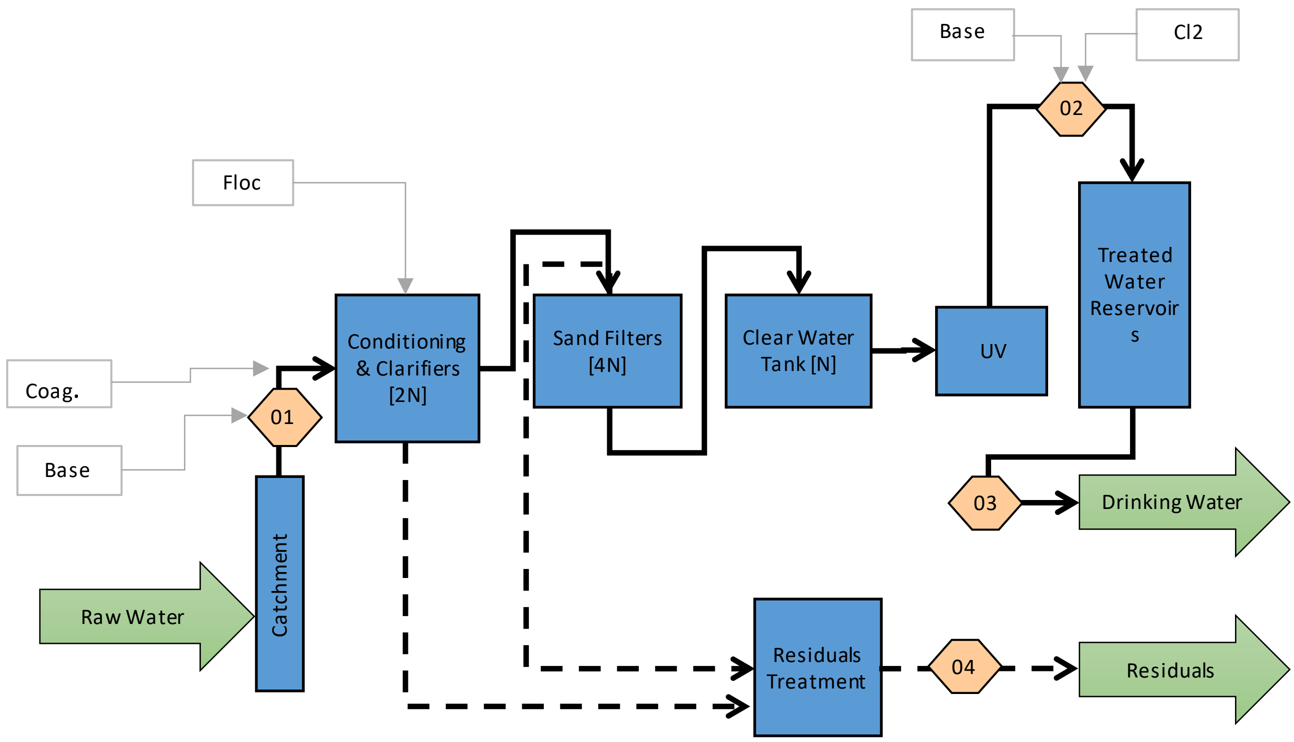


Figure 12: Dargaville WTP Process Sketch

The plant can be broken down into the following six unit processes:

1. Raw Water Conditioning

The raw water conditioning step incorporates the addition of alum, soda ash, and polyelectrolyte in the slow mixing tanks. Soda ash (10%) and polyelectrolyte (1%) are both made up onsite as batch solutions, alum (47%) is dosed at its delivered concentration. Carrier water pumps take a stream from the clearwater tank to deliver to the slow mixing tanks. The chemical dosing pumps inject into the carrier lines to dose the chemicals.

Primary Equipment:

- Slow mixing tanks 1 & 2 – 2x 5 m³ tanks at the end of the building
- Alum dosing pump
- Soda Ash dosing pump
- Polyelectrolyte dosing pump
- Polyelectrolyte batch mixing tanks – 2x 1 m³ tanks inside the building
- Soda Ash mixing tank – 1.5 m³ tank inside the building
- Alum dosing controller
- 3x Carrier water pumps

Figure 13: Alum Dosing Pump

Figure 14: Soda Ash Dosing Pump

Figure 15: Polyelectrolyte Dosing Pump

Figure 16: Chemical Carrier Pumps

Figure 17: Alum Dose Control

2. Clarification

The clarification step takes place in two equal sized square bottom hopper clarifiers. A sludge blanket settles to the bottom leaving a layer of clear water approximately 1.5m deep above it. The clear water is skimmed off the top of the clarifiers via the weirs and travels to the filters.

Primary Equipment:

- Clarifiers 1 & 2 – 2x 276 m³ tanks
- Hach 1720C low range Turbidity Analyser

3. Filtration

The four Candy Ltd rapid sand filters operate as two banks of filters with turbidity constantly monitored. The filtrate flows into the underground clearwater tank. A backwash pump and blower are used to backwash, and air scour the filters when necessary. The dirty backwash flows into a repurposed underground tank.

Primary Equipment:

- Filters 1, 2, 3, & 4 – 4x 46 m³ tanks
- 4x Hach 1720E low range Turbidity Analysers
- 2x Hach SC100 universal controller Turbidity Transmitters
- Backwash Pump
- Blower
- Dirty backwash tank – 1,100 m³
- Clearwater tank – 46 m³

Figure 18: Turbidity Analysers and Transmitters for Filters

4. UV Disinfection

The two UV reactors operate as duty/standby. Each unit is capable of treating 225 m^3 at a UVT of 90.5%. There is a flowmeter upstream of both UV reactors and a feed pump on each UV.

Primary Equipment:

- UV reactors 1 & 2 – 2x Trojan UV Swift SC DO6
- Flowmeter
- RealTech UV254 UVT Analyser
- 2x UV reactor feed pumps

5. Chlorine Gas Disinfection

The chlorine gas can be injected from a 70kg cylinder or a 920kg drum. The gas is injected under vacuum by automatic valves. A carrier water pump takes a stream from the clearwater tank for the gas to be injected into. This super chlorinated water stream is mixed into the main treated water stream before the reservoir. A chlorine gas detection unit in the chlorine storage room monitors for leaks.

Primary Equipment:

- Duty 70kg Chlorine gas cylinder
- Duty 920kg Chlorine gas drum
- 2x Standby 70kg Chlorine gas cylinders
- Chlorinator unit with automatic valves
- Chlorine gas detector unit
- Carrier water pump

6. Storage

The treated water is stored in two reservoirs on site. These are 2,300 m^3 and 3,400 m^3 each, providing a minimum of 27 hrs of chlorine contact time if the plant is operating at full capacity (210 m^3/h). The water leaving the treatment plant is monitored for free available chlorine and pH.

Some properties on the Dargaville reticulation network require booster pumps to receive water from the plant. This includes properties on the upper end of Hokianga Road and the Baylys Beach storage reservoir. There is also a pump onsite for fire water supply.

Primary Equipment:

- Reservoir 1 – 2,300 m^3
- Reservoir 2 – 3,400 m^3
- Grundfos Reticulation booster pump skid
- Fire water pump
- 2x Free Available Chlorine (FAC) and pH analysers

Figure 19: Reticulation Booster Pump Skid

Figure 20: Final FAC and pH Analysers

Figure 21: Treated Water Reservoirs

3.2 Flows and Raw Water Quality

Based on the information provided, the Engineer has assumed a raw water flow of 2,200 to 5,040 m^3/d (at 100 – 210 m^3/h instantaneous flow over 22 -24 h/d) to discharge up to 4,800 m^3 daily.

Table 1 below shows the design flows treated and discharged by the water treatment process.

Table 1: Design Flows

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design
	Raw Water						
1	Raw Water (Daily)	m3/d	2,150	3,100	4,200	5,100	4,200
2	Operation	h/d	17.9	23.8	23.1	23.2	23.1
3	Raw Water (Instantaneous)	m3/h	120	130	182	220	182
4	Raw Water (Instantaneous)	L/s	33	36	51	61	51
	Treated Water						
5	Treated Water Design Flow	m3/d	2,000	3,000	4,000	5,000	4,000
6	Operation	h/d	16.7	23.1	22.0	22.7	22.0
7	Treated Water (Instantaneous)	m3/h	120	130	182	220	182
8	Treated Water (Instantaneous)	L/s	33	36	51	61	51
9	Yield	*%*	*93%*	*97%*	*96%*	*98%*	*96%*
10	Wastewater Flow	m3/d	151	100	200	100	200

A full lab analysis of the current raw water quality entering the treatment plant was not available. The properties shown in Table 2 below are representative of a sample of raw water discussed in the operator's 'C' Grade Assignment on the Dargaville WTP from 1996 and are assumed to still be representative of the current raw water quality.

Table 2: Summary of Raw Water Quality

Ref	Description	Unit	Turndown (Min.)	Ave	Design	Comments
	Raw Water Quality					
1	Turbidity	NTU	1.87	5.7	*6*	DWSNZ: < 2.5 NTU (GV)
2	pH	pH Units		7.5	7.5	DWSNZ: 7-8/8.5 pH (GV)
3	Total Alkalinity	mg/L (as $CaCO_3$)		32	32	
4	Total Hardness	mg/L (as $CaCO_3$)		17	17	DWSNZ: < 200 mg/L (GV) [Taste Threshold 100-300 mg/L]
5	Total Calcium	mg/L		8	8	
6	Total Fluoride	mg/L		0.07	0.07	

3.3 Treated Water Quality

Logs are kept by the operator of plant performance and treated water quality. The treated water quality data which was avaiable for the previous two months are shown in Figures 22-24 below.

Target treatment quality parameters are in line with DWSNZ (2005):

- Target of 1.3 mg/L FAC, but must be greater than 0.3 mg/L and less than 2.0 mg/L
- Target of 0.03 – 0.05 NTU, less than 0.30 NTU
- pH between 7 and 8

The Dargaville Water Treatment Plant is having no issue meeting these target treatment quality parameters at its current average flow of 2,880 m³/d, as seen in the data below.

