TE MATO VAI

Memorandum

15 December 2020

To	Turangi Landowners		
Copy to	Angelia Williams, Sione Likiliki, National Environmental Service, To Tatou Vai		
From	Matt Boyd	Tel	28851
Subject	PACl Trial Results Memo 2 - Turangi		

1 Summary of trial results from the Turangi intake

The Turangi intake started the polyaluminium chloride (PACl) trial on 19 October 2020, and To Tatou Vai (TTV) approved to connect the intake to the drinking water network on 22 October 2020 after reviewing results of the off-line trial (see the next section for more details about the trial stages).

During both stages of the trial, the contractor monitors the treatment plant and discharges to the environment

To date, the intake delivers treated water that meets the requirements. The measured discharges to the environment also meet the requirements.

2 Purpose of this memorandum

The Cook Islands Government directed the Te Mato Vai project contractor McConnell Dowell to carry out water treatment commissioning trials at all the intakes progressively. The first of the trials commenced on Monday 28 September 2020 at Ngatoe Intake. The commissioning trial begins with polyaluminium chloride (PACl) first dosed into the settling tank/s which are located below the intakes. The active component of the PACl is aluminium which dissolves into the water and causes dirt to settle out of suspension.

This memo describes the trial process and presents an interim report of the results to date.

3 Trial Process

The first stage of the trial is undertaken while the network is **off-line**, that means that none of the raw water that is dosed with the PACl leaves the site and instead is stored in the storage tanks located just below the settling tanks. This stage of the trial continues for a few to several days while samples are taken and tested for dissolved aluminium, turbidity, pH and E.coli.

If acceptable results are achieved for the **off-line trial** the results are forwarded to To Tatou Vai (TTV) for their approval to discharge the treated water to the network. TTV compare the results to the World Health Organisation (WHO) drinking water standards and provide permission based on what is safe for human consumption. If

their permission to release is received, the second stage of the trial (the **on-line trial**) is started. The **on-line trial** is when the treated water is then discharged to the network.

It should be noted that two of the treatment plants don't have storage tanks, and at one of the sites the tank is too small to receive an adequate volume of water for an **off-line trial**. For these three treatment plants results from other plants will be used to assess whether or not the dosing can go directly **on-line**. These plants will still have regular dissolved aluminium, turbidity, pH and E.coli samples taken to ensure they meet the WHO drinking water standards and they will be some of the last plants to be trialled.

Once the **on-line trial** has started (when treated water enters the pipe network), it will continue at each intake for the remaining trial period which could be as long as six months, depending on when we receive sufficient data to determine how to best operate the plants in the future. The Contractor will do regular testing of the treated water for dissolved aluminium initially per day at each treatment plant for the first part of the trial and eventually reduced testing to once per week.

Additional to the treated water tests, Environmental sampling of the water discharging from the ponds is done for dissolved aluminium, turbidity, and pH, in the streams. Results from these tests are sent to the National Environment Service (NES). The stream is sampled while a discharge from the pond to the stream occurs, and also background sampling in the stream when no discharge occurs is undertaken.

The stream sampling locations are listed below and presented in Appendix A.

- 20m above the discharge point
- At the point of discharge
- 20m below the discharge point
- 50m below the discharge point (note this is the point where the target concentration should not be exceeded)
- Midway to the lagoon
- 100m above the lagoon

NES and the Landowners will be advised of all the above results. This environmental sampling will be conducted initially weekly then fortnightly after the initial discharge sample.

4 Results

4.1 Intake performance

The requirements for the treated water that is supplied to the drinking water network are as follows:

- The turbidity after the AVG should be lower than the raw stream turbidity.
- The E. coli concentration after the AVG generally should be lower than the raw stream concentration.
- The dissolved aluminium concentration after the AVG should be lower than 0.2 mg/L, and must not be higher than 0.3 mg/L.

If the treated water quality meets the turbidity, E. coli and dissolved aluminium requirements, it can be discharged to the drinking water network with the approval of TTV the network operator.

Table 1 presents the results to date from the **off-line** and **on-line trial**. The results are compared to the limits for discharge.

Cells that are greyed out indicate that no sample was taken at that time for the parameter in question.

To date, the intake has delivered treated water that met all requirements.

