Appendix D:

Chain of Custody Forms

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

ANALYSIS REQUEST

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T **0508 HILL LAB** (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Office use only
(Job No)

Quote No 67532

Primary Contact Oliver Bone 245579

Submitted By Ruth Hughes 222585

Client Name 4SIGHT Consulting Limited 95478

Address PO Box 911310, Victoria Street West
Auckland 1142

Phone 09 303 0311 *Mobile*

Email

Charge To 4SIGHT Consulting Limited 95478

Client Reference AA1146 Stormwater - Quarterly

Order No

Results To

Please refer to the Quote for a list of the Default Report Recipients

☐ *Email Other*

☐ *Other*

CHAIN OF CUSTODY RECORD

Sent to
Hill Laboratories

☐ *Tick if you require COC to be emailed back*

Date & Time:

Name:

Signature:

Received at
Hill Laboratories

Date & Time:

Name:

Signature:

Condition

☐ *Room Temp* ☐ *Chilled* ☐ *Frozen*

Temp:

☐ Sample & Analysis details checked

Signature:

ADDITIONAL INFORMATION

Priority ☐ **Low** ☑ **Normal** ☐ **High**

☐ **Urgent** (ASAP, extra charge applies, please contact lab first)

NOTE: The estimated turnaround time for the types and number of samples and analyses specified on this quote is by 4:30 pm, 5 working days following the day of receipt of the samples at the laboratory.

Requested Reporting Date:

Quoted Sample Types

Surface Water (SW), Saline (Sal)

No.	*Sample Name*	*Sample Date/Time*	*Sample Type*	*Tests Required*
1	SLY MH1 - Pipe		SW	TOC, CODTt, Turb, SS, Tan, pH, VSS, CuDt, PbDt, ZnDt, TPHHS_C7-9
2	SLY MH11 - Pipe		SW	TOC, CODTt, Turb, SS, Tan, pH, VSS, CuDt, PbDt, ZnDt, TPHHS_C7-9
3	SLY MH1 - Mixing Zone Site 1 Surface		Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
4	SLY MH1 - Mixing Zone Site 2 Surface		Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
5	SLY MH1 - Mixing Zone Site 3 Surface		Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
6	SLY MH11 - Mixing Zone Site 1 Surface		Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
7	SLY MH11 - Mixing Zone Site 2 Surface		Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
8	SLY MH11 - Mixing Zone Site 3 Surface		Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
9	SLY MH1 Site 1- Mixing Zone Composite		Sal	Tan, pHsal
10	SLY MH11 Site 1 Mixing Zone Composite		Sal	Tan, pHsal

No.	Sample Name	Sample Date/Time	Sample Type	Tests Required
11	SLY MH1 - Mixing Zone Site 4 Mid Depth		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
12	SLY MH1 - Mixing Zone Site 5 Mid Depth		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
13	SLY MH1 - Background Site 1 Surface		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
14	SLY MH1 - Background Site 2 Surface		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
15	SLY MH1 - Background Site 3 Surface		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
16	SLY MH11 - Background Site 1 Surface		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
17	SLY MH11 - Background Site 2 Surface		Sal	ICPminD, TurbSal, Sal, SSsal, CuDXuSal
18	SLY MH9		SW	ICPminD, SS, pH, CuDt
19	SLY Pst DSD		SW	ICPminD, SS, pH, CuDt
20	SLY Kaiti Beach Rd		SW	SS, pH, CuDt, PbDt, ZnDt
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Office use only
(Job No)

Quote No 79937

Primary Contact Oliver Bone 245579

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Phone 09 303 0311 *Mobile*

Email

Charge To 4SIGHT Consulting Limited 95478

Client Reference AA1146 Stormwater Monthly

Order No

Results To

Please refer to the Quote for a list of the Default Report Recipients

☐ *Email Other*

☐ *Other*

ADDITIONAL INFORMATION

CHAIN OF CUSTODY RECORD

Sent to
Hill Laboratories

☐ *Tick if you require COC to be emailed back*

Date & Time:

Name:

Signature:

Received at
Hill Laboratories

Date & Time:

Name:

Signature:

Condition

☐ *Room Temp* ☐ *Chilled* ☐ *Frozen*

Temp:

☐ Sample & Analysis details checked

Signature:

Priority ☐ **Low** ☑ **Normal** ☐ **High**

☐ **Urgent** (ASAP, extra charge applies, please contact lab first)

NOTE: The estimated turnaround time for the types and number of samples and analyses specified on this quote is by 4:30 pm, 5 working days following the day of receipt of the samples at the laboratory.

Requested Reporting Date:

Quoted Sample Types

Surface Water (SW), Saline (Sal)

No.	*Sample Name*	*Sample Date/Time*	*Sample Type*	*Tests Required*
1	SLY MH1 - Pipe		SW	Turb, SS, VSS
2	SLY MH11 - Pipe		SW	Turb, SS, VSS
3	SLY MH1 - Mixing Zone Site 1 Surface		Sal	TurbSal, Sal, SSsal
4	SLY MH1 - Mixing Zone Site 2 Surface		Sal	TurbSal, Sal, SSsal
5	SLY MH1 - Mixing Zone Site 3 Surface		Sal	TurbSal, Sal, SSsal
6	SLY MH1 - Mixing Zone Site 4 Mid Depth		Sal	TurbSal, Sal, SSsal
7	SLY MH1 - Mixing Zone Site 5 Mid Depth		Sal	TurbSal, Sal, SSsal
8	SLY MH11 - Mixing Zone Site 1 Surface		Sal	TurbSal, Sal, SSsal
9	SLY MH11 - Mixing Zone Site 2 Surface		Sal	TurbSal, Sal, SSsal
10	SLY MH11 - Mixing Zone Site 3 Surface		Sal	TurbSal, Sal, SSsal

No.	*Sample Name*	*Sample Date/Time*	*Sample Type*	*Tests Required*
11	SLY MH1 - Background Site 1 Surface		Sal	TurbSal, Sal, SSsal
12	SLY MH1 - Background Site 2 Surface		Sal	TurbSal, Sal, SSsal
13	SLY MH1 - Background Site 3 Surface		Sal	TurbSal, Sal, SSsal
14	SLY MH11 - Background Site 1 Surface		Sal	TurbSal, Sal, SSsal
15	SLY MH11 - Background Site 2 Surface		Sal	TurbSal, Sal, SSsal
16	SLY MH9		SW	SS
17	SLY Pst DSD		SW	SS
18	SLY Kaiti Beach Road		SW	SS
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Appendix E:

Sampling Bottle Guide

E.1 Quarterly Sampling

COC Form No.	Eastland Port Site Number/Sample Name	Bottles required
1	SLY MH1	• ☐1 x TOC125 (Unpreserved; Amber glass, Teflon lined lid, Container Size: 125 mL) • ☐1 x TPH250 (Sulphuric acid pres; Amber glass, Teflon lined lid, Container Size: 250 mL) • ☐1 x S100 (Sulphuric acid pres; Polyethylene, Container Size: 100 mL) • ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) • ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
3	SLY MH1 – Mixing Zone Site 1 (Surface)	• ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) • ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
4	SLY MH1 – Mixing Zone Site 2 (Surface)	• ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) • ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
5	SLY MH1 – Mixing Zone Site 3 (Surface)	• ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) • ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
9	SLY MH1 – Mixing Zone Composite being 1/3rd each Sites 1,2 & 3 (Surface)	• ☐1 x UP250 (Unpreserved; Polyethylene, Container Size: 250 mL)
11	SLY MH1 – Mixing Zone Site 4 (Mid depth)	• ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) • ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
12	SLY MH1 – Mixing Zone Site 5 (Mid depth)	• ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) • ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
13	SLY MH1 – Background Site 1 (Surface)	• ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) • ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
14	SLY MH1 – Background Site 2 (Surface)	• ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) • ☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
15	SLY MH1 – Background Site 3 (Surface)	• ☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)

		•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
2	SLY MH11	•☐1 x TOC125 (Unpreserved; Amber glass, Teflon lined lid, Container Size: 125 mL) •☐1 x TPH250 (Sulphuric acid pres; Amber glass, Teflon lined lid, Container Size: 250 mL) •☐1 x S100 (Sulphuric acid pres; Polyethylene, Container Size: 100 mL) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) •☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
6	SLY MH11 – Mixing Zone Site 1 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
7	SLY MH11 – Mixing Zone Site 2 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
8	SLY MH11 – Mixing Zone Site 3 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
10	SLY MH11 – Mixing Zone Composite (Surface)	•☐1 x UP250 (Unpreserved; Polyethylene, Container Size: 250 mL)
16	SLY MH11 – Background Site 1 (Surface)	•☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) •☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
17	SLY MH11 – Background Site 2 (Surface)	•☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL) •☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
18	SLY MH9	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
19	SLY Post DSD	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)
20	SLY Kaiti Beach Road	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L) •☐1 x NWU100 (Unpreserved; Polyethylene, rinsed with Type 1 water; Laboratory to filter, Container Size: 100 mL)

E.2 Monthly Sampling

COC Form No.	Eastland Port Site Number/Sample Name	Bottles required
1	SLY MH1	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
3	SLY MH1 – Mixing Zone Site 1 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
4	SLY MH1 – Mixing Zone Site 2 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
5	SLY MH1 – Mixing Zone Site 3 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
11	SLY MH1 – Mixing Zone Site 4 (Mid depth)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
12	SLY MH1 – Mixing Zone Site 5 (Mid depth)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
13	SLY MH1 – Background Site 1 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
14	SLY MH1 – Background Site 2 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
15	SLY MH1 – Background Site 3 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
2	SLY MH11	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
6	SLY MH11 – Mixing Zone Site 1 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
7	SLY MH11 – Mixing Zone Site 2 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
8	SLY MH11 – Mixing Zone Site 3 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
16	SLY MH11 – Background Site 1 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
17	SLY MH11 – Background Site 2 (Surface)	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
18	SLY MH9	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
19	SLY Post DSD	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)
20	SLY Kaiti Beach Road	•☐1 x UP1L (Unpreserved; Polyethylene, Container Size: 1 L)

Appendix F:

Guideline for Marine Sampling

GUIDELINE FOR CARRYING OUT SOUTHERN LOG YARD STORMWATER AND MARINE RECEIVING ENVIRONMENT SAMPLING

Prepared By Mark Poynter: 10 October 2016

This Guideline is intended to support the SOP’s and other Protocols established for Eastland Port Logyard Stormwater sampling. Relevant SOPs and other Documents are listed at the end of this Guideline.