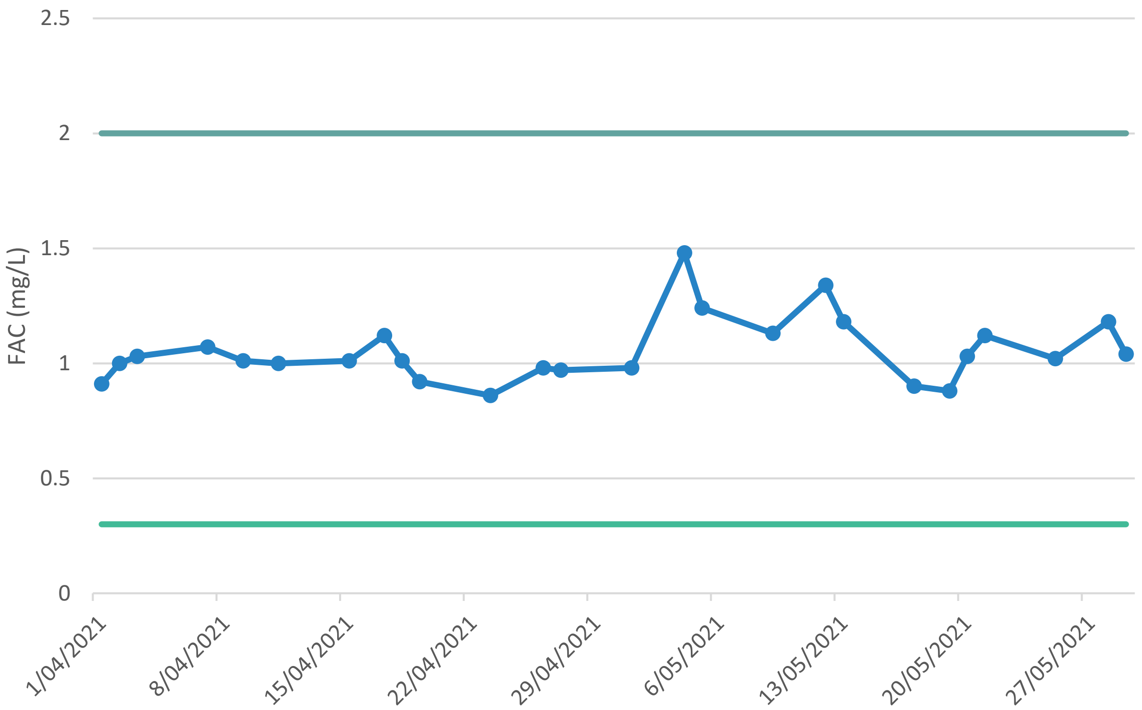


Figure 22: Residual Chlorine of Treated Water from Dargaville WTP

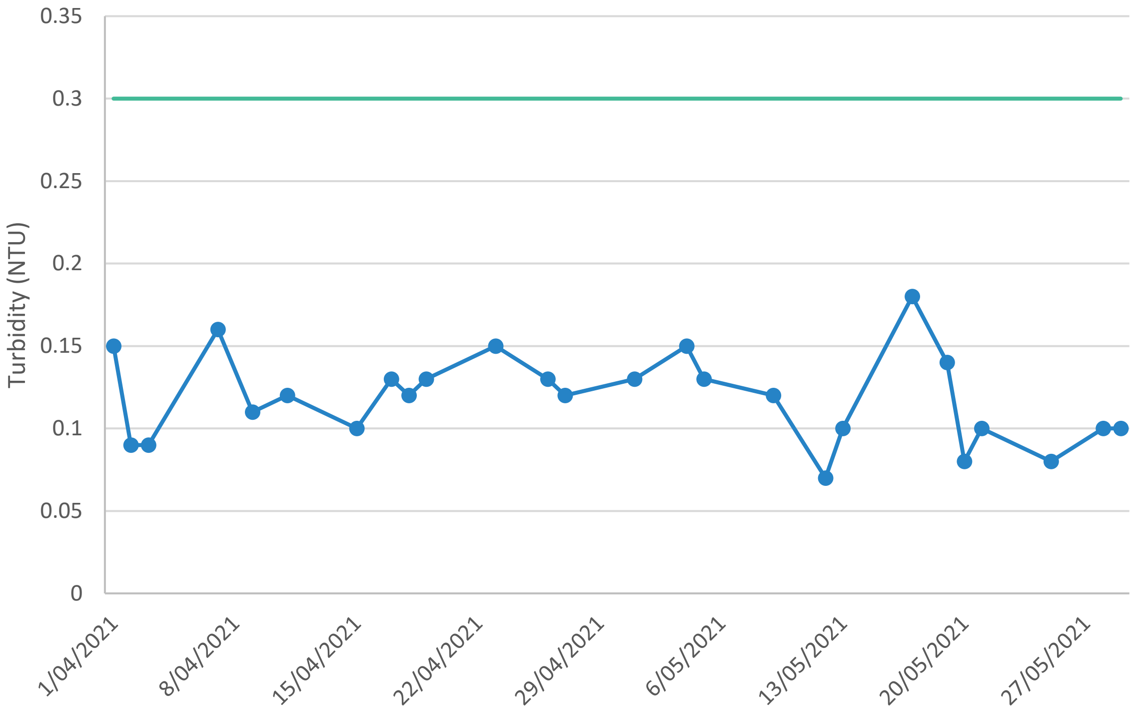


Figure 23: Turbidity of Treated Water from Dargaville WTP

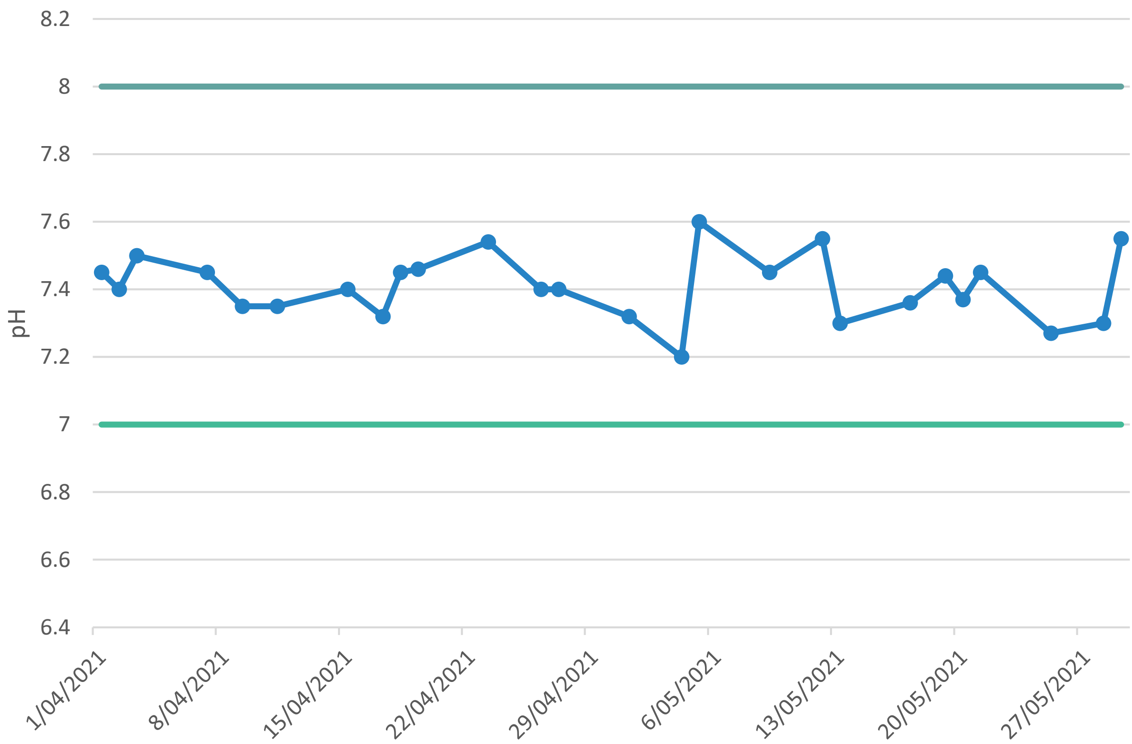


Figure 24: pH of Treated Water from Dargaville WTP

3.4 Process Performance

The Dargaville Water Treatment plant is currently producing high quality drinking water at an average flowrate of 2,000 – 3,000 m³/d. The process consists of six unit processes; Raw Water Conditioning, Clarification, Rapid Sand Filtration, UV Disinfection, Chlorine Gas Disinfection, and Treated Water Storage.

The conventional water treatment process is effective, and the plant is capable of treating up to 4000 m³/d (equivalent to 182 m³/h @ 22 h/d) based on the capacity of the unit processes. As the capacity of the Treated Water Reservoirs is very large (a combined 5,700 m³ of storage), the instantaneous discharge from them to reticulation is also quite large (up to 58 L/s) over a finite period.

The throughput of the plant is currently around 120 m³/h (equivalent to approximately 3,000 m³/d over 24 h/d) which was initially thought to be a restriction imposed on the plant by the size of the inlet pipe diameter (250 mm). However, pipeline sizing calculations have revealed that this pipe should be more than capable of transporting up to 220 m³/h, the equivalent of 5,100 m³/h over 24 h/d (refer to Appendix 6.3 General Line Sizing for calculations).

It has also been concluded that the dosing of chemicals and the respective chemical pipeline sizes is not placing any restrictions on the process. However, both the backwash pump and air scour blower appear to be undersized to properly backwash and air scour the filters.

The maximum consented water take for the Dargaville Water Treatment Plant is 57 L/s, which is the only identified restriction on the plant's processing capacity, limiting it to a maximum of around 5,000 m³/d.

4. LIMITATIONS

This report has been prepared by Apex Environmental (Apex) for Awa Environmental Consultancy (Awa) on behalf of the Kaipara District Council and may only be used and relied on by Awa for the purpose agreed between Apex and the Awa as set out in this report.

The design evaluation completed by Apex Environmental is based on As-Built drawings provided by the Kaipara District Council, information gained from one site visit and discussion with the Dargaville Water Treatment Plant operator, and photographs taken of the plant during the site visit.

Kaipara District Council were able to provide some As-Built drawings of the Unit Processes which have been used to estimate the size and capacity of the Unit Processes.

It is worth noting that Kaipara District Council could not provide any piping and instrumentation diagrams (P&IDs) from after the upgrades to the plant that saw UV disinfection introduced. Due to this, the Engineer's understanding of how the plant operates is largely based on the site visit and discussions with the Water Treatment Plant operator.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report, and on assumptions made by Apex described in this report. Apex has no responsibility or obligation to update this report to account for events or changes occurring after the date that the report was prepared.

5. SUMMARY AND CONCLUSION

Awa Environmental Consultancy (Awa) contracted Apex Environmental Limited (Apex) to review and evaluate the design flow capacity of the Dargaville Water Treatment Plant on behalf of the Kaipara District Council.

Apex's Engineer has calculated the drinking flow capacity of the Dargaville Water Treatment Plant (WTP) to be 4,000 m^3/d (equivalent to 182 m^3/h @ 22 h/d).

The flow capacity of the WTP is not limited by the Unit processes, such as Raw Water Conditioning; Clarifiers; Sand Filters; UV Disinfection or Treated Water Reservoirs. These are all sized to be more than adequate for a flow of 4000 m^3/d and are having no issues producing high quality drinking water at the current flows. As the capacity of the Treated Water Reservoirs is very large (a combined 5,700 m^3 of storage), the instantaneous discharge from them is also quite large (182 m^3/h) over a finite period.

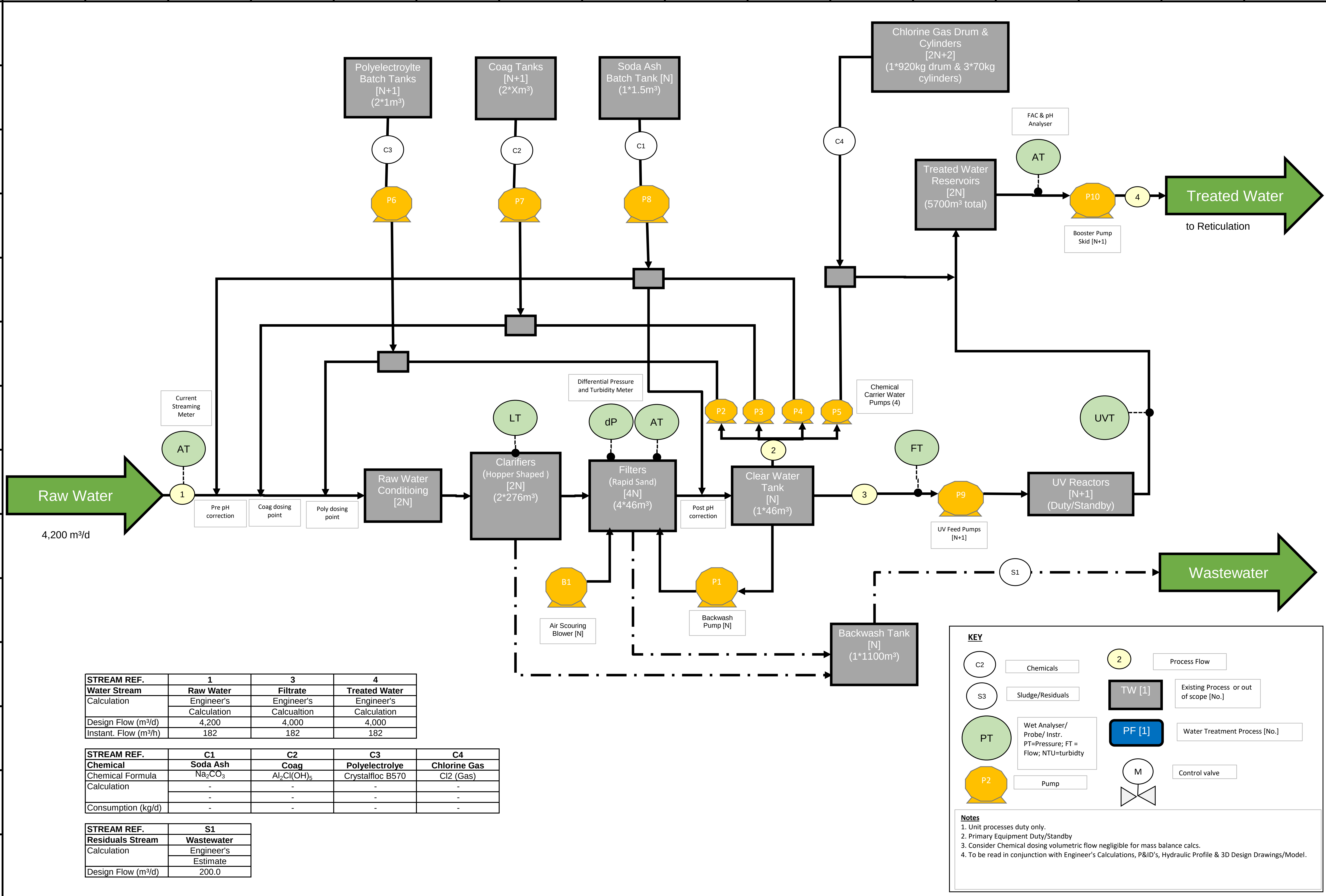
Apex's Engineer has also noted that the throughput of the plant is not restricted by the hydraulics of the plant or the incoming pipeline, although it is currently only producing 2,000 – 3,000 m^3/d. The only limiting factor identified for the plant's processing capacity is the availability of raw water (both flow and pressure). It was also identified that the backwash pump and air scour blower are undersized for backwashing and air scouring the rapid sand filters.