Table 1 Treated water quality results for the off-line and on-line trial at Turangi.

	Turbidity (NTU)			E.Coli (MPN/100 mL)			Dissolved Aluminium (mg/L)			Comments
Treatment quality requirement	Passes when post AVG is lower than stream			Generally post AVG is lower than stream			Passes when post AVG concentration is below 0.2 mg/L			
Date / Time	**Stream**	**Post AVG**	**Status**	**Stream**	**Post AVG**	**Status**	**Post Settling Tank**	**Post AVG**	**Status**	
19/10/2020 13:00	0.44	0.23	OK				0.070	0.102	OK	
19/10/2020 14:00	0.32	0.11	OK	41.4	8.6	OK	0.090	0.079	OK	
19/10/2020 15:00	0.38	0.17	OK				0.098	0.066	OK	
19/10/2020 16:00	0.32	0.28	OK				0.090	0.067	OK	
20/10/2020 13:00	0.33	0.02	OK				0.062	0.050	OK	
20/10/2020 14:00	0.74	0.10	OK	2419.6	1	OK	0.167	0.047	OK	
20/10/2020 15:00	0.72	0.06	OK				0.073	0.075	OK	
20/10/2020 16:00	0.19	0.09	OK				0.086	0.056	OK	
21/10/2020 13:00	0.43	0.15	OK				0.086	0.067	OK	
21/10/2020 14:30	0.42	6.00	Not OK					0.048	OK	Caused by manual backwash, Re-checked half an hour later - ok
21/10/2020 15:00	0.39	0.13	OK				0.068	0.072	OK	
21/10/2020 16:00	0.41	0.13	OK				0.058	0.069	OK	
22/10/2020	TTV approved discharge of treated water to network . Trial is now an on-line trial.									
22/10/2020 12:35	0.80	0.07	OK	21.3	<1	OK	0.069	0.050	OK	
23/10/2020 10:56	2.15	1.37	OK							
23/10/2020 16:30		0.40								
24/10/2020 10:40	0.39	0.06	OK							
25/10/2020 9:45	0.23	0.12	OK							
26/10/2020 9:30	0.20	0.08	OK							
27/10/2020 10:22	3.96	0.42	OK							
28/10/2020 10:30	0.56	0.12	OK							
29/10/2020 10:45	0.51	0.21	OK	42.6	<1	OK				
30/10/2020 10:30	0.24	0.16	OK	35	<1	OK		0.046	OK	
31/10/2020 8:38	2.22	0.22	OK							
1/11/2020 10:30	3.29	0.88	OK							
2/11/2020 12:31	1.09	0.57	OK							
3/11/2020 10:54	4.34	0.35	OK	90.8	204.6	Not OK		0.010		We think this is a result of a high rain event during the night, and a backwash by the AVG just before the sample was taken. Results in adjacent days do not indicate a problem.
5/11/2020 11:54	0.63	0.28	OK	39.3	2	OK				
7/11/2020 8:37	0.90	0.66	OK							
8/11/2020 8:29	0.19	0.13	OK							
9/11/2020 11:18	2.70	2.95	Not OK							We suspect that this sample was

	Turbidity (NTU)			E.Coli (MPN/100 mL)			Dissolved Aluminium (mg/L)			Comments
										taken after an AVG backwash. The measurements in the adjacent days do not indicate a problem with the plant performance.
10/11/2020 10:55	0.45	0.98	Not OK	22.8	<1	OK	0.067	0.062	OK	We suspect that this sample was taken after an AVG backwash. The measurements in the adjacent days do not indicate a problem with the plant performance.
11/11/2020 11:29	0.41	0.09	OK							
12/11/2020 16:23	1.00	0.55	OK	23.1	1	OK				
13/11/2020 11:39	1.08	0.07	OK							
14/11/2020 10:36	0.39	0.09	OK							
15/11/2020 13:11	0.53	0.07	OK							
16/11/2020 10:26	0.32	0.04	OK							
18/11/2020 10:57	0.64	0.19	OK							
19/11/2020 11:42	0.47	0.01	OK	35	<1	OK	0.073	0.067	OK	
20/11/2020 10:57	1.03	0.40	OK							
21/11/2020 10:54	0.99	0.45	OK							
22/11/2020 10:15	0.83	0.17	OK							
23/11/2020 15:50	1.20	0.12	OK							
24/11/2020 12:17	0.38	0.01	OK							
25/11/2020 12:37	0.29	0.17	OK							
26/11/2020 10:58		0.01								
27/11/2020 14:48	0.59	0.03	OK							
1/12/2020 10:00	2.40	0.23	OK				0.054	0.065	OK	