1. Land (logyard) and marine (mixing zone and background) sampling are required. One objective of the sampling is to relate concentrations of sampled contaminants in the logyard stormwater to concentrations at the mixing zone boundary (see below), in order to understand the dilution achieved. The preference is for the logyard samples to be collected first and the marine samples to be collected second from a small boat. Ideally the marine samples should be collected within 30minutes of the logyard samples. Note there is a separate protocol which covers sampling from a small boat. Anyone undertaking the boat work should be familiar with that Health and Safety SOP.

2. Resources need to be well organised prior to sampling to achieve the above outcome. Personnel need to be available to sample the logyard stormwater monitoring sites and be able to communicate with the personnel collecting the marine samples. If the same people are collecting the logyard samples as the marine samples, then before the logyard samples are collected, the boat needs to have been launched and all equipment loaded and ready for immediate departure. In this case, a technician should remain with the boat while the other person returns to the yard to collect the samples.

3. In the boat, all sample containers and sampling equipment should be secure and have been prepared and located so that it is available in the sequence it will be required. Labelling sample bottles, assembling samplers (secchi disk and van dorn sampler) while ‘underway’ should be avoided if possible. Tracer dye should have been premixed (about 3 tablespoons of dye powder to 5 litres of water should suffice but adjust strength as required after the first sampling round) and dye powder thoroughly dissolved and be in a secure plastic screw top 2 or 5 litre container.

4. Be careful with the dye and in particular the powder concentrate when mixing. It is non-toxic ‘Rhodomine’ dye but makes a big mess if spilt. Be gloved up and in a location where splashes, drips and spill can be handled with plenty of rinsing with water and washed away.

5. Either way this monitoring requires either two or three people. The boat work requires two people and the logyard sampling one person and whatever other people are required to facilitate access to the sampling points.

6. Logyard sampling protocols are already established and are not covered further in this guideline.

7. The marine sample collection can be organised in any sequence preferred by the sampler. The following is suggested.

Northern Discharge

8. Motor to the Northern Discharge sampling area, take a moment to note berthed ships, ship traffic and the ability or any impediments to access the sampling locations. Sampling within 20m of a berthed vessel or mooring hawsers is to be avoided for health and safety reasons.

9. Do things in a sequential and logical sequence and apply judgment as required.

10. Approach the northern stormwater discharge outlet point and release about 1 litre of the tracer dye into the discharge plume, or as close to it as can be safely negotiated in the boat. Note that the dye tracer is simply used as an indicator of the direction and relative dispersion of the surface field of stormwater. Watching this dye disperse for a few minutes should give the observer a clear idea of the direction and dispersion of the stormwater which has come from the pipe. If there is doubt, or the dye field is too light to easily track, then the dye field can be seeded with more dye at any location.

11. Samples are collected on an imaginary 50m radius 'mixing zone edge'. This is an important concept and is a boundary which is specifically mentioned in the resource consent. It is not critical if this is 45m or 55m but it needs to be as close to 50m as the sampler can estimate by sight in the field. Normally this would be done by establishing some land reference points beforehand, or it can be done by using a hand held GPS tracker. Whatever the preference keep it simple and record how it was done. GPS fix the position of each sampled location in any event and ensure that location data is filed with the other field data.

12. Based on the direction and dispersion of the dye field, the observer estimates where the stormwater field would likely cross the mixing zone edge. It is not necessary that the observer/sampler waits until the dye field actually crosses the mixing zone boundary 50m from the outlet point. That can be done but it unnecessarily delays sampling for no particular advantage.

13. Based on that estimation, two surface samples will be collected within the field on the 50m radius line (these represent the discharge stormwater concentration after reasonable mixing), and one sample from elsewhere on the line but beyond the plume (this represents a 'background' condition but close to the outlet point).

14. The location of these two samples within the stormwater field and the other sample is fluid and will depend on the behaviour of the stormwater discharged (as indicated by the dye) on any particular day due to weather and tide.

15. Two samples collected at depth can be at a predetermined mid depth. 4m depth is suggested. These samples will still be on the notional 50m radius line and it is suggested they are also from within the arc of the dispersing field. They will simply be mid depth samples from about the same locations as the two surface samples.

16. Some judgement needs to be applied here depending on weather and wind conditions. If the dye is held close to the quay wall due to 'onshore 'wind and appears to track as a very narrow band (maybe only a metre or so wide) within the mixing zone and across the mixing zone edge, it may not be practical to collect two samples in the field without in essence sampling the same location twice. In this situation collect one surface sample at the probable location of the stormwater field, and one close to it but say 5-10m away, and one elsewhere as described above. Alternatively, there may be occasions when the stormwater appears to be dispersing throughout the entire mixing zone and is considered likely to cross the mixing zone boundary at more or less all points. In that case just collect the 3 samples at equidistant points on the 50m radius boundary.

17. Having finished the mixing zone boundary sampling move to the three background sites within the port zone. Only surface samples are required at those sites.

Southern Discharge

18. This area will only be sampled by boat under very calm and safe sea conditions. These conditions should be established and recorded beforehand.

19. The mixing zone radius for the southern discharge is 30m from the outlet point not 50m.

20. Sampling for this site is to be done on a ‘do what you can’ basis, provided it is safe.

21. It is not necessary to use the tracer day at this stormwater outlet site but this could still be done on some occasions. That is a matter of discretion for the sampler.

22. It may be possible and preferred on some days when the sampling is coincident with a low tide, to sample the mixing zone edge from the intertidal reef. In this case use of the Mighty Gripper might make collecting a sample from the reef edge easier and safer. If possible this could be done from the rock platform on either side of the natural channel which confines the discharge on low tide periods.

Appendix G:

Standard Operating Procedures

Eastland Port

4SIGHT CONSULTING

SOP Number 1.0

SOP Title Sample Handling, Shipment, Recordkeeping and Chain of Custody

	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Jesse Maize	11/12/2014
[illegible]	[illegible]	[illegible]	*Approved via email*	1[illegible]/12/2014
[illegible]	[illegible]	[illegible]	*Approved via email*	24/01/2015

[illegible]	24/01/2015

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]

Sample Handling, Shipment, Recordkeeping, and Chain-of-Custody

1.0 Purpose and Scope

1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, writing sample logs, labelling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Refer to site-specific Health and Safety Plan (HASP).

3.0 Terms and Definitions

3.1 Field Forms and Notes

Example field forms and notes are provided in their associated SOP and are to be completed for all sampling events.

- Standard Operating Procedure #2 for Groundwater Gauging (for groundwater bores)
- Standard Operating Procedure #3 for Groundwater Sampling (for groundwater bores)
- Standard Operating Procedure #4 for Stormwater Sampling (for sump tile drainage)
- Standard Operating Procedure #5 for Surface Water Sampling (for stream)

3.2 Chain-of-Custody

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4.0 Training and Qualifications

4.1 The Infrastructure Manager is responsible for determining which team members shall record information in the field notes and for checking sample logbooks and COC forms to ensure compliance with these procedures. The Infrastructure Manager shall review COC forms on a monthly basis at a minimum.

4.2 The Operations Manager is responsible for ensuring that all field personnel follow these procedures. The Infrastructure Manager is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analysis plan. The Infrastructure Manager is responsible for notifying the laboratory in writing if analytical request changes are required as a corrective action.

4.3 All field personnel are responsible for following these procedures while conducting sampling activities. Field personnel are responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

5.0 Sample Handling and Shipping

5.1 Sample Handling

Immediately following collection, label all samples as described in Section 6, below. The lids of the containers shall not be sealed with duct tape, but shall be placed directly into self-sealing bags. Prior to shipping, wrap glass sample containers on the sides, tops, and bottoms with bubble wrap or other appropriate padding and/or surround them in cushioning material to prevent breakage during transport. Pack all glass containers for water samples in an upright position,

Place the sample containers in an insulated chilly bin with frozen gel packs (e.g., “blue ice”) or ice in sealed self-sealing bags. Samples should occupy the lower portion of the chilly bin, while the ice should occupy the upper portion. Place an absorbent material (e.g., proper absorbent cloth material such as a Chucks wipe or paper towels) on the bottom of the chilly bin to contain liquids in case of spillage. Leave as much air as possible in the self-sealing bags to provide cushioning. Pack as required to avoid breakage of sample containers.

Prior to shipment, replace the ice or cold packs in the chilly bins so that samples will be maintained as close to 4 degrees Celsius (°C) as possible from the time of collection through transport to the analytical laboratory. Ship samples within 24 hours or on a schedule allowing the laboratory to meet holding times for analyses. The procedures for maintaining sample temperatures at 4°C pertain to all field samples. Samples are typically shipped to Hill Laboratories in Hamilton. Shipping address information is provided in Attachment 3.

If samples cannot be shipped the same day as they are collected, the chilly bin should not be sealed. The ice should be replenished/replaced before shipping. In no event may samples be stored in a refrigerator that is used for food; however, samples may be temporarily stored in a refrigerator that is clearly labelled “NOT FOR FOOD”, or similar.

5.2 Shipment

When a chilly bin is ready for shipment to the laboratory, place the chain-of-custody form inside a self-sealing bag and tape it to the inside of the insulated chilly bin. Then, seal the chilly bin with waterproof tape and label it with “Fragile,” “This-End-Up” (or directional arrows pointing up), or other appropriate notices. Tape any drain plugs shut as well. Tape the address label to the top of the chilly bin.

6.0 Recordkeeping

This section provides standards for documenting field activities, labelling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented. The laboratory-provided COC form or computer-generated COC (provided in Appendix A) shall be used.

6.1 Recordkeeping

The field forms and notes serve as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Field forms such as ground-water sampling forms will also be used.

6.2 Sample Labelling

Affix a sample label with adhesive backing to each individual sample container. Record the following information with a waterproof marker on each label:

- COC sample number;
- Date and time of collection;
- Sampler's initials; and
- Analysis to be performed on sample (if possible; there may not be adequate room on the label).

6.3 Custody Definition

For samples intended for analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. A description of sample custody procedures is provided below.