6. APPENDICES

6.1 Process Flow Diagram

6.2 Engineers Calculations

6.3 General Line Sizing



STREAM REF.	1	3	4
Water Stream	Raw Water	Filtrate	Treated Water
Calculation	Engineer's Calculation	Engineer's Calcualtion	Engineer's Calculation
Design Flow (m³/d)	4,200	4,000	4,000
Instant. Flow (m³/h)	182	182	182

STREAM REF.	C1	C2	C3	C4
Chemical	Soda Ash	Coag	Polyelectrolye	Chlorine Gas
Chemical Formula	Na_2CO_3	$Al_2Cl(OH)_5$	Crystalfloc B570	Cl2 (Gas)
Calculation	-	-	-	-
	-	-	-	-
Consumption (kg/d)	-	-	-	-

STREAM REF.	S1
Residuals Stream	Wastewater
Calculation	Engineer's Estimate
Design Flow (m³/d)	200.0

Issue	Description	Engineer (Date)
R0	FIRST ISSUE	T. Wright (11/06/21)

Record of Revisions

APEX ENVIRONMENTAL, Level 2, 19 Sophia Street, Timaru 7910
APEX ENVIRONMENTAL, 48 Stonedon Drive,

APEX ENVIRONMENTAL safe water by design

KAIPARA DISTRICT
Kaipara te Oranganui • Two Oceans Two Harbours

PROJECT
DARGAVILLE WATER TREATMENT PLANT

TITLE
PROCESS FLOW DIAGRAM (WITH FLOW BALANCE)

Engineer	T. Wright	11/06/2021
Checked	T. Board	11/06/2021
DRAWING NUMBER		ISSUE
210507-PFD.001		Draft_1

ENGINEER'S CALCULATIONS

CLIENT	AWA (on behalf of Kaipara DC)	**JOB. NO.**	210507	**PAGE**	1
JOB	Dargaville WTP Capacity Assessment	**ENGINEER**	THOMAS BOARD	**DATE**	25/06/21
SUBJECT	Engineer's Calculations	**CHECKED**	TESSA WRIGHT	**DATE**	25/06/21

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TABLE OF CONTENTS

1.0 DESIGN BASIS

1 Carry out a capacity assessment of Dargaville Water Treatment Plant (WTP)
Broad plan is:
1.1 Site Visit & Information Gathering: Visit the site, to review the plant which is a conventional water plant, based around Raw Water Conditioning; Clarification; Filtration and Clear Water Storage/Pumping with the Residuals returned to the sewer.
1.2 Information Required: Flows and water quality lab data, drawings, unit process sizing and primary equipment details.
1.3 To determine the capacity, I would also need to have a good look at the hydraulics (pipework and pipeline details and levels) and the control and automation (particularly the desludging, backwash/ripening setpoints) to calculate the yield.
1.4 Engineer's Calculations & PFD: Compile an abridged set of Engineer's Calculations to figure out the capacity of the unit processes/pumps/pipes and Process Flow Diagram (with Mass Balance)
1.5 Technical Note: Prepare a technical note detailing our findings.

2 Raw Water Quality: See information provided

3 Compliance with DWSNZ 2005 (Rev. 2008/18). Assume > 6 (To Be Confirmed).Check Fe, Mn, As etc

4 Multidisciplinary (Process, MEICA, Piping), including Civil/Geotec/Structural, Residuals

5 Location: Dargaville Water Treatment Plant, 198 Hokianga Road, Dargaville.

6 Budget: < $5,000 for this work under a standard Short Form Agreement, broken down as follows:
Principal Engineer [CPEng] (3 d x $165/h) + Mileage/lunch (400 kms @ 84c/km + $60, say $400)
+ 3 hour check/review by Dr. Matt Savage (@ $165/h) = $4850+GST.

7 Design Documents

Typical

1 Engineer's Calculations
2 Process Flow Diagram (PFD) with Flow Balance
3 Piping & Instrumentation Diagrams (P&ID's)
4 Engineer's Estimate (CAPEX & OPEX) [+/- 20-30%]
5 Design Statement
6 Hydraulics (including General Line Sizing, Line Loss, Hydraulic Profile, Pump Calcs)
7 Equipment Lists (including Unit porcess, Motors; Valves; Instruments/Analysers)
8 GA, Elevations and 3D Mechanical Drawings
9 Draft Functional Description, Level 1 (FD)
10 Preliminary Civil, Geotech Design

8 Information Required

1 **Flows:** Flow data. Instantaneous and daily
2 **Raw Water Quality**: Raw water quality lab data
3 **Treated Water Quality:** Treated water quality lab data
4 **Residuals**: Waste Discharge Details
5 **Process & Equipment**: Details of existing unit processes & primary equipment details/specs, particularly Reservoir, C
6 **EICA:** Details of existing Electrical, Control & Automation, including Instrument & Wet Analysers details/specs, partic
7 **Resource Consents**: Details of any restrictions/consent requirements particularly around wastewater & stormwater
8 **Drawings**: Existing Drawings, such as site layout, P&IDs, GA, sections, hydraulic profile etc
All existing layout drawings, All underground service drawings etc, Electrical drawings if possible
9 **Survey**: Existing Topo survey
10 **Chemicals:** Chemical inventory, details & preferred supplier
11 **Geotech information:** IL3 Seiemsic Requirement

9 Engineer's Notes

We had a good day yesterday and got most of the information we need. We are a bit short on existing drawings though, but thought to chase Brian Armstrong from Kaipara District Council today to see if he has any.
The typical drinking water demand from the plant is 2000-3000 m3/d, with the design flow of 4000 m3/d and the max capacity at around 4800 m3/d, as per the draft design flow table below.
Even though this plant was built in 1960, it is still running very well producing crystal clear low turbidity, chlorinated drinking water, thanks in part to a very passionate/dedicated operator.
Engineer's Calculations, PFD and abridged report to follow.

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
2.0	**DESIGN CRITERIA**							
2.1	**Design Flows**							
1	Description	Dargaville WTP, a conventional water treatment plant based around Raw Water Conditioning (Coagulation, Flocculation [& pre-pH control]), Clarification Filtration, post pH control, UV disinfection, Chlorine Gas Disinfection, Treated Water Storage followed by drinking water distribution (including a small boosterPS) Design flow is 4,000 m3/day (DW Register 2019) with average flows 2000-3000 m3/d						
	Raw Water							
2	Raw Water (Daily)	m3/d	2,150	3,100	4,200	5,100	4,200	The consented flow is 7
3	Operation	h/d	17.9	23.8	23.1	23.2	23.1	say 23 h/d
4	Raw Water (Instantaneous)	m3/h	120	130	182	220	182	
5	Raw Water (Instantaneous)	L/s	33	36	51	61	51	Maximum Consented v
	Treated Water							
6	Treated Water Design Flow	m3/d	2,000	3,000	4,000	5,000	4,000	Design 4-5 MLD
7	Operation	h/d	16.7	23.1	22.0	22.7	22.0	typ 20 h/d
8	Treated Water (Instantaneous)	m3/h	120	130	182	220	182	
9	Treated Water (Instantaneous)	L/s	33	36	51	61	51	
10	Yield	*%*	*93%*	*97%*	*96%*	*98%*	*96%*	typ. ~93-97% Yield
11	Wastewater Flow	m3/d	151	100	200	100	200	

Notes

Residuals: Constrant drain from the clarifiers (+ weekly manual descudge),
Backwash Sequence (which includes Draindowns, Backwash, Filter to Waste) 1/72 h

2.1.2 Population

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
1	System Population equivalent	pe	7,998	15,000	22,222	25,000	22,222	4,683 (DWO July 2019)
2	Flow/head.d	L/h.d	250	200	180	200	180	
3	Flow	m3/d	2,000	3,000	4,000	5,000	4,000	
4	People/House	No.	2.0	2.5	3.0	3.0	3.0	
5	Properties	No.	3999	6000	7407	8333	7407	

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
2.2	**Raw Water Quality**							
	2.2.1 Lab Data							
(i)	Description							
(ii)	Source Water							
(iii)	Details/Date	-						
(iv)	Temperature	Deg.C						
1	Turbidity	NTU	1.87	5.7			*6*	DWSNZ: < 2.5 NTU (GV
2	pH	pH Units		7.5			7.5	DWSNZ: 7-8/8.5 pH (G\
3	Total Alkalinity	mg/L (as CaCO3)		32			32	
4	Free CO2	mg/L (at 25 Deg.C)						
5	Total Hardness	mg/L (as CaCO3)		17			17	DWSNZ: < 200 mg/L (G
6	Electrical Conductivity	uS/cm						
7	TDS (Approx)	mg/L						DWSNZ: < 1000 (GV) [<
8	Total Suspended Solids	mg/L						
9	Aluminium (Dissolved)	mg/L						DWSNZ: < 0.10 mg/L (G
10	Total Boron	mg/L						
11	Total Calcium	mg/L		8			8	
12	Total Copper	mg/L						DWSNZ: < 1 mg/L (GV)
13	Dissolved Copper	mg/L						
14	Total Iron	mg/L						DWSNZ: < 0.20 mg/L (G
15	Dissolved Iron	mg/L						DWSNZ: < 0.20 mg/L (G
16	Total Magnesium	mg/L						
17	Dissolved Magnesium	mg/L						
18	Total Manganese	mg/L						DWSNZ: < 0.04-0.10 m
19	Dissolved Manganese	mg/L						DWSNZ: < 0.04-0.10 m
20	Total Potassium	mg/L						
21	Dissolved Potassium	mg/L						
22	Total Sodium	mg/L						DWSNZ: < 200 mg/L (G
23	Dissolved Sodium	mg/L						DWSNZ: < 200 mg/L (G
24	Total Zinc	mg/L						DWSNZ: < 1.5 mg/L (G\
25	Zinc (Dissolved)	mg/L						DWSNZ: < 1.5 mg/L (G\
26	Total Fluoride	mg/L		0.07			0.07	
27	Chloride	mg/L						DWSNZ: < 250 mg/L (G
28	Ammonia-N	mg/L						DWSNZ: < 1.5 mg/L (G\
29	Nitrate-N	mg/L						DWSNZ: < 50 mg/L (GV
30	Phophorous, DRP	mg/L						
31	Sulphate	mg/L						DWSNZ: <250 mg/L (G\
32	Arsenic (Dissolved)	mg/L						DWSNZ: < 0.01 mg/L (N
33	Silica (Soluble Reactive)	mg/L						
34	Total Organic Carbon	mg/L						nb. 3 to 4 mg/L conside
35	Dissolved Organic Carbon	mg/L						nb. 3 to 4 mg/L conside
36	UV Absorbance, A254 (Unfiltered -	AU/cm-1						
37	Filtered Transmittance	%T at 254nm						
38	Transmittance	%T at 254nm						
39	Faecal Coliforms	cfu/100mL						Statistically estimated (
40	Total Coliforms	MPN/100mL						
41	E-coli	MPN/100mL						
42	True Colour	CU						DWSNZ: < 10 TCU (GV)
43	Hydrogen Sulphide	mg/L						DWSNZ: < 0.05 mg/L (G
	Taste & Odour Compounds							
44	*Anatoxin-a (Toxin)*	ug/L						
45	*2-Methylisoborneol (2MIB) [Strong*	ng/L						DWSNZ: 'Should be acc
46	*Geosmin (Earthy Taste)*	ng/L						DWSNZ: 'Should be acc
47	Algal Cell Count	cells/mL						

Ref	Description (Determinand)	Unit	DWSNZ		ADWG	Design	Raw Water	Comments
			GV	MAV				
2.3	**Treated Water Quality {Drinking Water Quality}**							
	2.3.1 Drinking Water Standards for New Zealand 2005 (Revised 2008 & 2018)							
	Table 2.1 MAV for Microbial determinands (Pg. 7)							
1	Esherichia coli (Ecoli)	#/100mL	-	< 1		-	-	
2	Viruses	#/100mL	-	N/A		-	-	
3	Total Pathogenic Protozoa	#/100mL	-	< 1		-	-	
4	Thermotolerant Organisms	CFU/100mL			< 1	-	-	
5	Protozoa (Crypto/Gardia)	#/100mL			< 1	-	-	
	Table 2.2 MAV for Inorganic determinands (Pg. 8)						-	
6	Antimony	mg/L	-	0.02		-	-	
7	Arsenic	mg/L	-	0.01		-	-	
8	Bariu,	mg/L	-	0.7		-	-	
9	Boron	mg/L	0.5	1.4		-	-	
10	Bromate	mg/L	-	0.01		-	-	
11	Cadmium	mg/L	-	0.004		-	-	
12	Chlorate	mg/L	-	0.8		-	-	
13	Chlorine, FAC	mg/L	-	5		-	-	
14	Chlorite	mg/L	-	0.8		-	-	
15	Chromium	mg/L	-	0.05		-	-	
16	Copper	mg/L	-	2		-	-	
17	Cyanide	mg/L	-	0.6		-	-	
18	Cyanogen Chloride	mg/L	-	0.4		-	-	
19	Flouride	mg/L	0.7-1.0	1.5		-	-	
20	Lead	mg/L	-	0.01		-	-	
21	Manganese	mg/L	0.04-0.1	0.4	0.05	-	-	
22	Mercury, inorganic	mg/L	-	0.007		-	-	
23	Molybdenum	mg/L	-	0.07		-	-	
24	MonoChloroamine	mg/L	-	3		-	-	
25	Nickel	mg/L	-	0.08		-	-	
26	Nitrate	mg/L	-	50	5/10	-	-	
27	Nitrite	mg/L	0.2	3		-	-	
28	Selenium	mg/L	-	0.01		-	-	
29	Uranium	mg/L	-	0.02		-	-	