Notes:

Between 21 Oct 2020 and 2 Nov 2020, a shortage of laboratory supplies for dissolved aluminium tests resulted in testing for dissolved aluminium reduced to the key compliance samples.

4.2 Environmental Monitoring

For discharges from the ponds to the stream, the environmental requirements are that the dissolved aluminium 50 m downstream from the discharge point should be at or below 0.055 mg/L. Dissolved aluminium is monitored at several points as presented in Appendix A.

Results of the peak and background sampling monitoring discharges from the ponds to the stream are presented in Table 2. The row with the blue title indicates the location where the concentration should be at or below 0.055 mg/L. A green cell indicates that the value is below the target concentration. Cells that are greyed out indicate that no sample was taken at that time for the location in question.

The PMU uses two sampling methods.

Peak sampling is undertaken during a discharge from the pond to the stream. The sample is taken at a time when the discharged water from the pond has reached the specific sample location[1].

Background samples are taken in the stream, but not necessarily when a discharge from the ponds to the stream occurs. They measure how the background concentration in the stream is influenced by the infrequent pond discharges, as well as the natural dissolved aluminium level upstream of the treatment plants.

4.2.1 Naturally Occurring Dissolved Aluminium

The ANZECC guideline value for dissolved aluminium in streams is less than 0.055 mg/L at 50 m below the discharge point. The TMV project's goal is that the discharges from the treatment plants to the streams do not cause harm to the environment. Monitoring during the trial and some historic readings have shown that the natural dissolved aluminium levels can sometimes be greater than the ANZECC limit when measured upstream of the treatment plants. The September 2020 Te Mato Vai Ecology Baseline Report concludes that dissolved aluminium levels of up to 0.290 mg/L or greater (potentially up to 0.630 mg/L) would not result in environmental harm. Natural occurring dissolved aluminum levels have been measured to date up to 0.170 mg/L following rainfall events. The monitoring of releases from the treatment plant has shown that at 50 m downstream of the point of release, no elevation of dissolved aluminum is occurring as a result of any discharge, with results consistently showing lower readings than in the ponds. In the instance where the level at 50 m downstream of discharge is above the ANZECC limit, the data shows that this is likely the result of the natural background levels being elevated in a rainfall event. In most instances the treatment plants were not discharging during the time of sampling and the 50 m downstream sample was taken from the raw stream water only.

The results are considered acceptable despite being above the ANZECC limit provided a net decrease in dissolved aluminium is maintained 50 m downstream of any discharge point.

[1] We use a floating object to determine when pond water has reached the specific location. The floating object is used to determine the velocity of the stream. Considering this velocity and the distance to the sampling point, we calculate the earliest time that the pond discharge will reach the sampling point.

Table 2 Dissolved aluminium results (mg/L) from the Turangi stream sampling.

Sample Date			22 October 2020		28 October 2020		2 November 2020	
	Sample Location	**Limit**	**Result**	**Status**	**Result**	**Status**	**Result**	**Status**
		D.Alu mg/L	**D.Alu mg/L**	**Peak**	**D.Alu mg/L**	**Background**	**D.Alu mg/L**	**Background**
Pond	In Pond 1 (Upstream Pond)		0.074		0.069		0.057	
	In Pond 2 (Downstream Pond)							
Stream	In Stream (20 m upstream of Pond)		0.017		0.020		0.008	
	In Stream (at pond)		0.040					
	In Stream (20 m downstream of Pond)		0.026					
	In Stream (50 m downstream of Pond)	0.055	0.027	**OK**	0.020	**OK**	0.008	**OK**
	In Stream (1/2 way to lagoon)		No flow					
	In Stream (100 m from lagoon)		No flow					

Table 3 Dissolved aluminium results (mg/L) from the stream sampling (Cont.).