6.4 Sample Collection Custody Procedures

A sample is considered to be in custody if one of the following conditions is met:

- It is in one’s actual physical possession or view;
- It is in one’s physical possession and has not been tampered with (i.e., it is under lock or official seal);
- It is retained in a secured area with restricted access; or
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Field personnel shall also log individual samples onto COC forms (laboratory-supplied or computer generated) when a sample is collected. These forms may also serve as the request for analyses.

The field sampler(s) will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a chilly bin is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form.

The COC form shall be placed inside a self-sealing bag and taped to the inside lid of the chilly bin. Each chilly bin must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying COC forms. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the chilly bins. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. Example COC forms are provided in Attachment 2 and the notes on the following page apply to completing COC forms.

Following are notes related to completing the COC form:

Comments: This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis (e.g., a specific metals list, samples expected to contain high analyte concentrations). If a sample appears heavily contaminated, **field staff** must enter this information to alert the laboratory.

Type of Containers: Write the type of container used (e.g., 1-liter glass amber, for a given parameter in that column).

Preservatives: Field personnel should indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Sample Identification (ID) Number: This is typically a five-character alphanumeric identifier used by the contractor to identify samples. The use of this identifier is important since the laboratories are restricted to the number of characters they are able to use. Sample numbering shall be in accordance with the project-specific sampling and analysis plan.

Description (Sample ID): This name will be determined by the location and description of the sample, as described in the project-specific sampling and analysis plan. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer COC version is used, the sample identification can be input, but printed with this block black. A cross-referenced list of the COC Sample Number and sample identification must be maintained separately.

Date Collected: Record the collection date in order to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

Time Collected: When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations (e.g., 1815 instead of 6:15 p.m.). Record local time; the laboratory is responsible for calculating holding times to local time.

Lab Quote Number: Number from the original lab quote.

Matrix/QC: Identify the matrix (e.g., water, soil, air, tissue, fresh water sediment, marine sediment, or product). If a sample is expected to contain high analyte concentrations (e.g., a tank bottom sludge or distinct product layer), notify the laboratory in the comment section. Mark an “X” for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) purposes. The sample provided for MS/MSD purposes is usually a field duplicate.

Analytical Parameters: Enter the parameter by analysis desired (e.g., BTEX, PAHs, etc.). Whenever practicable, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion.

If the COC does not have a specific box for number of sample containers, use the boxes below the analytical parameter, to indicate the number of containers collected for each parameter.

Sampler’s Signature: The person who collected samples must sign here.

Relinquished By: The person who turned over the custody of the samples to a second party other than an express mail carrier, such as FedEx or DHL, must sign and date here.

Received By: Typically, a representative of the receiving laboratory signs and dates here. Or, a field crew member who delivered the samples in person from the field to the laboratory might sign here

Received By (Laboratory): This space is for the final destination (e.g., at a subcontracted laboratory). A representative of the final destination (e.g., subcontracted laboratory) must sign and date here.

Lab No. and Questions: This box is to be filled in by the laboratory only.

Total # of Containers: Sum the number of containers in that row.

Totals: Sum the number of containers in each column. Because COC forms contain different formats depending on who produced the form, not all of the information listed above may be recorded; however, as much of this information as possible shall be included.

7.0 Quality Control and Assurance

7.1 Recordkeeping, sample labelling, and chain-of-custody activities must incorporate quality control measures to ensure accuracy and completeness.

7.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the Infrastructure Manager.

8.0 Records, Data Analysis, Calculations

8.1 The COC/analytical request form shall be emailed from the laboratory to the Infrastructure Manager for verification of accuracy. Field records are scanned and placed in the project file on the server. Any changes to the analytical requests that are required shall be made in writing to the laboratory. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

8.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in the records. Significant changes shall be approved by the Infrastructure Manager.

9.0 Attachments

Attachment 1 Example Shipping Label

Attachment 2

Shipping Information

Hill Laboratories
ATTN: Sample Reception
1 Clyde Street
Hamilton East
HAMILTON 3216
Tel: 07 858 2000

Scion Laboratories
Attn: Murray Robinson
Te Papa Tipu Innovation Park
49 Sala Street,
ROTORUA 3010
Tel: +64 7 343 5899

Geotechnics
23 Morgan St,
Newmarket
AUCKLAND 1023
Tel: 09 362 1722

□

SOP Number	**4.0**
SOP Title	**STORMWATER SAMPLING**

	NAME	TITLE	SIGNATURE	DATE
Author	Terre Maize	Principal Environmental Consultant Andrew.Stewart Ltd.	Terre Maize	11/12/2014
Reviewer	Mark Poynter	Principal Ecologist Andrew.Stewart Ltd.	*Approved via email.*	17/12/2015
Authoriser	Martin Bayley	Logistics Infrastructure Manager Eastland Port Ltd.	*Approved via email.*	24/01/2015

Effective Date:	25/01/2015

READ BY

NAME	TITLE	SIGNATURE	DATE

STANDART OPERATING PROCEDURE

Stormwater Sampling

1.0 Purpose and Scope

1.1 This Standard Operating Procedure (SOP) provides guidance for collecting stormwater grab (also called dip) samples. The scope of this SOP covers the collection of stormwater grab samples. The stormwater samples may be collected from a variety of sources, including outfalls and manholes

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety Requirements

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the Sampling Contractor's site-specific health and Safety Plan (HASP) approved by EPL.

In no event are personnel to enter manholes or enter areas with unstable ground. Streams and rivers should not be entered without specific safety precautions in place.

2.1 Physical Hazards Associated with Stormwater Sampling

- Use proper tools to lift manhole covers as back strain may result
- Use poles or similar to collect grab samples from depth within manholes
- Stay away from manhole edges and do not enter manholes
- Do not collect samples from outfalls where flooding is occurring or where footing is not secure.

3.0 Qualifications and Training:

3.1 Training and Qualifications

- The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

3.2 Responsibilities:

- The Infrastructure Manager is responsible for ensuring that monitoring well sampling activities comply with this procedure. The Infrastructure Manager is responsible for ensuring that all field-sampling personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- The Infrastructure Manager is responsible for ensuring overall compliance with this procedure.

- The Operations Manager is responsible for ensuring that all field sampling personnel follow these procedures.
- Field sampling personnel are responsible for the implementation of this procedure.
- The field sampler and/or task manager is responsible for directly supervising the groundwater sampling procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

4.0 Procedure

4.1 Method Summary

Though it is not always feasible to collect discernable stormwater flows (discharges may be too shallow to collect a sample with a sample bottle, for example), a grab sample can be taken from any of several possible locations where water is flowing, including a pipe, swale or ditch. The site specific sampling plans and consents detail the areas/outfalls to be sampled.

1.) Collect sample in accordance with consent and management plan requirements (i.e., first flush, composite, etc.). Before you go outside, write the name of the person collecting the sample and the date the sample was collected on the collection bottle label.

2.) Put on the clean gloves. This prevents the possibility of your fingers or hands accidentally contaminating the sample. And when you remove the bottle's cap, be sure to place it on an uncontaminated surface (not on the ground) to prevent cross-contamination.

3.) Hold the bottle so the opening is facing upstream.

4.) Take care not to disturb the bottom of the stormwater flow, or walk in the discharge - both situations could contaminate your sample. Collect the sample from as close to the middle of the stormwater flow as possible; this provides the most representative sample of that discharge.

5.) Fill a decontaminated 0.5 L bottle with collected water and insert water quality metre (WQM) probes, record reading of pH, temperature, conductivity, and dissolved oxygen as required per sample location.

6.) Fill the lab's collection bottle as instructed by the lab. When preservatives are present in the bottle, fill a decontaminated container (see Standard Operating Procedure for Equipment Decontamination) from the flowing water and use this to fill the laboratory-provided bottle. Be sure to handle the preservative carefully; most are acids or bases and can cause skin or eye irritation if not handled correctly.

7.) Once filled, cap the sample bottle, write the time the sample was collected and place it inside a re-sealable plastic bag. Place the bag into a chilly bin and prepare the chilly bin for pickup or shipment to the lab. Take notes about how the sampling event went, and record a photo to document the facility's conditions. Detailed instructions are provided in the SOP: Sample Handling, Storage, and Shipping and SOP: Sample Handling, Storage, Shipment, and Recordkeeping.

5.0 Quality Control and Assurance

5.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific scope of works. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.

5.2 Quality control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific scope of works will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various QC samples such as trip blanks, field blanks, equipment rinse blanks, and field duplicate samples. Typically, duplicates are collected at a minimum rate of 10%.

6.0 Procedures, standards and references

SOP # 1: *Recordkeeping, Sample Labelling, and Chain-of-Custody*.

SOP # 6: *Equipment Decontamination*.

7.0 Attachments

Attachment 1 – Stormwater Sampling Form

Attachment 2 – Equipment Requirements

Attachment 1

Stormwater Sampling Form

Attachment 2

Equipment Requirements

Required Equipment

For each monitoring location, you will need:

- One pair powder-free, disposable nitrile or latex gloves
- One decontaminated bottle for collecting the sample
- Laboratory-supplied bottles
- Chilly bins for shipping the sample
- Ice
- Water Quality Metre (order from Geotechnics)
- Zipper locking bags
- Field Forms, pen & pencil, permanent marker.
- One camera for a visual record of sampling conditions
- Grab pole, zip ties, or similar equipment to reach sampling points.

SOP Number **6.0**

SOP Title **EQUIPMENT DECONTAMINATION**

	NAME	TITLE	SIGNATURE	DATE
Author	Terre Maize	Principal Environmental Consultant Andrew.Stewart Ltd.	Terre Maize	11/12/2014
Reviewer	Mark Poynter	Principal Ecologist Andrew.Stewart Ltd.	*Approved via email.*	17/12/2014
Authoriser	Martin Bayley	Logistics Infrastructure Manager Eastland Port Ltd.	Approved via email.	24/01/2015

Effective Date:	25/01/2015

READ BY			
NAME	TITLE	SIGNATURE	DATE

1.0 Purpose and Scope

1.1 This Standard Operating Procedure (SOP) describes methods of equipment decontamination, to be used for activities where samples for chemical analysis are collected or where equipment will need to be cleaned before leaving the site or before use in subsequent activities.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety Requirements

Typically, for equipment, a series of buckets are set up on a plastic-lined bermed area. Separate spray bottles containing cleaning solvents as described in this procedure and distilled water or deionised are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

All Field Personnel responsible for equipment decontamination must adhere to the site-specific health and safety plan (HASP) and must wear the personal protective equipment (PPE) specified in the Sampling Contractor's site-specific HASP. Generally, this includes, at a minimum, steel-toed boots, safety glasses, hard hats, and hearing protection (if heavy equipment is in operation). Nitrile and/or rubber gloves should also be used during decontamination to prevent skin contact with decontamination fluids and contaminants.