Ref	Description	Unit	DWSNZ		ADWG	Design	Raw	Comments
			GV	MAV		TW	Water	
	Table 2.5 GV for Aesthetic determinands (Pg. 11)							
26	Aluminium	mg/L	0.1	-	0.1-0.2	-	-	
27	Ammonia	mg/L	1.5	-	-	-	-	
28	Calcium	mg/L	;ee Hardness		-	-	-	
29	Chloride	mg/L	250	-	-	-	-	
30	**Chlorine**	mg/L	0.6-1	5	-	0.9	-	FAC 0.2-1.0 mg/L (0.8 r
31	2-Chlorophenol	mg/L	0.0001	0.01	-	-	-	
32	Colour	TCU	10	-	2/5 PCU	-	-	
33	Copper	mg/L	1		-	-	-	
34	1,2-dichlorobenzene	mg/L	0.001-0.002	1.5	-	-	-	
35	1,4-dichlorobenzene	mg/L	).0003-0.00	0.4	-	-	-	
36	2,4-dichlorobenzene	mg/L	0.0003-0.04	-	-	-	-	
37	Ethylbenzene	mg/L	0.002-0.08	0.3	-	-	-	
38	**Total Hardness [Ca+Mg]**	mg/L (as CaCC	100-200	-	150-200		-	
39	Total Alkalinity	mg/L (as CaCO3)				-	-	
40	Hydrogen Sulphide	mg/L	0.05	-	-	-	-	
41	**Iron**	mg/L	0.2	-	0.3	0.1-0.2	-	
42	Magnesium	mg/L	See Hardness		-	-	-	
43	**Manganese**	mg/L	0.04-0.1	0.4	5 (0.05 desi	0.02	-	
44	MonoChlorobenzene	mg/L	0.01	-	-	-	-	
45	**pH**	pH Units	7-8 (8.5)	-	7.4-8.3 (6.5-8.5)		-	
46	Sodium	mg/L	200	-	-	-	-	
47	Styrene	mg/L	0.004	0.03	-	-	-	
48	Sulphate	mg/L	250	-	-	-	-	
49	Taste	-	Acceptable		-	-	-	
50	Temperature	Deg.C	Acceptable, Preferably		-	< 25	-	
51	Toluene	mg/L	0.03-0.04	0.8	-	-	-	
52	**Total Dissolved Solids**	mg/L	1000	-	800	-	-	
53	1,2,3 Trichlorobenzene	mg/L	0.01	-	-	-	-	
54	1,2,4 Trichlorobenzene	mg/L	0.005	-	-	-	-	
55	1,3,5 Trichlorobenzene	mg/L	0.05	-	-	-	-	
56	2,4,6 Trichlorophenol	mg/L	0.002	-	-	-	-	
57	**Turbidity**	NTU	2.5	-	0.5/1	0.05	-	
58	Xylene	mg/L	0.02	0.6	-	-	-	
59	Zinc	mg/L	1.5-3	-	-	-	-	
60	THM	mg/L	-	-	0.05-0.1	-	-	
61	Corrosivity (Langelier Saturation Ir	-	-	-	0 +/- 0.5	-	-	
62	Silica	mg/L (as Si)	-	-	20-30	-	-	
63	Dissolved Organic Carbon	mg/L	-	-	-	-	-	
	Taste & Odour & Toxins							
1	*Anatoxin-a*	ug/L	< 0.1	< 0.1	3.0	3.0		
2	*2-Methylisoborneol (2MIB)*	ng/L	< 0.1	< 0.1	5.0	5.0		
3	*Geosmin*	ng/L	< 0.1	< 0.1	5.0	5.0		

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments

2.4 Other Requirements

2.4.1 Residuals Requirements
2.4.2 Noise Requirements
2.4.3 Other Requirements

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
1	Yield (Typical Conditions)	%						typ. 85-96%, as Calcula
2	Yield (Adverse Conditions)	%						As Calculated
3	Noise (by Day)	dBA						Target level at boundar
4	Noise (by Night)	dBA						
5	Chemical Usage	L/kg/a						Rough Estimate
6	Power Usage	kWh/a						Rough Estimate
7	Odour	Typically only applicable to wastewater plants						
8	Vectors	Flies and similar vectors are typically only relevent to wastewater plants, specfiically attachec						
9	Vermin	Not detailed						
10	Security	Security Fence						
11	Vehicle Movements	Not detailed						
12	Grafitti	Not detailed						

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
2.5	**Process Performance**							
	<u>Flows & Yields</u>							
1	Raw Water Feed Flow	m3/d						
2	Treated Water Flow	m3/d						
3	Instantaneous Flow	m3/h						
4	Yield	%						
	<u>Treated Water Quality</u>							
	Standard Suite of Determinands for NZDWS, with the following from onsite or handheld analysers							
1	*Turbidity*	NTU						
2	*pH*	pH Units			6.5 - 8.0			Future 6.5-8
3	*UVT*	%						
5	*FAC*	mg/L						Typically 0.9mg/L
6	*Total Iron*	mg/L						Design for NZDWS (or
7	*Total Mn*	mg/L						Design for NZDWS (or
8	*Esherichia coli (Ecoli)*	#						Assume UV Disinfectio

<u>Treated Water Quality</u>

The WTP product water shall meet the compliance criteria of the Drinking Water Standards of New Zealand (2005 revised 2018) for all design flows as follows;

- Bacterial Compliance Criterion 2A for continuously monitored chlorine disinfected water
- Protozoal Compliance 4 log removal credits

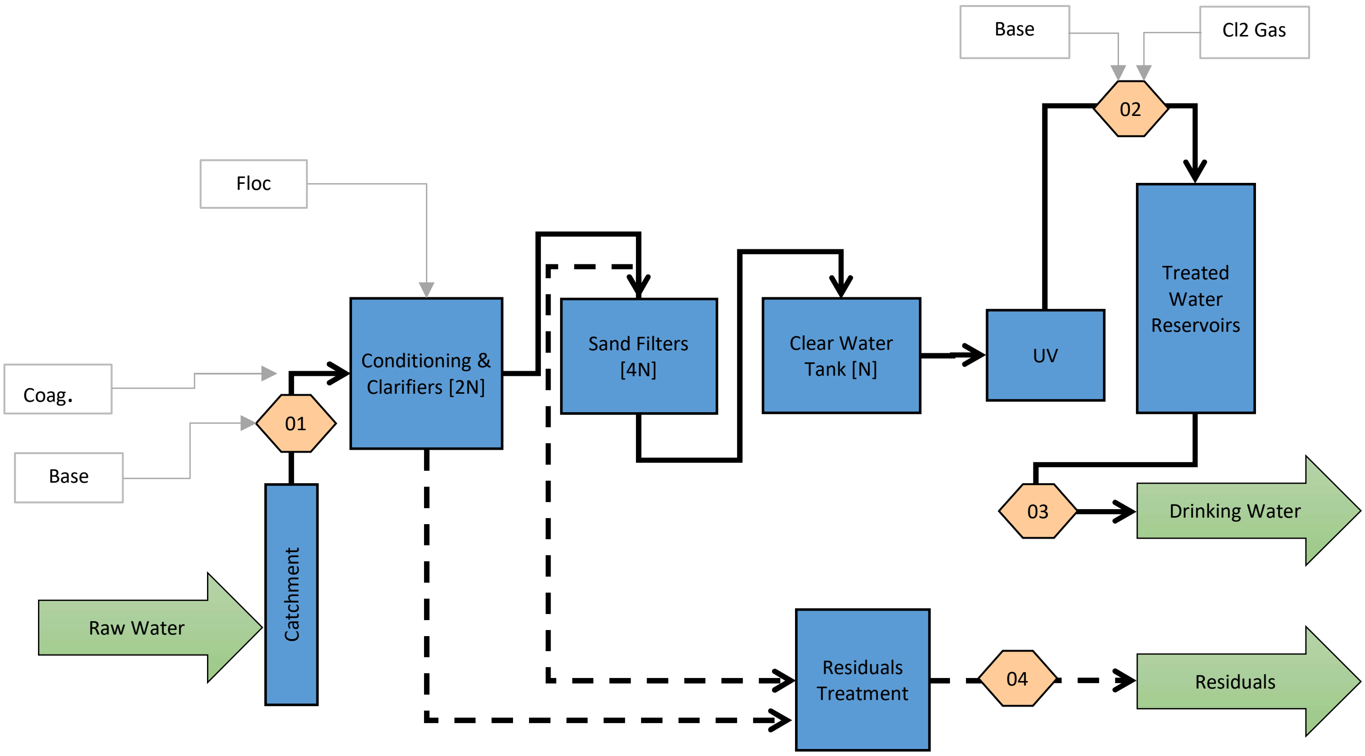
The water quality standards associated with the above compliance criteria in the Drinking Water Standards of New Zealand shall be met, and shall meet the minimum water quality criteria outlined in Table 9

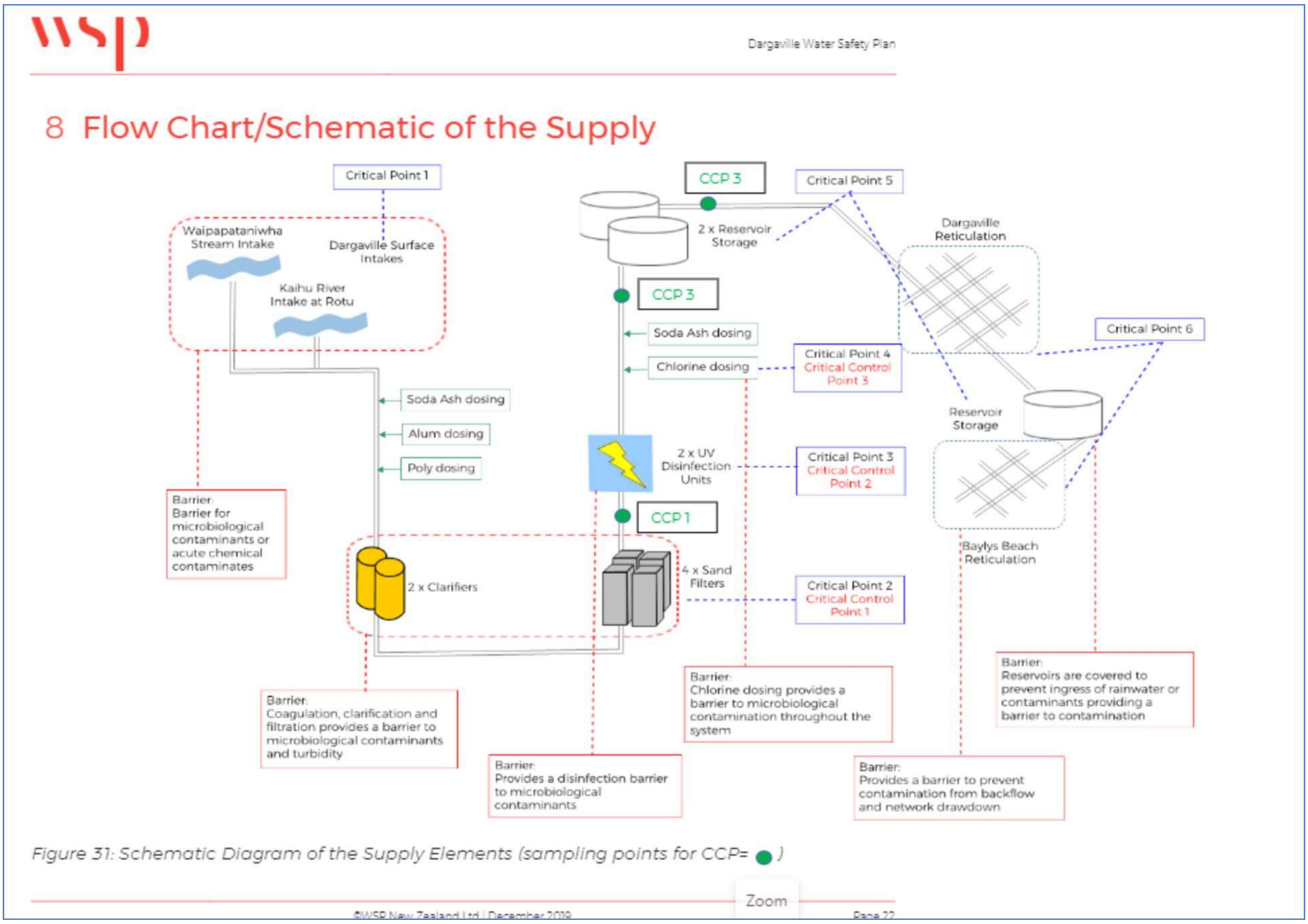
The protozoal compliance shall be achieved using filters or filters and UV or membrane.