Sample Date			9 November 2020		10 November 2020		25 November 2020		26 November 2020	
	Sample Location	Limit	Result	Status	Result	Status	Result	Status	Result	Status
		D.Alu mg/L	D.Alu mg/L	Bank-ground	D.Alu mg/L	Background	D.Alu mg/L	Background	D.Alu mg/L	Back-ground
Pond	In Pond 1 (Upstream Pond)		0.090		0.068		0.063		0.065	
	In Pond 2 (Downstream Pond)									
Stream	In Stream (20 m upstream of Pond)		0.008		0.040		0.150		0.170	
	In Stream (at pond)								0.125	
	In Stream (20 m downstream of Pond)		0.018		0.018		0.097		0.158	
	In Stream (50 m downstream of Pond)	0.055	0.019	**OK**	0.019	**OK**	0.143	Caused by high natural stream con-centrations of aluminium in the raw water on that day	0.086	Caused by high natu-ral stream concentra-tions of al-uminium in the raw water on that day
	In Stream (1/2 way to lagoon)								No flow	
	In Stream (100 m from la-goon)								No flow	

Notes:

Between 21 Oct 2020 and 2 Nov 2020, a shortage of laboratory supplies for dissolved aluminium tests resulted in testing for dissolved aluminium reduced to the key compliance samples.

4.3 Settling tank overflow test results

The settling tank at each intake is designed to overflow at the inlet if there is low demand to return raw stream water back to the stream. As part of the court appointed expert witness review it was agreed to manually trigger an overflow in at least one intake as part of the trial and test the water to ensure water with elevated dissolved aluminium was not passing back into the stream. This overflow test is only required in one intake because all intakes are constructed in the same way.

Environmental testing for dissolved aluminium was undertaken at three locations

- in the settling tank overflow chamber
- in the stream, upstream of the discharge point, and
- in the stream, 50 meters downstream of the discharge point.

Testing was undertaken at the beginning of the overflow, after 1 hour and then after 2 hours of continuous overflow.

Results

Results of the overflow test are presented in Table 4 and Table 5 showing that dissolved aluminium levels are not elevated above the limit due to the discharge.

Table 4 Settling tank overflow test results for Ngatoe

Time	Settling tank overflow chamber	Upstream of discharge	50m downstream of discharge	Limit < 0.055 D.Alu mg/L
Start of overflow	0.008	0.008	0.008	OK
After 1 hour	0.008	0.008	0.023	OK
After 2 hours	0.013	0.019	0.009	OK

Table 5 Settling tank overflow test results for Papua

Time	Settling tank overflow chamber	Upstream of discharge	50m downstream of discharge	Limit < 0.055 D.Alu mg/L
Start of overflow	0.008	0.016	0.016	OK
After 1 hour	0.008	0.008	0.008	OK
After 2 hours	0.008	0.008	0.017	OK

Regards

Matt Boyd
Deputy Project Manager

Appendix A
Environmental Sampling
Diagram

Environmental Sampling in Stream

1. Sample in the Pond (day before proposed release)
Done once per plant
Sample in the ponds for Al concentration
Testing:
- Dissolved Aluminium
- Turbidity
- pH