In addition to the aforementioned precautions, the following sections describe safe work practices that will be employed.

2.1 Chemical Hazards Associated with Equipment Decontamination

- Avoid skin contact with and/or incidental ingestion of decontamination solutions and water.
- Utilize PPE as specified in the site-specific HASP to maximize splash protection.
- Refer to material safety data sheets, safety personnel, and/or consult sampling personnel regarding appropriate safety measures (i.e., handling, PPE including skin and respiratory).
- Take the necessary precautions when handling detergents and reagents.

2.2 Physical Hazards Associated with Equipment Decontamination

- To avoid possible back strain, it is recommended to raise the decontamination area approximately 0.5m to 1m above ground level. Surfaces may become slippery when wet; use caution and clean up spills immediately.
- To avoid heat stress, over exertion, and exhaustion, it is recommended to rotate equipment decontamination among all site personnel.
- Take necessary precautions when handling field sampling equipment.

3.0 Qualifications and Training:

3.1 Training and Qualifications

- The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

3.2 Responsibilities:

- The Infrastructure Manager is responsible for ensuring that monitoring well sampling activities comply with this procedure. The Infrastructure Manager is responsible for ensuring that all field-sampling personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks.
- The Infrastructure Manager is responsible for ensuring overall compliance with this procedure.
- The Operations Manager is responsible for ensuring that all field sampling personnel follow these procedures.
- Field sampling personnel are responsible for the implementation of this procedure.
- The field sampler and/or task manager is responsible for directly supervising the groundwater sampling procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

4.0 Required Equipment

The following equipment and supplies are required:

- Decon 90 or similar phosphate-free detergent
- Clean tap water
- Distilled or deionised water
- Buckets
- Spray bottles
- Plastic sheeting or large rubbish bags
- Brushes (a toilet brush works well)
- Paper towels
- Aluminium foil or plastic (for wrapping clean equipment)
- Drums, buckets, or other suitable containers for waste containerisation
- Personal protective equipment – nitrile and/or rubber gloves, safety glasses and/or face shield required; disposable coveralls may also be required, depending on contaminant(s)

Pressure washer and material to construct bunded and lined area for containment of decontamination water (for heavy equipment decontamination only)

5.0 Procedure

5.1 Method Summary

Decontamination of equipment used in soil/sediment sampling, groundwater monitoring, well drilling and well development, as well as equipment used to sample groundwater, surface water, sediment, waste, asbestos, and the unsaturated zone, is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- Location where the decontamination procedures will be conducted
- Types of equipment requiring decontamination
- Frequency of equipment decontamination
- Cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- Method for containing the residual contaminants and wash water from the decontamination process
- Use of a quality control measure to determine the effectiveness of the decontamination procedure

The following subsections describe standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

5.2 Decontamination Area

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment

5.3 Types of Equipment

Decontamination of sampling equipment includes submersible pumps, bailers, interface probes, water level meters, and peristaltic pumps. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels, hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers.

Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

5.4 Frequency of Equipment Decontamination

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

5.5 Cleaning Solutions and Techniques

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A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools.

The decontamination procedure shall consist of the following:

1.) Wash with a non-phosphate detergent (Decon 90 or other suitable detergent) and potable water solution;

2.) rinse with potable water;

3.) rinse with deionized or distilled water; and

4.) spray with deionized or distilled water.

If possible, disassemble equipment prior to cleaning. Add a second wash at the beginning of the process if equipment is very soiled. Rinses with nitric acid or laboratory-grade isopropyl alcohol may also be required, depending on site-specific conditions and contaminants.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 1m) large-diameter pipe (100mm or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and potable water; (2) potable water rinse; (3) potable water rinse; and (4) deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Some decontamination solvents have health effects that must be considered. Decontamination water shall consist of distilled or deionized water. Steam-distilled water shall not be used in the decontamination process as this type of water usually contains elevated concentrations of metals. Decontamination solvents to be used during field activities will be specified in the scope of works.

Rinse equipment used for measuring field parameters, such as pH (indicates the hydrogen ion concentration – acidity or basicity), temperature, specific conductivity, and turbidity with deionized or distilled water after each measurement.

5.6 Containment of Residual Contaminants and Cleaning Solutions

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drill rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers until their disposition is determined by laboratory analytical results. Label containers in and arrange for appropriate disposal.

6.0 Quality Control and Assurance

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

7.0 Procedures, standards and references

Any project where sampling and analysis is performed shall be executed in accordance with an approved scope of works. This procedure may be incorporated by reference or may be incorporated with modifications described in the scope or HASP.

Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the Infrastructure Manager.

Eastland Port

4SIGHT CONSULTING

SOP Number **7.0**

SOP Title COLLECTION OF WATER SAMPLES FROM A BOAT

	NAME	TITLE	SIGNATURE	DATE
Author	Pamela Kane	Ecology Consultant		27/09/2016
Reviewer and approved for release by	Mark Poynter	Principal Ecologist		10/10/2016

Effective Date:	10/10/2016

READ BY

NAME	TITLE	SIGNATURE	DATE

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) is for the collection of water samples from streams, rivers, lakes, ponds, lagoons, embayment's, from a boat. It includes samples collected at the surface and at depth.

As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

This SOP sets a consistent protocol to ensure the quality of data collection—resulting in improved uniformity, reproducibility, verifiability, and defensibility of the data.

2.0 Safety Requirements

When sampling, the person performing the sampling should be wearing a lifejacket and adequate protective equipment and following appropriate boating safety procedures (See: Code of Practice for Safe Use of Small Boats).

A detailed health and safety plan is required for all sampling works. Staff training is required to help assure that sampling is conducted in a safe manner. Hazards, such as strong currents, can lead to severe injury or death, so special precautions are required.

3.0 Qualifications and Training:

3.1 Training and Qualifications

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP and the Code of Practice for Safe Use of Small Boats.

3.2 Responsibilities:

- The Infrastructure Manager is responsible for ensuring that sampling activities comply with this procedure. The Infrastructure Manager is responsible for ensuring that all field-sampling personnel involved shall have the appropriate education, experience, and training to perform their assigned tasks.
- The Infrastructure Manager is responsible for ensuring overall compliance with this procedure.
- The Operations Manager is responsible for ensuring that all field sampling personnel follow these procedures.
- Field sampling personnel are responsible for the implementation of this procedure.

4.0 Guidelines and Procedure

4.1 Method Summary

Sampling situations vary widely, and, therefore, no universal sampling procedure can be recommended.

However, sampling of water from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Dip/Mighty Gripper Sampler
- Direct Method
- Van Dorn Sampler

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and at selected depths.

4.2 Preparation

1) Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2) Obtain necessary sampling and monitoring equipment.
3) Decontaminate or pre-clean equipment, and ensure that it is in working order.
4) Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5) Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6) If necessary, use anchored buoys to identify and mark sampling locations.
7) GPS fix the positions of sampling sites if required.
8) Preferably, clearly pre-label sample bottles unless this can be done with dry hands on site.
9) Arrange sample containers in the order in which they will be collected.

4.3 Sampling Considerations

If surface water samples are required, direct dipping of the sample container into the water is desirable. Ensure the sample is collected ‘up current’ or away from any water which may have been influenced by the boat motor exhaust.

4.4 Sample Container Composition

Sample containers should be provided by the laboratory and be particular to the analyte(s) to be measured (they may be glass, plastic or Teflon). For example, devices which are free of metal surfaces should be used for collecting samples for metal analyses.

4.5 Dip/Mighty Gripper Sampler

A dip sampler is useful for situations where a sample is to be recovered from a high sided boat, or an outfall pipe or along a lagoon bank where direct access is limited and or for Health or Safety or reasons of practicality, should not be collected by hand. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1) Ensure that the sample container is pre labelled.
2) Assemble the device and ensure the sample container is securely affixed in the bottle grip-end.
3) Remove the sample container lid, being mindful that some laboratory sample bottles may contain acid (but see also below). Where any containers are being used which contain acid, ensure that appropriate Health and Safety protocols are applied.
4) Extend the device to the sample location and collect the sample being mindful of potential contamination sources at the water surface, or, collect the sample in a separate container, pre rinsed in the waters to be sampled, and then decant into the container supplied by the laboratory.
5) Retrieve the sampler and replace the container lid, or transfer the sample to the appropriate sample container as appropriate.

4.6 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilised to collect water samples from the surface. This method is not to be used for sampling contaminated lagoons or other impoundments where contact with contaminants are a concern, unless appropriate gloveware and applicable Health and Safety precautions are used.

Preferably, submerse the closed sample container, open the bottle/remove the cap, collect the sample and then cap the bottle while sub-surface. The collection bottle may be rinsed two times by the water body to be sampled at the sampling location. Avoiding entrain surface debris and the boat exhaust water into the sampling zone.

When using the direct method, do not use pre-preserved sample bottles as the collection method. This may dilute the concentration of preservative necessary for proper sample preservation. Collect in a separate clean container as described above and decant into the container containing the fixative.

4.7 Van Dorn Sampler

Van Dorn Samplers (Figure 1) are intended for shallow or deep waters. Van Dorn water sample collections should be taken before any sampling procedure or activity that may disturb bottom sediments to avoid increasing turbidity at the location. When discrete samples are desired from a specific depth a Van Dorn sampler will be used according to the following instructions.

- Open the Van Dorn water sampler by pulling the elastic bands and lids back and secure the hooks.
- Make sure the mechanism is locked so that it will be released by the releasers weight.
- Make sure the drain valve is closed.
- Attach the free end of the messenger line to the boat.
- Rinse the open sampler by immersing it in the water column.
- Lower the sampler to the desired depth. Avoid bottom disturbance.
- When the Van Dorn sampler is at the required depth, send down the messenger, closing the sampling device.
- Retrieve the sampler and set on a clean flat surface in a horizontal position.
- Discharge the first 10-20 ml to clear any potential contamination on the valve.
- Transfer the sample to the appropriate sample container. The amount of water flowing through the tubing can be adjusted by adjusting the air valve.