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments

3.1 Process Sketch

3.1.1 Process Sketch



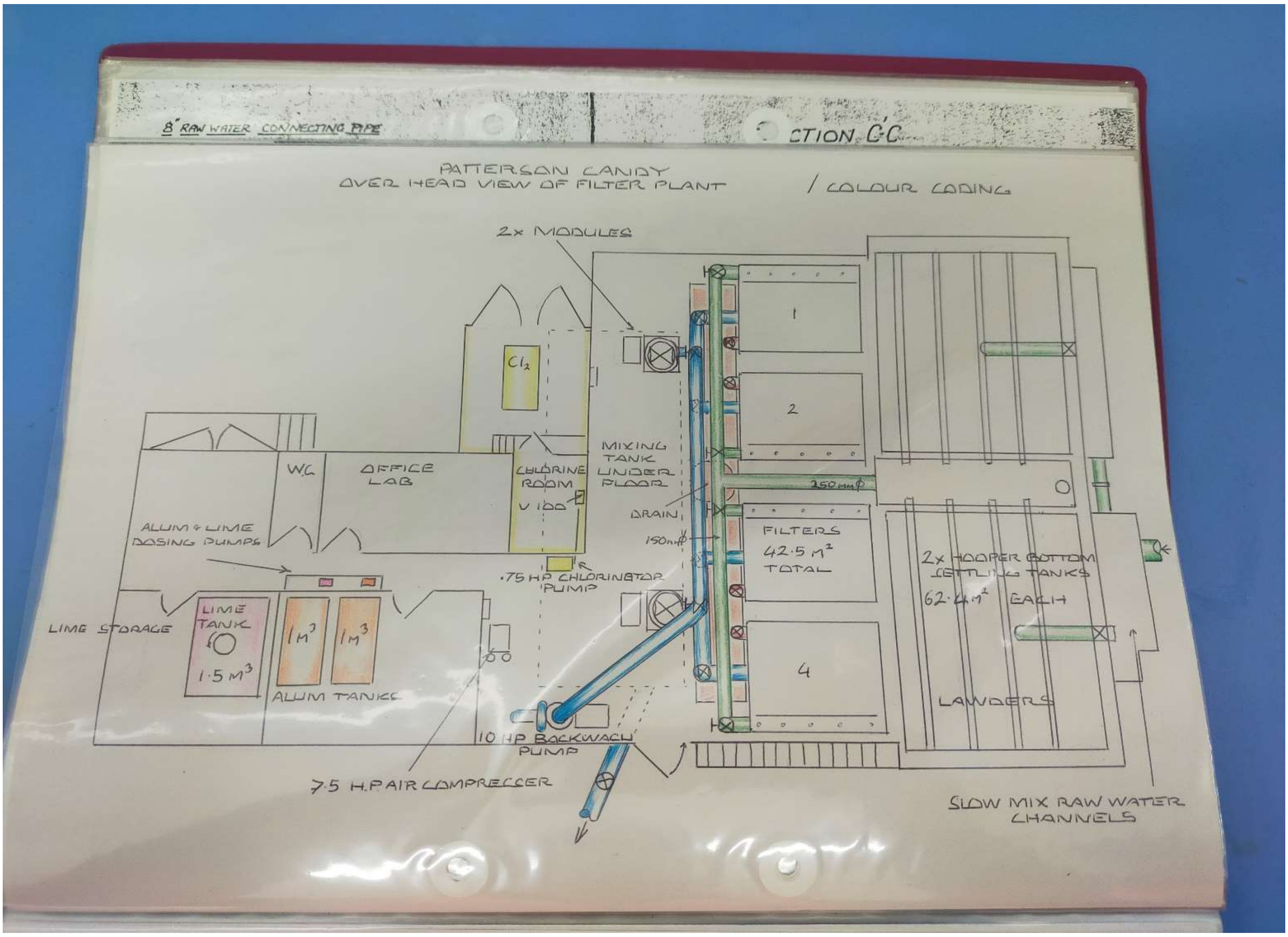


Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments

3.3 Water Treatment Process

3.3.1 Raw Water Feed

Description: Gravity fed at 120 m3/h (2280 m3/d over 24 h/d) from 1282 Ha catchment, located 30 kms north of Dargaville, through a 250mm diameter concrete lined steel pipe.

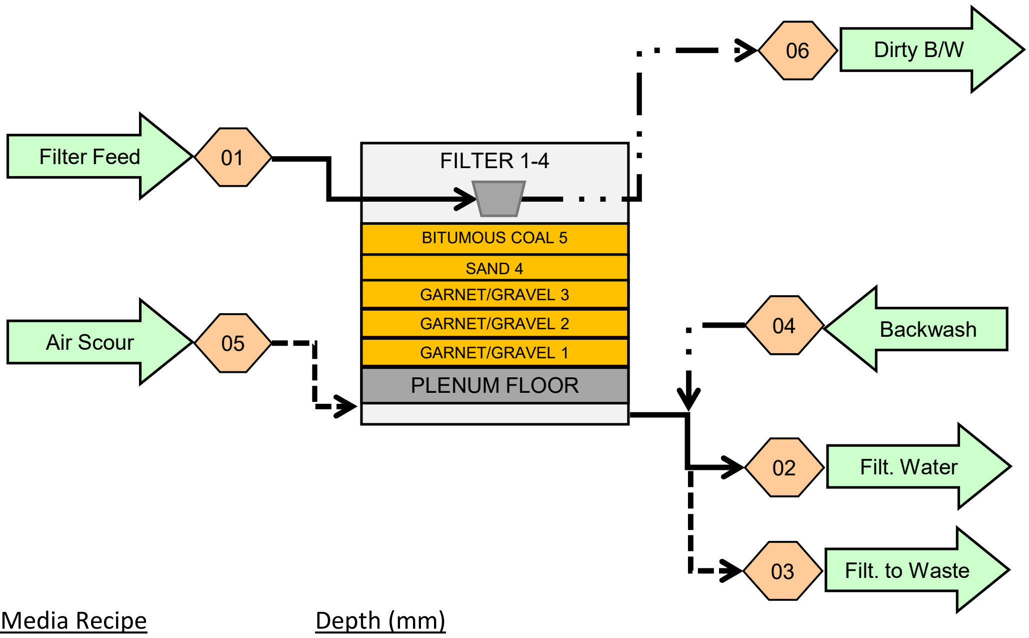


Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	3.3.2 Raw Water Conditioning							
1	Description	Rapid mix with a coagulant (Alum or PACl) through a tapping band, ~ 50m upsteam of the 2 slow mix (configured in parrallel)						
		Slow Mix Tanks [2N]						
2	Total Design Flow	m3/d	2,150	3,100	4,200	5,100	4,200	Design for 3720 m3/d
3	Operation	h/d	18	24	23	23	23	
4	Total Instant Flow	m3/h	120	130	182	220	182	360m3/h per DAF
5	Design Flow/Train	m3/d	1075	1550	2100	2550	2100	
6	Type	*Concrete open top slow mix tanks, upstream of the clarifiers*						
7	No. of Tanks	No.	2	2	2	2	2	
8	Design HRT	mins.						Design for 6 mins (Dela
9	Working Volume Required	m3						
10	Diameter	m						A = PI()*d^2/4
11	Total Tank Height	m						Cross checked with Hy
12	Freeboard	m						Typical 200mm-500m
13	Height (to TWL)	m						Cross checked with Hy
14	Working Volume	m3						Working
15	Hydraulic Retention Time	mins.						Set HRT to 6 mins for D
16	Photos							

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	3.3.3 Clarifiers							
1	Description	Clarification is the process of seperting solids from the liquid stream. Conventional clarification typically refers to Raw Water Conditioning (see above), which refers to Chemical addition/conditioning, rapid mixign, flocculation and sedimentation. Clarifiers (sedimentation tanks) are designed to promote the seperation of solids from liquids. These 2 x 62.4 m2 hopper bottom settling tanks, do not have scraper mechanisms, with conditioned raw water flowing up through the sludge/floc blanket into 8 launders. Solids are continuously removed via bleed lines, and manually desludged (typ 1/7 days)						
1	Total Design Flow	m3/d	2,150	3,100	4,200	5,100	4,200	Design for 3720 m3/d
2	Operation	h/d	18	24	23	23	23	
3	Total Instant Flow	m3/h	120	130	182	220	182	360m3/h per DAF
		L/s	33	36	51	61	51	
4	Design Flow/Train	m3/d	1075	1550	2100	2550	2100	
		m3/h	60	65	91	110	91	
5	Type	*2 x 62.4 m2 hopper bottom settling tanks (Concrete open top)*						
6	No. of Tanks	No.	2	2	2	2	2	
7	Total Plan Area/clarifier	m2	62.4	62.4	62.4	62.4	62.4	
8	Depth (effective)	m	3.5	3.5	3.5	3.5	3.5	Rough Estimate
9	Volume/Clarifier	m3	218.4	218.4	218.4	218.4	218.4	Rough Estimate
10	Actual Rise Rate	m/h	0.96	1.04	1.46	1.76	1.46	Conventional 1.5-2.5 m
11	Design HRT	h	3.6	3.4	2.4	2.0	2.4	Typ. 1.5-2 h
12	Photos							

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	3.3.4 Filters							
1	Description		Rapid Gravity Filters, Multi-media, rectangular, open top for turbidity/suspended solids removal. Pre-treatment Raw Water Conditoning with PACl (or similar) Typical Filtration Rate: 5-10 m/h					
2	Type		Constant rate with varying water levels and influent flow splitting					
3	Design Flow	m3/h	120.0	130.0	182.0	220.0	182.0	
4	Number of Filter Tank(s)	No.	4	4	4	4	4	Square Gravity Filters F
5	Tank Diameter	m						
6	Vessel Length/Height	m						
7	Tank Area/filter	m2	10.63	10.63	10.63	10.63	10.63	Engineers Assumption
8	Total Area	m2	42.5	42.5	42.5	42.5	42.5	
9	Filtration Rate	m/h	2.8	3.1	4.3	5.2	4.3	Typ. < 10 m3/m2.h (5-1
10	Media Volume	m^3						
	Filter Media Recipe							
	Anthacite	ton						
	Filter Sand	ton						
	V. Fine Garnet	ton						
	Fine Garnet	ton						
	Coarse Garnet	ton						
	Sub-Total	ton	0	0	0	0	0	

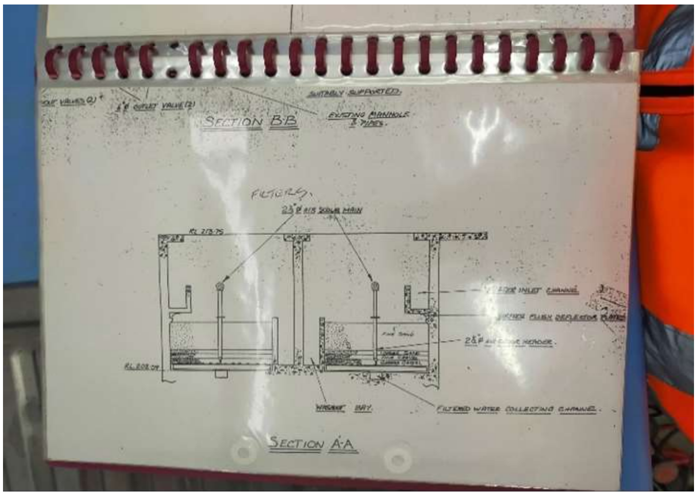
PFD Sketch - Filtration



Filter Media Recipe	Depth (mm)	
Layer 1 (Top)	400	Anthacite [> 1450 kg/m3 particle density], Effective Size [D10 (mm)] = 1.2 , Unifo
Layer 2	600	Filter Sand [> 300 mm, UC < 1.4], [typical density 1560 kg/m3 particle density], E
		Preferred sand media: 18/36 Filter Sand (0.8 to 0.4 mm, < 1.4 Uniformity Coefficie
Layer 3 (Bottom)	50	V. Fine Garnet [> 2500 kg/m3 particle density]. Effective Size [D10 (mm)] = 1-3
Layer 4 (Bottom)	50	Fine Garnet. Effective Size [D10 (mm)] = 3-6
Layer 5 (Bottom)	100	Coarse Garnet. Effective Size [D10 (mm)] = 6-12
Depth:Effective Size	**1200**	L/d10 (filter coal) + L/d10 (sand) + Garnet >= 1200

Ref	Backwash & Airscour Rates	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
1	Backwash Rate	m3/m2.h	25.0	30.0	48.0	48.0	18.8	Set by Eng. (range 48-7
2	Backwash Flow	m3/h	266	319	510	510	200	
3	Air Scour Rate	m3/m2.h	40.0	47.1	54.0	54.0	47.1	Set by Eng. (range 54-9
4	Air Scour Flow	Nm3/hr	425	500	574	574	500	

Ref	Description	Unit	Turndown (Min.)	Ave	Max	Future	Design	Comments
	Headloss Calcs							
1	Clean bed headloss @ 2.85 MLD	mm	400	500	825	800	800	Typically 500mm-825m
2	Rate of headloss development *1	mm/h	45	55	60	60	60	Typically 60mm/h-45m
3	Total estimated headloss after 24	mm	1480	1820	2265	2240	2240	Typically 1950mm-190
	Rough Filter Dimensions							
4	Total Tank Height	m						
5	Freeboard	m						
6	Top of Media to O/F	m						
7	Media Depth	m						
8	GL to Plenum Floor	m						
	Filter Nozzles							
9	Nozzle Spacing	mm	151 [18 No.] & 152 mm [24 No/]					Typically < 180
10	Min. Nozzle Wall Clearance	mm	< 100	< 100	< 100	< 100	< 100	nozzle closest to the w
11	Nozzles Rate	Nozzle/m2	43	43	43	43	43	Typically 19-30 nozzle/
12	Nozzle Notes	Filter nozzle density be increased to 43 No./m2improve backwash/air scour distribution, reduce pressure drop and extend filtration before backwash.						
13	Nozzles/Filter	No/filter	457	457	457	457	457	
14	Total Nozzles	No.	1828	1828	1828	1828	1828	
15	Nozzles to order (+ spares)	No.	-	-	1,901	1,901	1,901	assume 2-4% spares
16	Nozzle Type	ALTEK Industries 'D' Nozzle, Type D-36x0.3-M24-45-200-s or similar With the expanding dowel the filter nozzle is Type DSP8/28-36x0.3-50-200-s plus DG50/28x2 EPDM washer.						
17	Nozzle cap slot size	mm	0.30	0.30	0.30	0.30	0.30	NB. Specified filter san
18	Filter Floor Plate Thickness	mm	Assume 8 to 28 mm					
19	Photos							



Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	3.3.5 <u>UV Disinfection</u>							
1	Description	Filtrate passes through a fully automated UV reactor (2 No [N+1]) with a variable UV dose. A UVT analyser will monitor UV transmissivity for compliance.						
2	Client & Legislative Requirements	System Design will exceed the requirements of 3/4 log credits, by providing 5 Log credits, upto 2 for the Cartridge filters and 3 (perhaps future 4) for UV disinfection, In light of the recent Havlock North Report, we have included multiple barriers to future proof this plant for future compliance requirements. Critical spares (Lamps [2], Sleeves [2], Sensor [1] & ballast [1] to be held on-site						
3	Design Flow	m3/h	120	130	182	220	182	
4	Number of Units	No.	1	1	1	1	1	
5	Configuration	No.	2 No. (1 duty, 1 standby)					
6	Flow Per Unit	m3/h	120.0	130.0	182.0	220.0	182.0	
7	Protozoa Reduction	Log	> 3	> 3	> 3	> 3/4	> 3	to provide bacterial co
8	Design UV Transmittance	%/1 cm	97%	95%	92%	95%	95%	
9	UV Unit	type	Trojan DO6 UV Rector for 354 m3/h (@ 97% UVT); 334 m3/h (@ 95% UVT); 255 m					
10	Acceptable Flow/unit	m3/h	354	334	255	255	**334**	Typical sizing:
11	UV Dose	mJ/cm2	> 97	> 95	> 92	> 92	> 95	
12	Type	EQUIPMENT DETAILSTrojanUVSwift™SC D03▪ Delivered dose is validated - TrojanUVSwiftSC - D03 E						
13	Features	Auto-wiper. Limit starts to < 4 times/day. The UV units can stay energised for 30 mins to 1 hour, without water flowing through the unit Communication. Our preferred protocol is Ethernet IP, with Modbus TCP as an alternative.						
14	Material	-	316L SS					
15	Lamp Power	kW	2	2	2	2	2	
16	Trojan Sizing Information							

Trojan DO3 UV Rector for 155 m3/h (@ 97% UVT)
Trojan DO6 UV Rector for 354 m3/h (@ 97% UVT); 334 m3/h (@ 95% UVT); 255 m3/h (@ 92% UVT)
Trojan DO12 UV Rector for 690 m3/h (@ 97% UVT); 600 m3/h (@ 95% UVT)
Trojan DO18 UV Rector for 942 m3/h (@ 94% UVT); 853 m3/h (@ 93% UVT); 778 m3/h (@ 92% UVT)

UVT	%	92%	93%	94%	95%	97%	B	S
DO3	m3/h	*100*	*110*	*122*	*140*	155	20-25	35-40
DO6	m3/h	**255**	*280*	*309*	334	354	35	45
DO12	m3/h	541	*593*	*622*	*645*	690	54	70
DO18	m3/h	778	853	942	*950*	*1050*	73	95

17 Photos

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
3.3.6	Treated Water Storage							
1	Description	Two (2) Large Concrete Circular Reservoirs. Reservoir 1 (2300 m3) & Reservoir 2 (3400)						
		Typically Treated Water Tank (x m3, with 30 mins HRT allowing for Baffling factor)						
1	Treated Water (Daily)	m3/d	2000	3000	4000	5000	4000	
2	Operation	h/d	17	23	22	23	22	
3	Treated Water (Instantaneous)	m3/h	120	130	182	220	182	
		L/s	33	36	51	61	51	
4	Type	*Cylindrical closed top, coated steel Tank (to AS/NZ)*						
		Capacity 1,000,000 L Diameter 14.516m, Height (to TWL) 6.144m).						
		(Reliant Permastore Tanks & Silos)						
		Consider IL3 Siesmic/Earthquake Rating & Baffling factor						
5	No. of Tanks	No.	2	2	2	2	2	
6	Required Working Volume	m3	2300	3400	5700	5700	5700	1000 m3 min
7	Diameter	m						A = PI()*d^2/4
8	LxW	m2						
9	Total Tank Height	m						Cross checked with Hyc
10	Freeboard	m						200mm-500mm Typica
11	Height (to TWL)	m						Cross checked with Hyc
12	Calculated Working Volume	m3						93.5 m3 existing
13	Check	-						
14	Total Tank Volume	m3	2300	3400	5700	5700	5700	Assume 80%-90% full
15	Hydraulic Retention Time	mins.	1150.0	1569.2	1879.1	1554.5	1879.1	HRT (h) = Vol (m3)/ Flo
16	Hydraulic Retention Time	h	19.2	26.2	31.3	25.9	31.3	
17	Theoretical Detention Time, TDT	mins.	1150	1569	1879	1555	1879	TDT=V/Q
18	Baffling Factor, BF	-	0.70	0.50	0.30	0.5	0.5	BF of 0.15 used for Sed
19	Contact Time, T	mins.	805.0	784.6	563.7	777.3	939.6	T (> 5-30 mins)= TDT x I
20	Contact Time, T	h	13.4	13.1	9.4	13.0	15.7	
21	FAC Dose	mg/L	0.8	0.8	0.8	0.8	0.8	
22	CT Value	mg.min/L	644.0	627.7	450.99	621.8	751.6	> 3.3 to 8 mg.min/L (Ne
23	Low Level Setpoint	%	10%	10%	10%	10%	10%	
24	Typical Photos & Figure							

Table 15.2: Baffle factors for use in measuring detention time

Baffle condition	Baffle factor	Baffle description
Unbaffled (mixed flow)	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet flow velocities.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffles.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intrabasin baffles, outlet weir or perforated launders.
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet, and intra-basin baffles.

Figure 15.1: Baffle characteristics of a pipe and tank

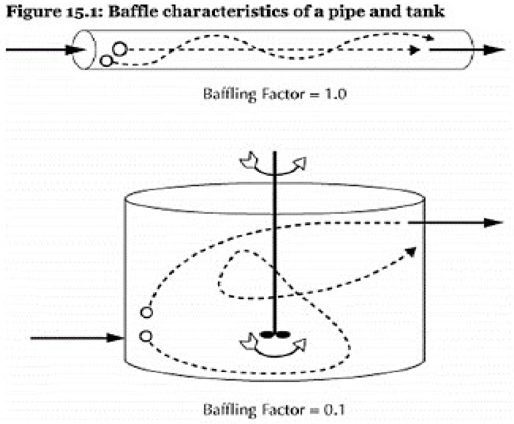


Table 15.5: Chlorine C.t values for 99 percent inactivation (2 logs)

Micro-organism	C.t values	Conditions
Bacteria	0.08 mg.min/L	1–2°C; pH 7
	3.3 mg.min/L	1–2°C; pH 8.5
Viruses	12 mg.min/L	0–5°C; pH 7–7.5
	8 mg.min/L	10°C; pH 7–7.5
Giardia	230 mg.min/L	0.5°C; pH 7–7.5
	100 mg.min/L	10°C; pH 7–7.5
Cryptosporidium	Not inactivated	

Ex WHO 2004.

Ref	Description	Unit	Turndown (Min.)	Ave	Max	Future	Design	Comments
	3.3.7 Residuals (Wastewater) Management							
	A.1 Residuals Sump							
1	Description	An old 1100 m3 enclosed concrete reservoir has been retrofitte into a dirty backwash buffer tank						
2	Design Flow	m3/d	151	100	200	100	200	
		m3/h	266	319	510	510	200	Dirty B/W Flow
3	Type	-	Concrete underground tank					
4	No. of Tanks	No.	1	1	1	1	1	
5	Required Working Volume	m3						
6	Diameter	m						
7	Total Tank Height	m						
8	Freeboard	m						
9	Height (to TWL)	m						
10	Calculated Working Volume	m3	1100.0	1100.0	1100.0	1100.0	1100.0	
11	Total Tank Volume	m3	-	-	-	-	-	
12	Hydraulic Retention Time	h	175.4	264.0	132.0	264.0	132.0	Typically for 2 hours
		mins	248.5	207.1	129.4	129.4	330.0	
13	Typical Photos & Figure							

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments

3.4 Anscillary Processes

3.4.1 Service Water (Emergency Shower/Eyewash; Site Hoses; Toilet/WH Basin etc)

A Safety Shower/Eye Wash [1]

B Hose [1]

C Lab. Sink & Bench [1]

3.4.2 Fixtures & Fittings

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments

4.0 CHEMICALS (Delivered By Tanker, IBC or 200L Drum or 20L Container [Chlorine Gas delivered as 1 ton drum or 70-10

4.1 C1 Alum (Coagulant)

4.2 C2 Polymer (Flocculant) [or PACl]

4.3 C3 Soda Ash (pH Control)

4.4 C4 Chlorine Gas (Disinfection) [1]

4.5 - Chemical Safety & HSNO (including Chlorine Gas Safety, as required)

- 4.2.1 Chemical Delivery Apron
- 4.2.2 Windsock [1 No.]
- 4.2.3 Chlorine Room Heater [1 No.]
- 4.2.4 Chlorine Gas Detection [1 No.] (Sensor, Flasher & Hooter)
- 4.2.5 Automatic shut-off system (West Water [Australia] or Chem Feed
- 4.2.6 Extractor Fan [1 No.]

Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
4.1	**C1 Coagulant (Polyaluminium Chloride, PACl {Trade Name "LIQUIPAC") [N+1]**							
1	Description	*Coagulant is dosed to destabilise colloidal material in the raw water, so that it forms larger particulates which can be removed by flotation*						
		Coagulant is also added to aid the agglomeration of fine floc such that removal by the Settlers is ensured.						
		A basic jar test was carried out by Ixom (chemical supplier)						
2	Raw Water (Daily)	m3/d	2150	3100	4200	5100	4200	nb. Effective Coagulatio
3	Operation	h/d	18	24	23	23	23	
4	Raw Water (Instantaneous)	m3/h	120.0	130.0	182.0	220.0	182.0	We carried out some Ja
		L/s	33	36	51	61	51	
5	Dose Rate (based on 100%)	mg/L	10	15	20	20	15	The best results came v
6	Quantity required (based on 100%	kg/d	22	47	84	102	63	use 20-40 mg/L, but us
7	Commercial Concentration	w/w	50	40	30	30	40	PACl SDS: Clear Liquid,
8	Specific Gravity	-	1.2	1.2	1.2	1.2	1.2	
9	Quantity of Commercial Chemical	kg/d	43	116	280	340	158	
10	Flowrate of Commercial Chemical	L/d	35.8	96.9	233.3	283.3	131.3	
11	Contingency	%	2%	0%	2%	2%	2%	
12	Expected Commercial Flowrate	L/d	37	97	238	289	134	
		L/h	2.0	4.1	10.3	12.5	5.8	
13	Water Stream ACH Consumption	L/a	13341	35359	86870	105485	48864	
14	Guaranteed	L/a	15000	39000	96000	117000	54000	Add another 10 contin
15	Raw Water pH	-	7.5	7.5	7.5	7.5	7.5	
	<u>Dosing Pumps [N+Box]</u>							
16	Number of Duty Dosing Pumps	No.	1	1	1	1	1	1 duty
17	Number of Standby Dosing Pumps	No.	0	0	0	0	0	1 Standby
18	Total number of Dosing Pumps	No.	1	1	1	1	1	
19	Flowrate required per pump	L/h	2.0	4.1	10.3	12.5	5.8	
20	Selected Capacity of pump	L/h	30.0	30.0	30.0	30.0	30.0	Duty Point 30 L/h, 7 ba
21	Preliminary head required	bar	7	7	7	7	7	
22	Commercial Concentration (w/v)	w/v	50%	40%	30%	30%	40%	
	<u>Storage Tank</u>							
23	Principal's Requirements	The Contractor shall confirm that all chemicals required shall be commercially available and i						
24	Total Design Flowrate	L/d	37	97	238	289	134	
25	Total Max. Flowrate	L/h	30.0	30.0	30.0	30.0	30.0	
26	Storage volume required	L	1097	2906	7140	8670	4016	
27	Type of Storage Tank		PE Tank [OR Glass Lined PVC]					
28	Number of Tanks	No	1	1	1	1	1	
29	Volume per Tank	litres	5000	5000	5000	5000	5000	Grundfos Tanks: 40, 75
30	Storage Capacity	days	137	52	21	17	37	30 d Ave Dose & Max P
	Working Volume (30d)	L	1097	2906	7140	8670	4016	APD Hazsure Standard
	Delivery Volume (14d)	L	512	1356	3332	4046	1874	APD Hazsure Non- Star
	Total Volume	L	5512	6356	8332	9046	6874	
31	System Selected							
	Liquid PACl	Liquid PACl Storage Tank 7500 L (assuming 5000L min delivery)						
	Powder PACl	Mixing (1000L) & Dose Tank (1500 L)						