2 samples, 1 per pond at star locations ★

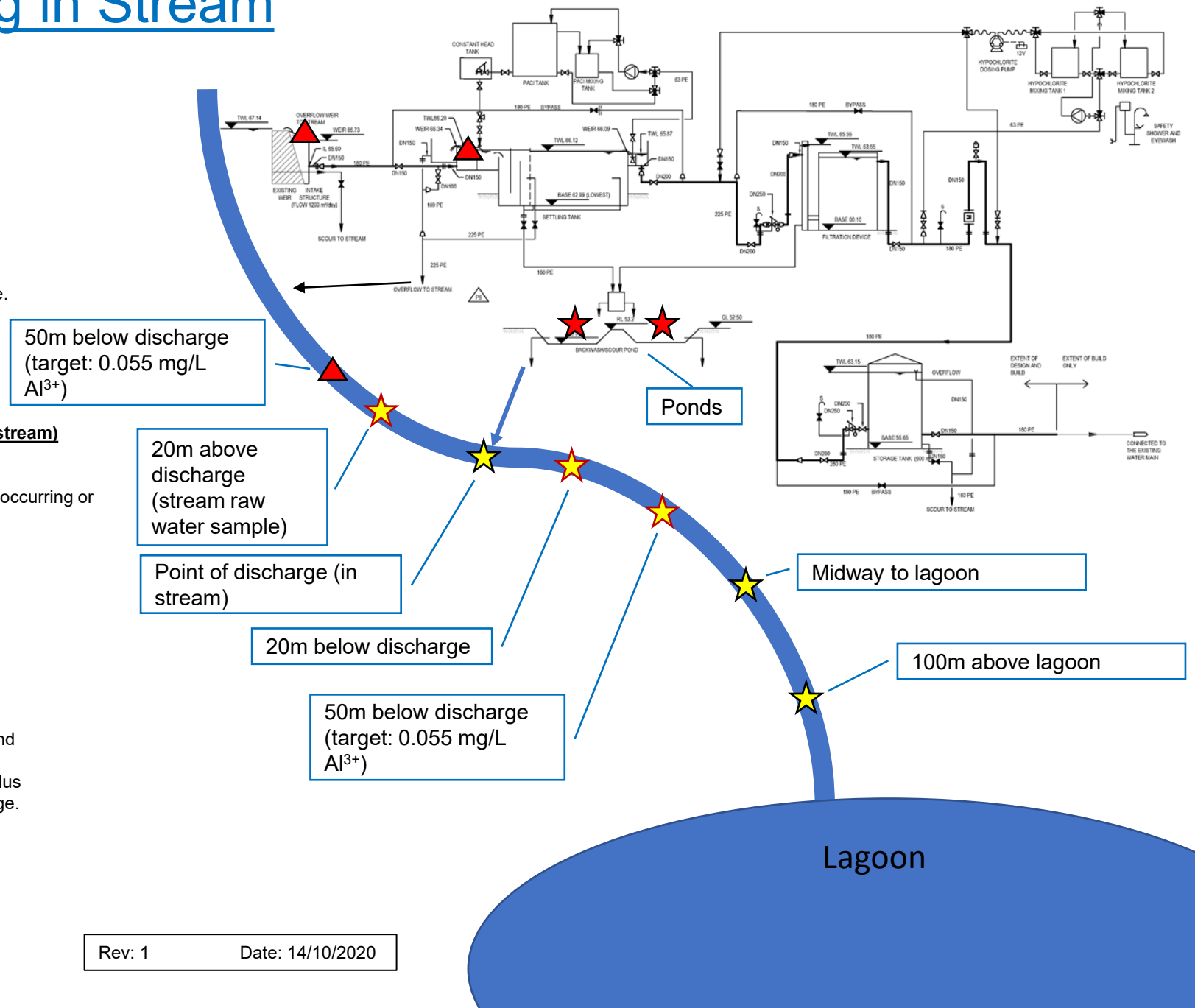
2. Environmental Peak Sampling (manual discharge to stream)
1 to 2 times at each plant at different stream conditions.
Sampled during a controlled release from the ponds to the stream,
Timed sampling based on stream flow rate 60 mins after initial release.
Testing:
- Dissolved Aluminium
- Turbidity
- pH
- 8 samples per test at star locations ★☆☆

3. Environmental Background Sampling (automatic discharge to stream)
- No less than weekly for first month
- No less than fortnightly for remaining months

These samples are taken in the stream, regardless of if a discharge is occurring or not.
This sampling serves to monitor the background dissolved aluminium concentrations in the stream.
Testing:
- Dissolved Aluminium
- Turbidity
- pH
- 5 samples per test at star locations ★☆

4. Settling Tank Overflow to Stream
done twice in total for trial including a high energy plant
First part: contained in chamber (control). Raw water and chamber and at 50 m downstream of discharge.
Second part: if first part ok: discharge to stream. Start, Plus 1 hour, plus 2 hours, Raw water and chamber and at 50 m downstream of discharge.
Samples locations:
- raw water and
- water going into the overflow chamber (within settling tank)
- 50 m downstream of discharge

Testing:
- Dissolved Aluminium
- Turbidity
- pH
- 9 samples per test at locations ▲



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