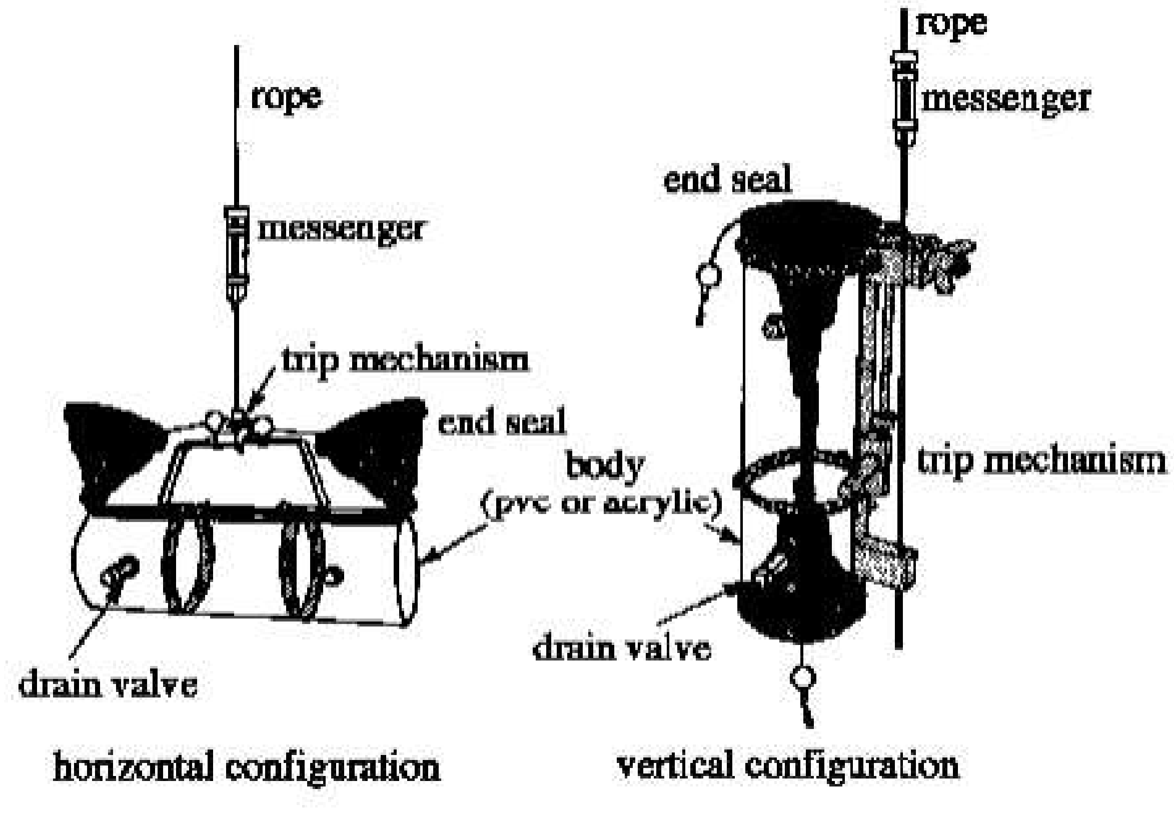

Figure 1: Van Dorn Sampler (Horizontal and Vertical Sampler)

4.8 Sample Preservation, Containers, Handling and Storage

Once samples have been collected, follow these procedures:

- Transfer the sample(s) into suitable labelled sample containers.
- Fill a decontaminated 0.5 L bottle with collected water and insert water quality metre (WQM) probes, record reading of pH, temperature, conductivity, and dissolved oxygen as required per sample location
- Preserve the sample if appropriate, or use pre-preserved sample bottles.
- Cap the container, put it in a Ziploc plastic bag and place a chilly bin, cooled as appropriate.
- Record all pertinent data in the site logbook or on a field data sheet.
- Rinse/Decontaminate all sampling equipment prior to the collection of further samples.
- On land, complete the chain of custody form.

See SOPs for Equipment Decontamination and for Sample Handling, Storage, and Recordkeeping, and Recordkeeping, Sample labelling, and Chain of Custody.

4.9 Interferences and Potential Problems

There are two primary interferences or potential problems with surface water sampling. These include cross-contamination of samples and improper sample collection.

Cross-contamination problems can be eliminated or minimised through the use of dedicated sampling equipment. Always collect samples from low-contaminant to high-contaminant concentration areas and decontaminate/rinse equipment between samples.

Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimising disturbance of the sample site will eliminate these problems.

5.0 Quality Control and Assurance

Manufacturer's instructions, if any, for calibrating or maintaining the accuracy of the instrument shall be followed.

6.0 Procedures, standards and references

SOP, *Recordkeeping, Sample Labelling, and Chain-of-Custody*.

SOP, *Equipment Decontamination*.

7.0 Equipment requirements

Equipment needed for collection of water samples includes:

- Dip/Mighty Dipper Sampler
- Water Quality Meter

- Van Dorn Sampler, graduated line and messenger weight assembled
- Labelled Sample collection bottles
- Self-sealing plastic bags
- Pre frozen chilli paks as appropriate
- Chilly bin(s)
- Chain of custody forms, field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Camera
- Logbook/forms and waterproof pen

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Appendix D:

Photographs

Photo 1: Manhole 1 (Photograph taken during sampling on 03/11/2021)

Photo 2: Manhole 11 (Photograph taken during sampling on 03/11/2021)

Photo 3: Manhole 9 (Photograph taken during sampling on 03/11/2021)

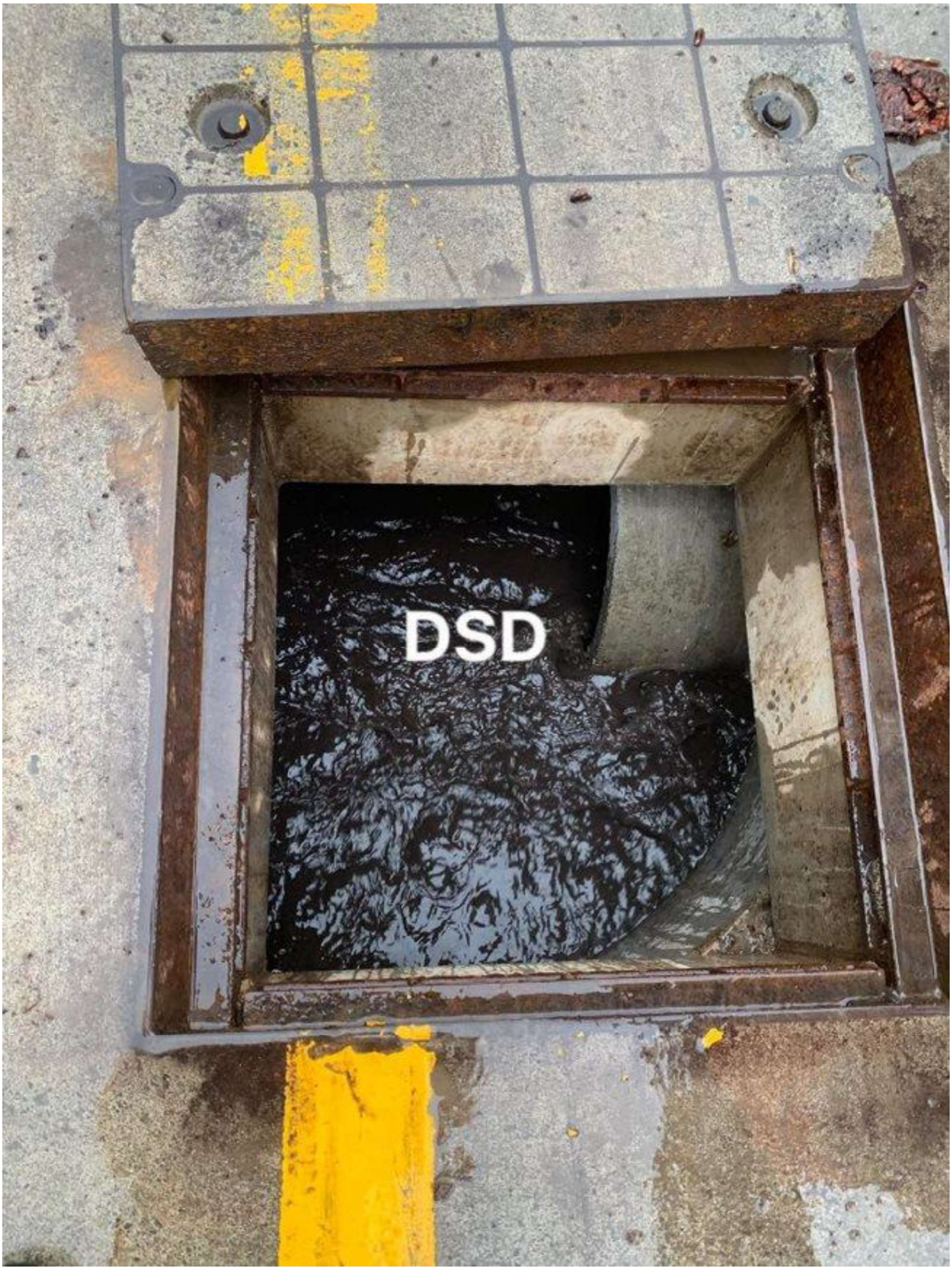

Photo 4: Post DSD (Photograph taken during sampling on 03/11/2021)

Photo 5: Kaiti Beach Rd (Photograph taken during sampling on 03/11/2021)

Appendix E:

Field Sheets

Eastland Port

4SIGHT CONSULTING

Marine Water Sampling Form

Job Information		**Equipment**	
Date: 3/11/21	**Time:** Arrive: 0800 Depart: 1030	**Water quality equipment description:** Temp	Calibration Records Filed? [✓ Y] N NA
Project Name: EPL Outsourced Compliance Programme	**Project Number:** AA1146	**Interface Probe Number:** 14	Calibration Records Filed? [✓ Y] N NA
Site Location: Southern logyard	**Operator:** D Williams	**Sampling Equipment Type:** Grabs	
Weather: Heavy Rain	**Rainfall event start time/date:** 2am	~~Event Rainfall~~ **Depth:**	**Number of dry days before sampling:** 7

Reason for sampling: Standard Compliance Programme (Circle frequency: Monthly/2 Monthly/[✓ Quarterly]/6 Monthly) or Additional Monitoring (describe):