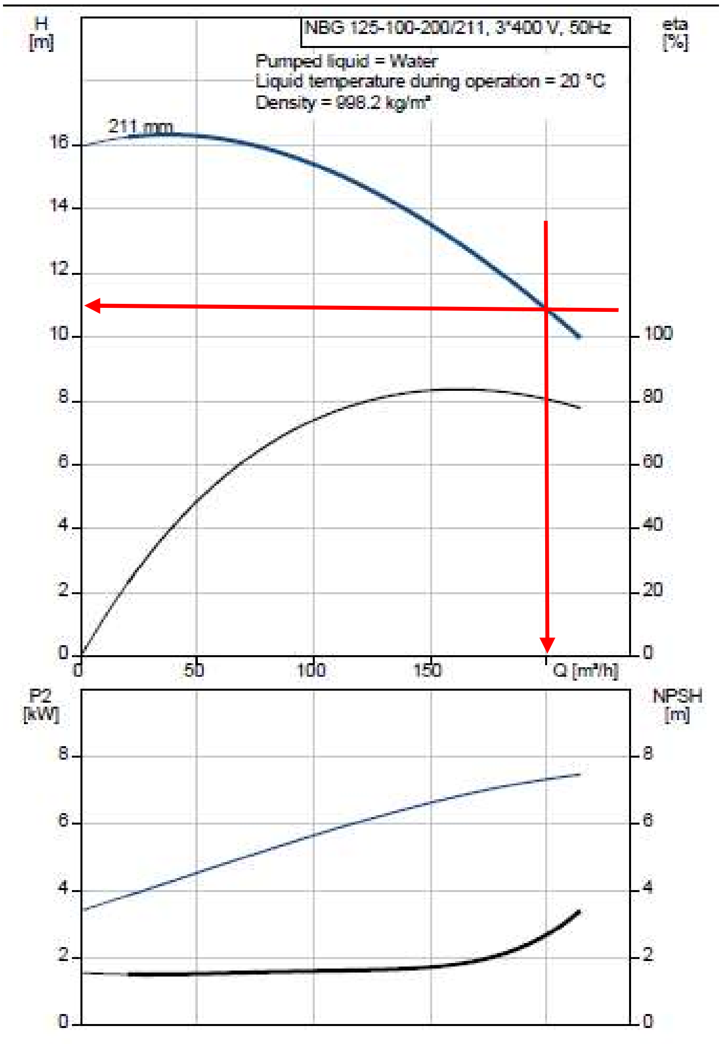
Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
4.2	C2 Flocculant - Polymer Powder (Water Stream Dosing [1], Solids Stream [Thickening & Dewatering] Dosi							
1	Description	Flocculant (Polymer) for floculation of solids in the Floc Tank						
		Use Powdered Polymer in prefence to Liquid/Emmulsion, to reduce OPEX costs						
2	Raw Water (Daily)	m3/d	2150	3100	4200	5100	4200	
3	Operation	h/d	17.9	23.8	23.1	23.2	23.1	
4	Raw Water (Instantaneous)	m3/h	120	130	182	220	182	
5	Dose Rate (based on 100%)	mg/L	0.15	0.25	1.0	0.25	0.2	Typical Poly Dose 0.15
6	Quantity required (based on 100%	kg/d	0.3	0.8	4.2	1.3	0.8	Typical Dose Rate (also
7	Commercial Concentration	w/w	0.15	0.15	0.15	0.15	0.20	Typ. 0.1 to 0.2 to 0.4%
8	Specific Gravity	-	1.0	1.0	1.0	1.0	1.0	Assumed, Cationic
9	Quantity of Commercial Chemical	kg/d	215	517	2800	850	420	
10	Flowrate of Commercial Chemical	L/d	215.0	516.7	2800.0	850.0	420.0	
11	Contingency	%	2%	2%	2%	2%	2%	
12	Expected Commercial Flowrate	L/d	219.3	527	2856.0	867	428	
13	Water Stream Chemcial Consumpt	L/a	80045	192355	1042440	316455	156366	
14	Guaranteed	L/a	89000	212000	1147000	349000	173000	Add another 10% conti
15	Raw Water pH	-	6.9	6.9	6.9	6.9	6.9	
	<u>Dosing Pumps [2N]</u>							
16	Number of Duty Dosing Pumps	No.	1	1	1	1	1	1-2 duty
17	Number of Standby Dosing Pumps	No.	1	1	1	1	1	1 boxed spare
18	Total number of Dosing Pumps	No.	2	2	2	2	2	
19	Flowrate required per pump	L/h	12.2	22.1	123.8	37.4	18.6	
20	Selected Capacity of pump	L/h	30.0	30.0	30.0	30.0	30.0	Duty Point 30 L/h, 7 ba
21	Preliminary head required	bar	7	7	7	7	7	
22	Commercial Concentration (w/v)	w/v	50%	50%	50%	50%	50%	
	<u>Storage Tank</u>							
23	Principal's Requirements	The Contractor shall confirm that all chemicals required shall be commercially available and i						
24	Total Design Flowrate	L/d	219	527	2856	867	428	
25	Total Max. Flowrate	L/h	30.0	30.0	30.0	30.0	30.0	
26	Storage volume required	L	6579	15810	39984	12138	5998	
27	Type of Storage Tank		PE Tank [OR Glass Lined PVC]					
28	Number of Tanks	No	1	1	1	1	1	
29	Volume per Tank	litres	1000	1000	1000	1000	1000	Grundfos Tanks: 40, 75
30	Storage Capacity	days	5	1.9	0	1	2	Design > 14 d - 30 d @
31	Tank Selected	Mixing (500L) & Dose Tank (1000 L)						
	<u>Polymer Make-up Unit</u>							
32	Mixing Tank Capacity	L	500	500	500	500	500	12 Batches/d
33	Dose Tank Storage Capacity	d	4.6	1.9	0.4	1.2	2.3	
34	Dose Tank Storage Capacity	h	109	46	8	28	56	
35	Dose Tank Storage volume require	L	1000	1000	1000	1000	1000	
36	Type of Storage Tank	-	Mixing (500L) & Dose Tank (1000 L)					
37	Number of Dose Tanks	No.	1	1	1	1	1	
38	Volume per Tank	litres	1,000	1,000	1,000	1,000	1,000	
39	Total Volume	litres	1,000	1,000	1,000	1,000	1,000	
	<u>Carrier Water Line</u>							
40	Flowrate	m3/h	2.0	2.5	3.0	3.0	3.0	Typ. 3 m3/h
41	No. of Lines	No.	2	2	2	2	2	
42	Flow/line	m3/h	1.0	1.3	1.5	1.5	1.5	
43	Pipe Dia	NB	25	25	25	25	25	
44	Cross Sectional Area	m2	0.000491	0.000491	0.000491	0.000491	0.000491	
45	Velocity	m/s	0.57	0.71	0.85	0.85	0.85	
46	Dilution Factor	-	48	60	71	71	71	Typ. 50-100

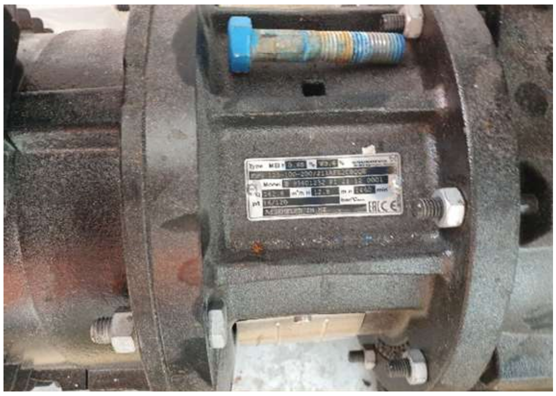
Ref	Description	Unit	Turndown (Min.)	Ave	Max	Future	Design	Comments
	4.2.1	**C2 Polymer Powder Make, Storage & Dosing [N+Box]**						
1	Description	*Polymer Powder Make-up*						
		Polymer emulsion for Water Stream and Sludge Thickening and Dewatering						
2	Water Stream Dosing	kg/d	215.0	516.7	2,800.0	850.0	420.0	
3								
4								
5	Sub-Total	kg/d	215.0	516.7	2,800.0	850.0	420.0	
6	Flowrate of Commercial Chemical	L/d	215.0	516.7	2800.0	850.0	420.0	
7	Contingency	%	2%	2%	2%	2%	2%	
8	Expected Commercial Flowrate	L/d	219	527	2856	867	428	
8	Principal's Requirements	The Contractor shall confirm that all chemicals required shall be commercially available and i						
9	Total Design Flowrate	L/d	219	527	2856	867	428	
10	Total Max. Flowrate	L/h	27.4	65.9	357.0	108.4	53.6	
11	Storage volume required	L	6579	15810	85680	26010	12852	
12	Type of Storage Tank		PE Tank [OR Glass Lined PVC]					
13	Number of Tanks	No	1	1	1	1	1	
14	Volume per Tank	litres	1000	1000	1000	1000	1000	Grundfos Tanks: 40, 75
15	Storage Capacity	days	5	1.9	0	1	2	Design > 14 d - 30 d @
16	Tank Selected	Mixing (500L) & Dose Tank (1000 L)						

Ref	Description	Unit	Turndown (Min.)	Ave	Max	Future	Design	Comments
	4.4 C3.2 Soda Ash Make-up & Dosing (Dosing [N+Box])							
A	Soda Ash Make-up & Dosing							
1	Description	Liquid Soda Ash (made up from powder) is accurately dosed to raise the pH of the treated water, to ensure NZDWS GV's of 7.0 to 8.5, added pre-disinfection. Always within range 7 to 7.75, with target 7.25 +/-0.25						
2	Raw Water (Daily)	m3/d	0	0	0	0	0	
3	Operation	h/d	215	517	2800	850	420	
4	Raw Water (Instantaneous)	m3/h	215	517	2800	850	420	
5	Dose Rate (based on 100%)	mg/L	**2.1**	**2.7**	**4.6**	**4.6**	**2.8**	Dose Rate
6	Quantity required (based on 100%	kg/d	0.0	0.0	0.0	0.0	0.0	
7	Commercial Concentration (w/w)	w/w	100	100	100	100	100	100% w/w Powder, but
8	Specific Gravity	-	1.00	1.00	1.00	1.00	1.00	SG. 1.23-1.33 (@ 20 De
9	Quantity of Commercial ACH requi	kg/d	0	0	0	0	0	
10	Flowrate of Commercial ACH requi	L/d	0.0	0.0	0.0	0.0	0.0	
11	Commercial Flowrate (Instant)	L/h	0.00	0.00	0.00	0.00	0.00	
12	Contingency	%	2%	2%	5%	5%	5%	
13	Expected Commercial Flowrate	L/d	0.0	0.0	0.0	0.0	0.0	
14	Commercial Flowrate (Instant)	L/h	0.0	0.0	0.0	0.00	0.0	

Ref	Description	Unit	Turndown (Min.)	Ave	Max	Future	Design	Comments
	4.5 ***C4 Chlorine Gas (Disinfection) [1] [Existing]***							
	Chlorine Gas (Disinfection) Calculations							
1	Description	Chlorine gas injected into carrier water						
2	Type	-		Liquified gas				
3	Raw Water (Daily)	m3/d	2000	3000	4000	5000	4000	
4	Operation	h/d	16.7	23.1	22.0	22.7	22.0	
5	Raw Water (Instantaneous)	m3/h	120.0	130.0	182.0	220.0	182.0	
		L/s	33	36	51	61	51	
6	Chlorine Dose Rate	mg/L	0.5	1.5	2.5	5.0	3.0	
7	Quantity of Chlorine required	kg/d	1.0	4.5	10.0	25.0	12.0	Max. Cl2 withdrawal ra
8	Daily consumption	kg/h	0.060	0.195	0.455	1.100	0.546	flow rate 0.6 kg/h (per
9	Rotameter flow	g/h	60	195	455	1100	546	0 to 500 g/ Currently s
10	Chlorinator Rotameter Analogue	%	10%	33%	76%	183%	91%	
11	No of chlorinators	No.	1	1	1	1	1	
12	Chlorinator Arrangement	-		1 duty only (N)				
13	Chlorinator Duty	kg/h	1.5	1.5	1.5	1.5	1.5	
14	Number of Duty Chlorine Storage	No.						
15	Number of Standby Chlorine Stora	No.						
16	Number of Chlorine Storage in Sto	No.						
17	Total Number of Chlorine Storage	No.						
18	Storage Type	kg	1210	1210	1210	1210	1210	
19	Storage Capacity	days	1210	269	121	48	101	
	Dilution Water Pipe Sizing							
20	Carrier Water Flow	m3/h						
21	Carrier Water Flow	L/s						
22	Carrier Water Pressure	Bar						
23	Dilution Water Pipe Size	mm						
24	Velocity	m/s						

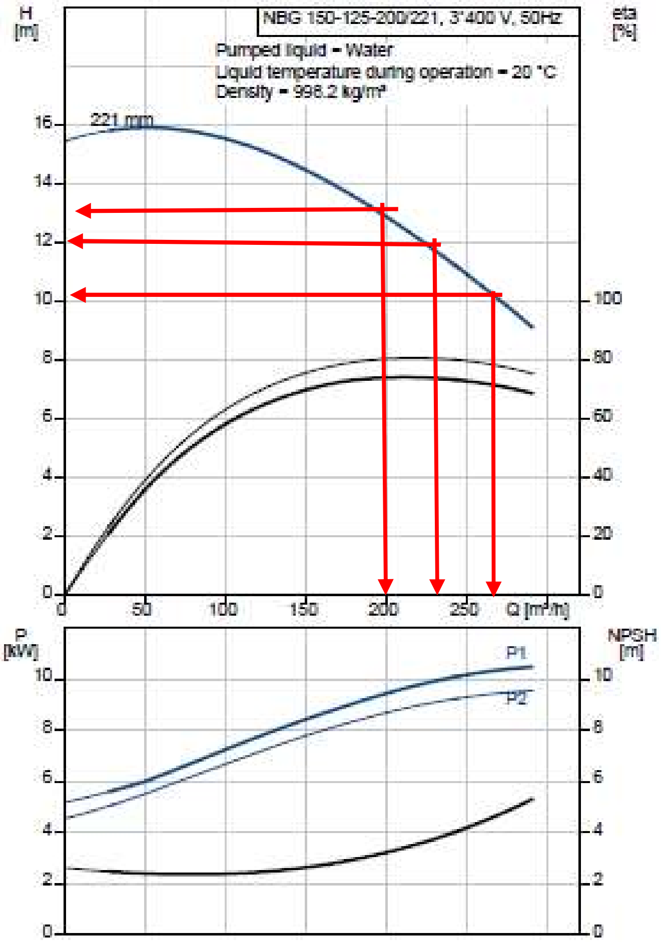
Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
5.0	**PRIMARY EQUIPMENT TECHNICAL SPECIFICATIONS**							
	5.1 Backwash Pump (1 No. [N only])							
1	Description	Backwash Pump (N+only). Dry Mounted on DOL/VFD. Duty Point 200 m3/h @ 1.1 Bar[g] TDH (Cast Iron Housing; Cast Iron Impeller)						
2	No. of Pumps	No.	1	1	1	1	1	
3	Configuration	d/a/s	1 No. (1 duty only [N])					
4	Duty Flowrate	m3/h	200	200	200	-	200	Duty Point 200 m3/h, 1
5	Head	bar	0.9	1	1.1	-	1.1	
6	Efficiency	%	78.6%	78.6%	78.6%	-	78.6%	
7	Motor Rating, Rated Power P2	kW	6.1	6.8	7.5	-	7.5	Calculated
8	Speed	rpm	1473 rpm (on DOL/VFD)					
9	Manufacturer	-	Grundfos End Suction Dry Mounted Centrifugal Pump					
10	Model	-	Grundfos NBG 125-100-200/211 AFE2CBQQE (Product no. 99801232)					
11	Material	-	Cast Iron Housing; Cast Iron Impeller					
12	Gross Weight/unit	kg	Net Weight 160 kg, Gross +10%=181 kg (Shipping Volume -0.509 m3)					
13	Pump Curve			Typical Pump Photo				



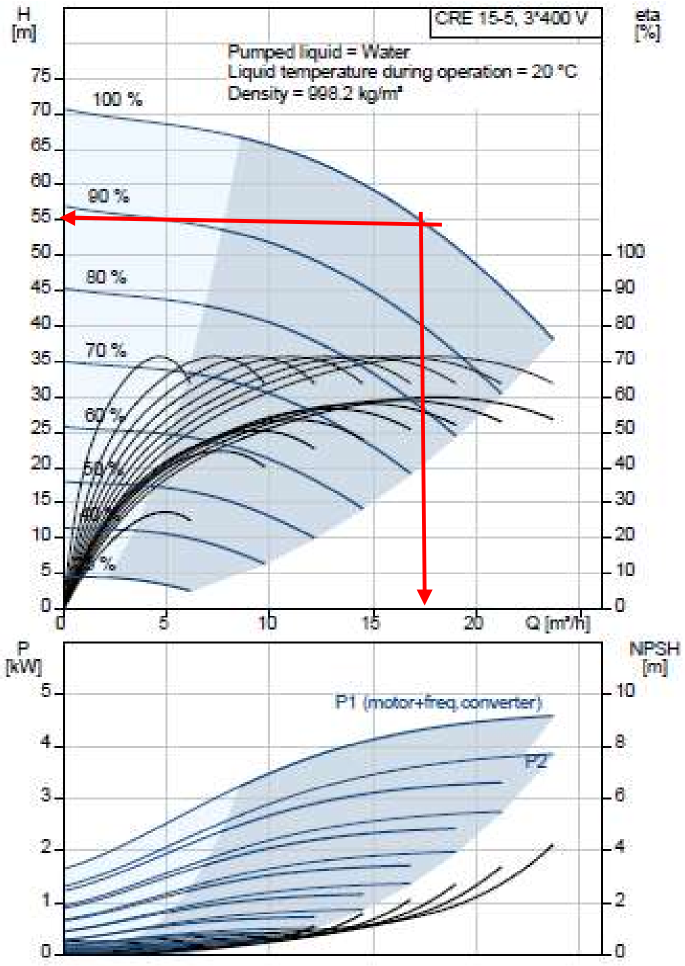


Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	5.2 Air Scour Blower (1 No. [N only])							
1	Description	Air Scour Blower, for Filters (1 No. [N only]), that meets the following duty point for the Conventional Filtration, to air scour the filters. The pressure is only 0.5 Bar[g] enough to lift the sand media filter bed around 40% bed expansion, for a good air scour and backwash.						
2	No. of Blowers	No.	1	1	1		1	1 duty + boxed spare
3	Configuration	d/a/s	1 No. (1 duty only) Blower for air scour of 1 filter at a time					
4	Duty Flowrate	Nm3/h	330	330	500		330	Duty Point 330 m3/h, 0
5	Head	bar	0.5	0.5	0.5		0.5	Typically 0.5 Bar
6	Motor Rating	kW	5.5	5.5	15		5.5	3 Phase 50 Hz Motor (\
7	Type & Model	Hwang Hae 3 Phase Ring Blower Motor						
8	Typical Blower Photo	nb. Pressure Filter Operating Pressure 1 to 3 bar						

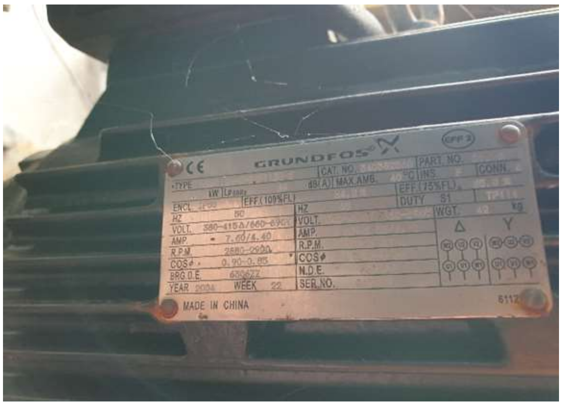
Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	5.3 UV Feed Pumps (2 No. [N+1])							
1	Description	UV Feed Pumps (2 No. [N+1])						
		Dry Mounted on DOL/VFD. Duty Point 240 m3/h @ 1.2 Bar[g] TDH						
		(Cast Iron Housing; Cast Iron Impeller)						
2	No. of Pumps	No.	1	1	1	1	1	
3	Configuration	d/a/s	2 No. (1 duty, 1 Standby [N+1])					
4	Duty Flowrate	m3/h	260	240	200	-	240	Duty Point 240 m3/h, 1
5	Head	bar	1	1.2	1.3	-	1.2	
6	Efficiency	%	70.1%	70.1%	70.1%	-	70.1%	
7	Motor Rating, Rated Power P2	kW	9.9	11.0	9.9	-	11.0	Calculated
8	Speed	rpm	1460 rpm (on DOL/VFD)					
9	Manufacturer	-	Grundfos End Suction Dry Mounted Centrifugal Pump					
10	Model	-	Grundfos NBG 150-125-200/221 (Product No. 96770787) [Discontinued]					
11	Material	-	Cast Iron Housing; Cast Iron Impeller					
12	Gross Weight/unit	kg	Net Weight 245 kg, Gross +10%=266 kg (Shipping Volume 0.96 m3)					
13	Pump Curve			Typical Pump Photo				



Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	5.4 Treated Water Pump Skid (2 No. [N+1])							
1	Description	Treated Water Pump Skid (2 No. [N+1])						
		Dry Mounted on an intergratefd VFD. Duty Point 17 m3/h @ 5.5 Bar[g] TDH						
		(Cast Iron Housing; Cast Iron Impeller)						
2	No. of Pumps	No.	1	1	1	1	1	
3	Configuration	d/a/s	2 No. (1 duty, 1 Standby [N+1])					
4	Duty Flowrate	m3/h	260	240	200	-	17	Duty Point 17 m3/h, 5..
5	Head	bar	1	1.2	1.3	-	5.54	
6	Efficiency	%	70.1%	70.1%	70.1%	-	63.1%	
7	Motor Rating, Rated Power P2	kW	9.9	11.0	9.9	-	4.0	Calculated
8	Speed	rpm	360-3530 rpm (on integrated VFD)					
9	Manufacturer	-	Grundfos Vertical Dry Mounted Centrifugal Pump					
10	Model	-	CRE15-5 A-F-A-E-HQQE (Product No. 96512709)					
11	Material	-	Cast Iron Housing; Stainless Steel Impeller					
12	Gross Weight/unit	kg	Net Weight 79 kg, Gross +10%=87 kg (Shipping Volume ? m3)					
13	Pump Curve			Typical Pump Photo				



Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments
	5.5 Fire Water Pump (1 No. [N only])							
1	Description	Fire Water Pump (1 No. [N only])						
		Dry Mounted on DOL/VFD. Duty Point ? m3/h @ ? Bar[g] TDH						
		(Cast Iron Housing; Cast Iron Impeller)						
2	No. of Pumps	No.	1	1	1	1	1	
3	Configuration	d/a/s	1 No. (1 duty only [N + Boxed spare])					
4	Duty Flowrate	m3/h						Duty Point m3/h, bar
5	Head	bar						
6	Efficiency	%						
7	Motor Rating, Rated Power P2	kW						
8	Speed	rpm						
9	Manufacturer	-						
10	Model	-						
11	Material	-						
12	Gross Weight/unit	kg						
13	Pump Curve							



Ref	Description	Unit	Turndown (Min.)	Ave	Peak	Max	Design	Comments

5.6 Soda Ash Carrier Water Pumps (1 No. [N only]) {Pre & Post pH Correction}
5.7 Alum Carrier Water Pumps (1 No. [N only])
5.8 Polymer Carrier Water Pumps (1 No. [N only])
5.9 Chlorine Carrier Water Pumps (1 No. [N only])

GENERAL LINE SIZING CALCULATION

AWA/KAIPARA DISTRICT COUNCIL
210507 Dargaville WTP Capacity Assessment

25/06/2021
Sheet 1 of 1

LIQUID LINE SIZING

P&ID No.	Line No. NB				Liquid Type Code	Line Sch	Line ID (mm)	Pipe Roughness (mm)	Flow Rate (m3/h)	Pressure (barg)	Density (kg/m3)	Viscosity cP	Friction factor	Reynolds No. (Re)	Velocity (m/s) Actual	Velocity (m/s) Allowable	Pressure Drop (bar/100m) Actual	Pressure Drop (bar/100m) Allowable
Kaipara																		
Raw Feed Line (Min)	250	HL	1C1	SS	U	80	264.67	0.04572	**100.0**	4	1000	1	1.80E-02	1.34E+05	0.50	2.5	0.009	0.15
Raw Feed Line (Ave)	250	HL	1C1	SS	U	80	264.67	0.04572	**130.0**	4	1000	1	1.73E-02	1.74E+05	0.66	2.5	0.014	0.15
Raw Feed Line (Peak)	250	HL	1C1	SS	U	80	264.67	0.04572	**182.0**	4	1000	1	1.65E-02	2.43E+05	0.92	2.5	0.026	0.15
Raw Feed Line (Max)	250	HL	1C1	SS	U	80	264.67	0.04572	**210.0**	4	1000	1	1.62E-02	2.81E+05	1.06	2.5	0.034	0.15
Raw Feed Line (Design)	250	HL	1C1	SS	U	80	264.67	0.04572	**300.0**	4	1000	1	1.55E-02	4.01E+05	1.51	2.5	0.067	0.15

VAPOUR TYPE CODES

A	Vapour line - continuous operation	**E**	Safety and blowdown inlet
B	Vapour line - Intimitant operation	**F**	Safety and blowdown outlet
C	Compressor suction	**G**	Flare header
D	Compressor discharge	**H**	Column Overhead

LIQUID TYPE CODES

P	Pump Suction Boiling Liquid	**T**	Pump (centrifugal) Discharge High Pres.
Q	Pump Suction Non-Boiling Liquid	**U**	Water
R	Gravity Flow & Reboiler liquid feed line	**V**	Unit Line Boiling Liquid
S	Pump (centrifugal) Discharge Low Pres	**W**	Unit Line Non-Boiling Liquid

NOTES

1 Note Max velocity based on API 14E where Vmax = C/sqrt(density)
C=195 (SI units), density is in kg/m3 and velocity is in m/s

2 For two phase flow use mixed density and furhter calculations should be carried out to check in best flow regime.

3 Note Maximum pressure drop shoud be less than 3% of the set pressure (API521)

4 For diphasic lines with significant quantities of liquid (ie upstream of Flare KO drum)
pv^2 should be less than 50000 and mach<0.25