Sample Details				Water Quality Parameters			Observations					
EPL Site Number	#406 Lab Sample ID	Sample Time	Depth of sample	Temp (°C)	Salinity (ppt)	pH	Debris? (Y/N: type)	Foams/Scums (Y/N)	Visual clarity (Clear/Lightly Turbid/Turbid/Very Turbid)	Secchi depth (m)	Dredging Influence (Y/N)	Photos reference
MH1 Mix Zone 1	4911	0945	Surface	14.3	32.2	8.0	N	N	Lightly Turbid	0.3	N	
" Mix Zone 2	4912	0940	Surface	15.1	33.3	8.1	N	N	Clear	1.0	N	
MZ 3	4913	0935	Surface	15.1	33.3	8.0	N	N	Clear	1.1	N	
Mid Depth 4	4914	0947	3m	15.1	32.~~9~~6	8.1	N	N	Clear	–	N	
Mid Depth 5	4915	0938	3m	15.2	32.~~4~~9	8.1	N	N	Clear	–	N	
MZ Comp	4916	0940	Surface	15.0	32.8	8.0	N	N	Lightly Turbid	0.6	N	
Background 1	4917	0953	Surface	15.0	34.5	8.1	N	N	Clear	0.5	N	
BG 2	4918	0958	Surface	15.1	26.9	8.0	N	N	Light Turbid (River)	0.3	N	
BG 3	4919	1006	Surface	15.1	31.1	8.0	N	N	Clear	0.9	N	

Sample Details				Water Quality Parameters			Observations					
EPL Site Number	Lab Sample ID	Sample Time	Depth of sample	Temp (°C)	Salinity (ppt)	pH	Debris? (Y/N: type)	Foams/Scums (Y/N)	**Visual clarity** (Clear/Lightly Turbid/Turbid/Very Turbid)	Secchi depth (m)	Dredging Influence (Y/N)	Photos reference

Additional Comments:

Locations not sampled (reasons):

Field Quality Control Checks					
Was pre-cleaning sampling equipment used for these samples?	[✓ Y]	N	Consistent with COC form?	[✓ Y]	N
Was pre-cleaning sampling equipment properly protected from contamination?	[✓ Y]	N	COC Filled out?	[✓ Y]	N
Sampling has been undertaken in accordance with the Site Specific Sampling Protocol and SOPs?	[✓ Y]	N	Signed: D Williams		

Eastland Port 4SIGHT CONSULTING

Stormwater Sampling Form

Job Information		**Equipment**				
Date:	**Time:** Arrive: 0800 Depart: 1030	**Water quality equipment description:**	Calibration Records Filed?	[✓ Y]	N	NA
Project Name: EPL Outsourced Compliance Programme	**Project Number:** AA1146	**Interface Probe Number:** 14	Calibration Records Filed?	[✓ Y]	N	NA
Site Location: Southern logyard	**Operator:**	**Sampling Equipment Type:**				
Weather: Heavy Rain	**Rainfall event start time/date:** 2am 3/11/21	**Event Rainfall Depth:**	**Number of dry days before sampling:** 7			
Reason for sampling: Standard Compliance Programme (**Circle frequency**: Monthly/2 Monthly/[✓ Quarterly]/6 Monthly) or Additional Monitoring (describe):						

Sample Details #405					**Observations**			
EPL Site Number	**Lab Sample ID**	**Sample Time**	**Pipe Flow Depth (m)**	**Flow (Strong/Moderate/Light)**	**Debris Present** (Y/N: type)	**Foams/Scums**	**Clarity** (Clear/Slightly Turbid/Turbid/Very Turbid)	**Photos Reference**
MH1	4906	0835		Moderate	Y only lite	N	Turbid	
MH11	4907	0821		Moderate	Y Lite	N	Turbid	
DSD	4908	0810		Strong	Y Lite	N	Turbid	
MH9	4908	0847		Strong	Y Lite	N	Turbid	
Kaiti Bch	4910	0900		Moderate	Y Lite	N	Turbid	

Additional Comments:

Field Quality Control Checks					
Was pre-cleaning sampling equipment used for these samples?	[✓ Y]	N	Consistent with COC form?	[✓ Y]	N
Was pre-cleaning sampling equipment properly protected from contamination?	[✓ Y]	N	COC Filled out?	[✓ Y]	N
Sampling has been undertaken in accordance with the Site Specific Sampling Protocol and SOPs?	[✓ Y]	N	Signed: D Williams		

Prepared by 4Sight Consulting Limited for Eastland Port Limited

Eastland Port

Daily Summary Sheet

4SIGHT CONSULTING

Site Name: Southern logyard	
Operator: Dion Williams	**Date:** 3/11/21
Reason for Visit: Quarterly	**Weather Conditions:** Heavy Rain

Time	Comments
MH1	Medium flow Light Debri Discolour turbid
MH11	" " " " " "
DSD	Strong flow, Quite Full, Light Debri
MH9	Strong ~~Modrat~~ flow, Light Debri Turbid
Kaiti Bch	Moderate flow, Light Debri, Turbid.
	Marine Sites
	Other than Plume heading along Wall out
	to harbour Entrance Direction the harbour
	was Quite Clear.
	Background Site 2 was murky Muddy
	look but the River had started to brown
	and was the Cause of this site discolouring

Aerial imagery sourced from Gisborne District Council GIS viewer (2017).

N

Scale 1:2,000 @ A4

0 40 80m

AA1146 - Outsourced Compliance Program

Southern Logyard Stormwater Outfall: **Northern Site**

Figure prepared for Eastland Port Ltd by 4Sight Consulting.

Date: 18/04/2019
Version: 0.1
Drawn: Sam Hendrikse
Checked: Oliver Bone
Approved: Mark Poynter

4SIGHT CONSULTING

Appendix F:

Laboratory Analysis Reports

linnaeus

Analysis Report

Customer: Eastland Port

Address: 1 Kaiti Beach Road
Gisborne, 4010

Attention: Marie Knue

Date Received: 3/11/2021 10:30 AM

Date Completed: 10/11/2021 10:27 AM

Purchase Order #:

Sample Type: Water

	Units	2021004906 SLY MH1	2021004907 SLY MH11	2021004908 SLY Pst DSD	2021004909 SLY MH9
		3/11/2021 8:35	3/11/2021 8:21	3/11/2021 8:10	3/11/2021 8:47
Test					
Site Visit		Sampling	Sampling	Sampling	Sampling

	Units	2021004910 SLY Kaiti Beach Rd
		3/11/2021 9:00
Test		
Site Visit		Sampling

Comments: These samples were also analysed byRJ Hill Laboratories. Please see attached report.

Test Standards:

Test	Methodology
Site Visit	*

Authorised By:

Kyrste Barton
Laboratory Technician
BSc Biological Sciences

Certified By:

Stephanie Brew
Water Chemistry KTP
Dipl. Biologist

S. Brew

The NZ mark of competence
Tohu Matatau Aotearoa

Tests indicated as not accredited are outside the scope of the laboratory's accreditation

Methods marked with a * are not IANZ accredited.

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“Detailed activity” stating the start and completion dates and times of individual tests have not been recorded on this report. This information is available upon request.

linnaeus

Analysis Report

Customer:	Eastland Port	Date Received:	3/11/2021 10:30 AM
Address:	1 Kaiti Beach Road Gisborne, 4010	Date Completed:	10/11/2021 9:58 AM
Attention:	Marie Knue	Purchase Order #:	

Sample Type: Water

	Units	2021004911 SLY MH1 - Mixing Zone Site 1 Surface	2021004912 SLY MH1 - Mixing Zone Site 2 Surface	2021004913 SLY MH1 - Mixing Zone Site 3 Surface	2021004914 SLY MH1 - Mixing Zone Site 4 Mid Depth
		3/11/2021 9:45	3/11/2021 9:40	3/11/2021 9:35	3/11/2021 9:47
Test					
pH - Water		8.0	8.1	8.0	8.1
Salinity	ppt	32.2	33.3	33.3	32.6
Temperature on Site	°C	14.3	15.1	15.1	15.1

	Units	2021004915 SLY MH1 - Mixing Zone Site 5 Mid Depth	2021004916 SLY MH1 - Site 1 - Mixing Zone Composite	2021004917 SLY MH1 - Background Site 2 Surface	2021004918 SLY MH1 - Background Site 2 Surface
		3/11/2021 9:38	3/11/2021 9:40	3/11/2021 9:53	3/11/2021 9:58
Test					
pH - Water		8.1	8.0	8.1	8.0
Salinity	ppt	32.9	32.8	34.5	26.9
Temperature on Site	°C	15.2	15.0	15.0	15.1

	Units	2021004919 SLY MH1 - Background Site 3 Surface
		3/11/2021 10:06
Test		
pH - Water		8.0
Salinity	ppt	31.1
Temperature on Site	°C	15.1

Comments:

Test Standards:

Test	Methodology
pH - Water	APHA 23rd 4500-H+ B. Unless stated, measured between 18-22°C
Salinity	APHA 23rd Ed 2520 B
Temperature on Site	APHA 23rd Ed 2550 B

Authorised By:	Certified By:
Lucas Campton Laboratory Technician Bachelor Science	Stephanie Brew Water Chemistry KTP Dipl. Biologist

S. Brew

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The NZ mark of competence
Tohu Matatau Aotearoa

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Methods marked with a * are not IANZ accredited.

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"Detailed activity" stating the start and completion dates and times of individual tests have not been recorded on this report. This information is available upon request.

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

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W www.hill-laboratories.com

Certificate of Analysis

Page 1 of 1

Client:	4SIGHT Consulting Limited	**Lab No:**	2755898 SPv1
Contact:	Marie Knue C/- 4SIGHT Consulting Limited PO Box 402053 Tutukaka 0153	**Date Received:**	04-Nov-2021
		Date Reported:	08-Nov-2021
		Quote No:	73295
		Order No:	AA1146
		Client Reference:	AA1146-PSize-SLY
		Submitted By:	Stephanie Brew

Sample Type: Aqueous

Sample Name:	SLY MH1 03-Nov-2021 8:35 am	SLY MH11 03-Nov-2021 8:21 am	SLY MH9 03-Nov-2021 8:47 am	SLY Pst DSD 03-Nov-2021 8:10 am	SLY Kaiti Beach Rd 03-Nov-2021 9:00 am
Lab Number:	2755898.1	2755898.2	2755898.3	2755898.4	2755898.5
Particle size analysis‡	See attached report	See attached report	See attached report	See attached report	See attached report

Analyst's Comments

‡ Analysis subcontracted to an external provider. Refer to the Summary of Methods section for more details.

Appendix No.1 - Waikato University Report

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Particle size analysis	Malvern Laser Sizer particle size analysis from 0.05 microns to 3.4 mm. Samples are measured in volume %. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-5

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed on 08-Nov-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Analysis - Under

Malvern Instruments

Measurement Details

Sample Name	2755898.1
SOP File Name	HydroLV.cfg
Lab Number	2021244/1
Operator Name	hharveyw

Measurement Details

Analysis Date Time	5/11/2021 2:13:05 PM
Measurement Date Time	5/11/2021 2:13:05 PM
Result Source	Measurement

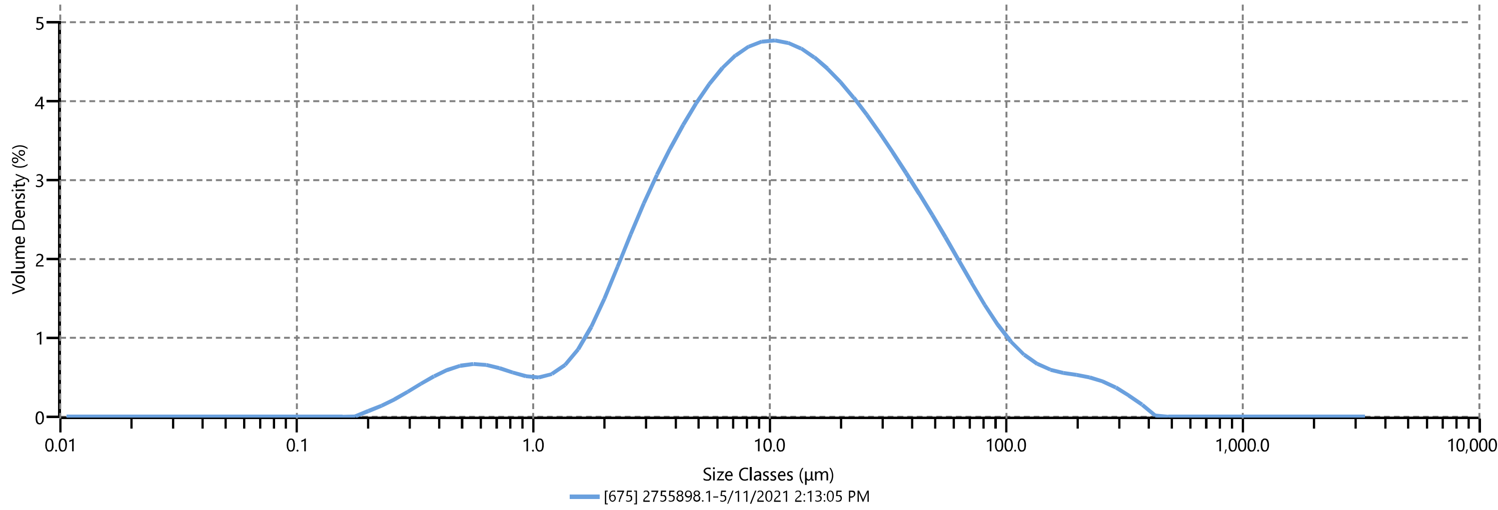
Analysis

Particle Name	Water
Particle Refractive Index	1.500
Particle Absorption Index	0.010
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.31 %
Laser Obscuration	19.47 %

Result

Concentration	0.0164 %
Span	5.046
Uniformity	1.816
Specific Surface Area	1406 m^2/kg
D [3,2]	4.27 µm
D [4,3]	25.7 µm
Dv (10)	2.26 µm
Dv (50)	11.3 µm
Dv (90)	59.3 µm
Volume Below (10) µm	46.19 %
Volume Above (2.5) µm	88.66 %

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0597	0.00	0.357	0.98	2.13	9.27	12.7	53.68	76.0	92.98	454	100.00	2710	100.00
0.0114	0.00	0.0679	0.00	0.405	1.40	2.42	10.85	14.5	57.57	86.4	94.16	516	100.00	3080	100.00
0.0129	0.00	0.0771	0.00	0.460	1.90	2.75	12.78	16.4	61.37	98.1	95.13	586	100.00	3500	100.00
0.0147	0.00	0.0876	0.00	0.523	2.44	3.12	15.04	18.7	65.05	111	95.92	666	100.00		
0.0167	0.00	0.0995	0.00	0.594	3.00	3.55	17.60	21.2	68.59	127	96.58	756	100.00		
0.0189	0.00	0.113	0.00	0.675	3.55	4.03	20.43	24.1	71.96	144	97.13	859	100.00		
0.0215	0.00	0.128	0.00	0.767	4.07	4.58	23.52	27.4	75.16	163	97.63	976	100.00		
0.0244	0.00	0.146	0.00	0.872	4.54	5.21	26.83	31.1	78.15	186	98.09	1110	100.00		
0.0278	0.00	0.166	0.00	0.991	4.96	5.92	30.35	35.3	80.94	211	98.53	1260	100.00		
0.0315	0.00	0.188	0.00	1.13	5.38	6.72	34.04	40.1	83.52	240	98.95	1430	100.00		
0.0358	0.00	0.214	0.06	1.28	5.83	7.64	37.86	45.6	85.88	272	99.33	1630	100.00		
0.0407	0.00	0.243	0.18	1.45	6.37	8.68	41.78	51.8	88.01	310	99.64	1850	100.00		
0.0463	0.00	0.276	0.36	1.65	7.08	9.86	45.74	58.9	89.91	352	99.87	2100	100.00		
0.0526	0.00	0.314	0.63	1.88	8.02	11.2	49.72	66.9	91.57	400	100.00	2390	100.00		

Analysis - Under

Malvern Instruments

Measurement Details

Sample Name	2755898.2
SOP File Name	HydroLV.cfg
Lab Number	2021244/2
Operator Name	hharveyw

Measurement Details

Analysis Date Time	5/11/2021 2:35:04 PM
Measurement Date Time	5/11/2021 2:35:04 PM
Result Source	Measurement

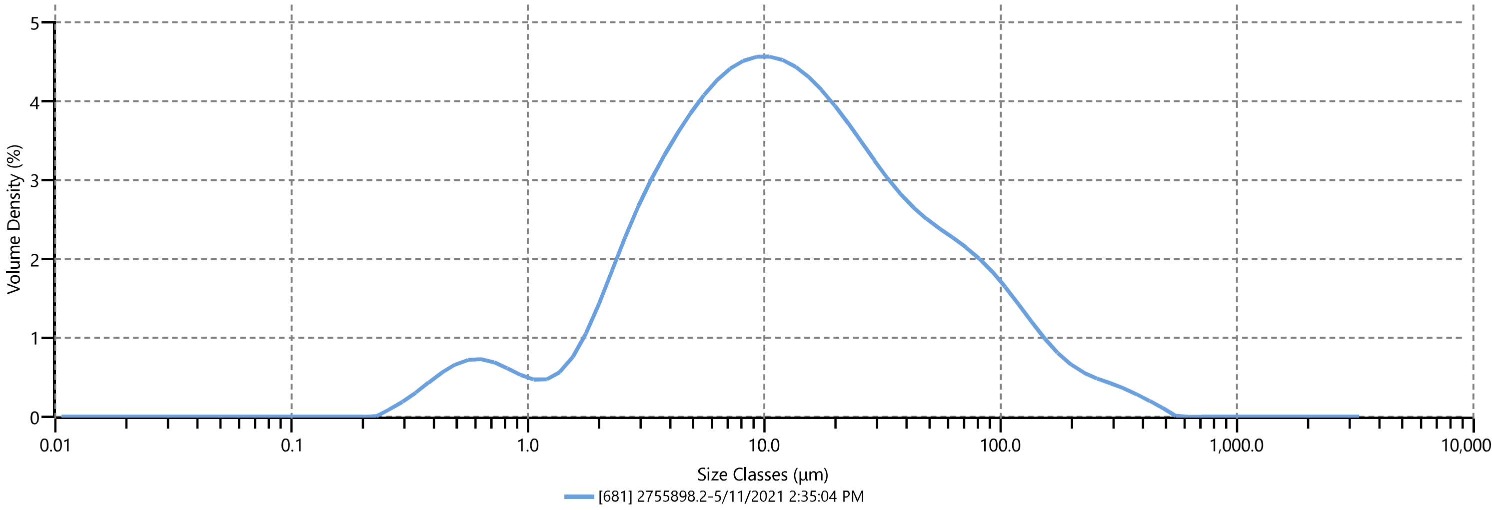
Analysis

Particle Name	Water
Particle Refractive Index	1.500
Particle Absorption Index	0.010
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.27 %
Laser Obscuration	15.36 %

Result

Concentration	0.0131 %
Span	6.523
Uniformity	2.152
Specific Surface Area	1269 m²/kg
D [3,2]	4.73 µm
D [4,3]	31.4 µm
Dv (10)	2.40 µm
Dv (50)	12.1 µm
Dv (90)	81.2 µm
Volume Below (10) µm	44.39 %
Volume Above (2.5) µm	89.41 %

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0597	0.00	0.357	0.49	2.13	8.57	12.7	51.54	76.0	89.13	454	99.90	2710	100.00
0.0114	0.00	0.0679	0.00	0.405	0.85	2.42	10.11	14.5	55.24	86.4	90.81	516	100.00	3080	100.00
0.0129	0.00	0.0771	0.00	0.460	1.32	2.75	12.02	16.4	58.83	98.1	92.34	586	100.00	3500	100.00
0.0147	0.00	0.0876	0.00	0.523	1.88	3.12	14.25	18.7	62.29	111	93.72	666	100.00		
0.0167	0.00	0.0995	0.00	0.594	2.48	3.55	16.76	21.2	65.57	127	94.91	756	100.00		
0.0189	0.00	0.113	0.00	0.675	3.09	4.03	19.54	24.1	68.68	144	95.91	859	100.00		
0.0215	0.00	0.128	0.00	0.767	3.67	4.58	22.54	27.4	71.58	163	96.74	976	100.00		
0.0244	0.00	0.146	0.00	0.872	4.19	5.21	25.75	31.1	74.29	186	97.41	1110	100.00		
0.0278	0.00	0.166	0.00	0.991	4.63	5.92	29.15	35.3	76.81	211	97.96	1260	100.00		
0.0315	0.00	0.188	0.00	1.13	5.02	6.72	32.71	40.1	79.17	240	98.43	1430	100.00		
0.0358	0.00	0.214	0.00	1.28	5.41	7.64	36.39	45.6	81.38	272	98.83	1630	100.00		
0.0407	0.00	0.243	0.00	1.45	5.87	8.68	40.15	51.8	83.46	310	99.19	1850	100.00		
0.0463	0.00	0.276	0.08	1.65	6.50	9.86	43.96	58.9	85.45	352	99.49	2100	100.00		
0.0526	0.00	0.314	0.24	1.88	7.37	11.2	47.77	66.9	87.34	400	99.73	2390	100.00		

Analysis - Under

Malvern Instruments

Measurement Details

Sample Name	2755898.3
SOP File Name	HydroLV.cfg
Lab Number	2021244/3
Operator Name	hharveyw

Measurement Details

Analysis Date Time	5/11/2021 2:53:07 PM
Measurement Date Time	5/11/2021 2:53:07 PM
Result Source	Measurement

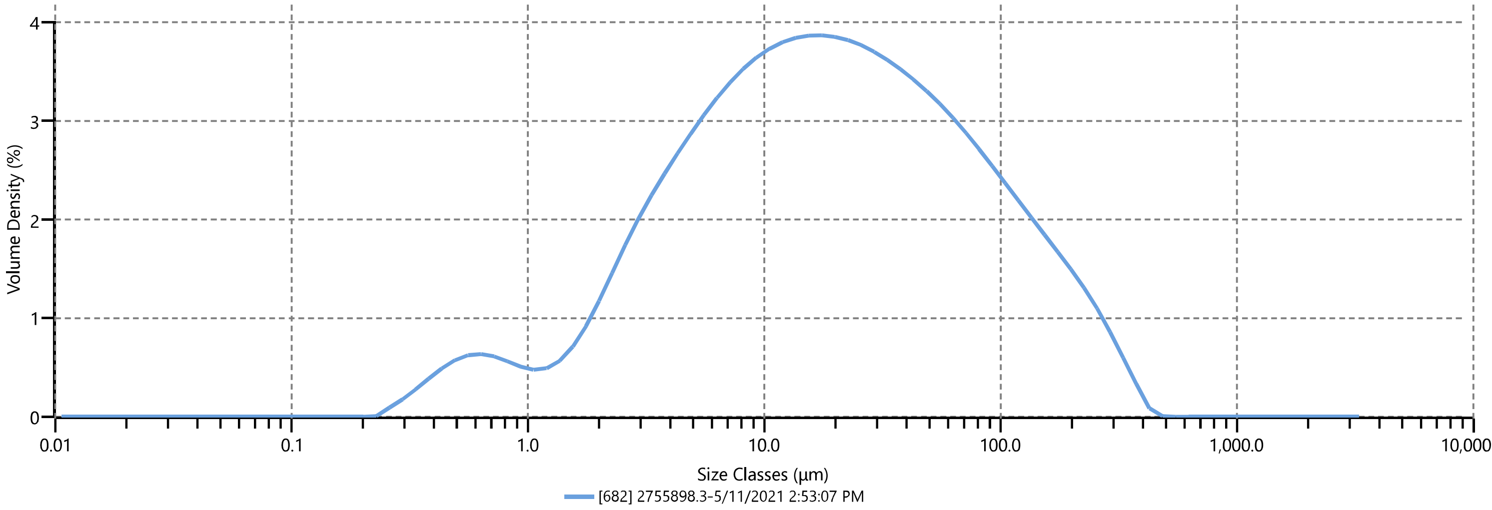
Analysis

Particle Name	Water
Particle Refractive Index	1.500
Particle Absorption Index	0.010
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.40 %
Laser Obscuration	15.62 %

Result

Concentration	0.0159 %
Span	6.538
Uniformity	1.995
Specific Surface Area	1091 m^2/kg
D [3,2]	5.50 µm
D [4,3]	43.7 µm
Dv (10)	2.65 µm
Dv (50)	18.2 µm
Dv (90)	122 µm
Volume Below (10) µm	35.04 %
Volume Above (2.5) µm	90.68 %

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0597	0.00	0.357	0.46	2.13	7.73	12.7	40.97	76.0	82.38	454	100.00	2710	100.00
0.0114	0.00	0.0679	0.00	0.405	0.78	2.42	8.95	14.5	44.17	86.4	84.64	516	100.00	3080	100.00
0.0129	0.00	0.0771	0.00	0.460	1.19	2.75	10.40	16.4	47.39	98.1	86.76	586	100.00	3500	100.00
0.0147	0.00	0.0876	0.00	0.523	1.67	3.12	12.08	18.7	50.62	111	88.74	666	100.00		
0.0167	0.00	0.0995	0.00	0.594	2.19	3.55	13.95	21.2	53.83	127	90.57	756	100.00		
0.0189	0.00	0.113	0.00	0.675	2.73	4.03	16.01	24.1	57.02	144	92.25	859	100.00		
0.0215	0.00	0.128	0.00	0.767	3.24	4.58	18.24	27.4	60.16	163	93.79	976	100.00		
0.0244	0.00	0.146	0.00	0.872	3.71	5.21	20.63	31.1	63.25	186	95.18	1110	100.00		
0.0278	0.00	0.166	0.00	0.991	4.13	5.92	23.18	35.3	66.26	211	96.43	1260	100.00		
0.0315	0.00	0.188	0.00	1.13	4.53	6.72	25.88	40.1	69.20	240	97.53	1430	100.00		
0.0358	0.00	0.214	0.00	1.28	4.93	7.64	28.71	45.6	72.05	272	98.44	1630	100.00		
0.0407	0.00	0.243	0.00	1.45	5.40	8.68	31.65	51.8	74.81	310	99.16	1850	100.00		
0.0463	0.00	0.276	0.08	1.65	5.99	9.86	34.69	58.9	77.45	352	99.66	2100	100.00		
0.0526	0.00	0.314	0.23	1.88	6.76	11.2	37.80	66.9	79.98	400	99.94	2390	100.00		

Analysis - Under

Malvern Instruments

Measurement Details

Sample Name	2755898.4
SOP File Name	HydroLV.cfg
Lab Number	2021244/4
Operator Name	hharveyw

Measurement Details

Analysis Date Time	5/11/2021 3:07:57 PM
Measurement Date Time	5/11/2021 3:07:57 PM
Result Source	Measurement

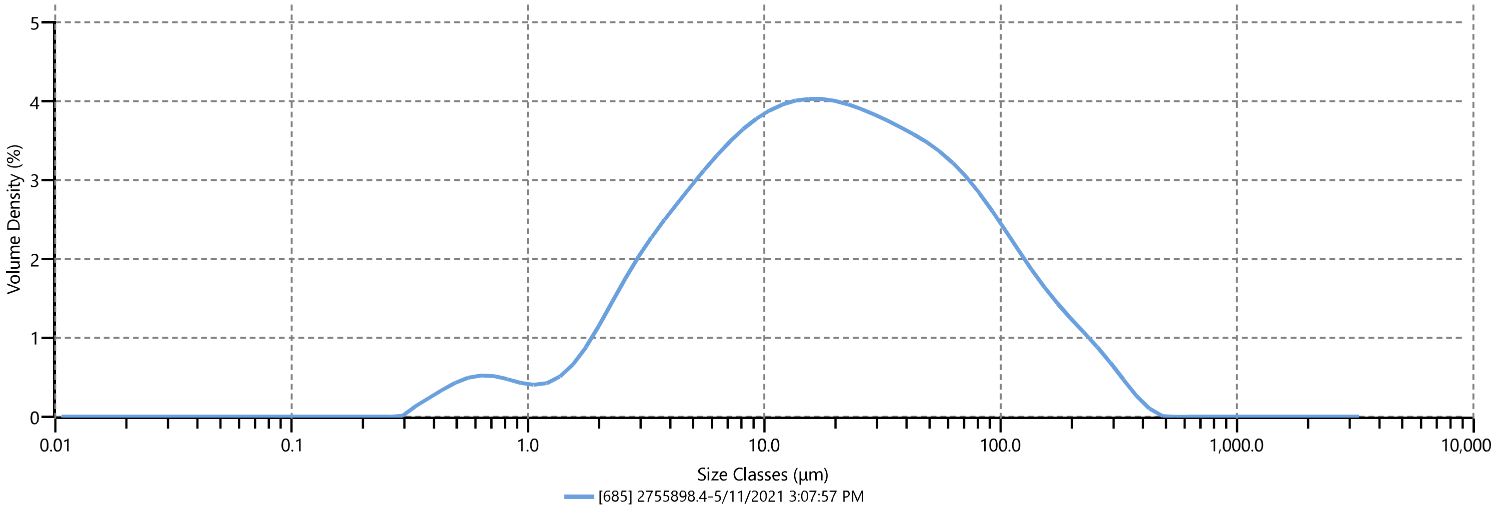
Analysis

Particle Name	Water
Particle Refractive Index	1.500
Particle Absorption Index	0.010
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.39 %
Laser Obscuration	14.51 %

Result

Concentration	0.0152 %
Span	5.849
Uniformity	1.845
Specific Surface Area	932.2 m^2/kg
D [3,2]	6.44 µm
D [4,3]	41.5 µm
Dv (10)	2.96 µm
Dv (50)	18.3 µm
Dv (90)	110 µm
Volume Below (10) µm	34.22 %
Volume Above (2.5) µm	92.07 %

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0597	0.00	0.357	0.12	2.13	6.34	12.7	40.40	76.0	83.66	454	100.00	2710	100.00
0.0114	0.00	0.0679	0.00	0.405	0.31	2.42	7.56	14.5	43.74	86.4	86.03	516	100.00	3080	100.00
0.0129	0.00	0.0771	0.00	0.460	0.60	2.75	9.02	16.4	47.10	98.1	88.20	586	100.00	3500	100.00
0.0147	0.00	0.0876	0.00	0.523	0.95	3.12	10.71	18.7	50.46	111	90.17	666	100.00		
0.0167	0.00	0.0995	0.00	0.594	1.37	3.55	12.60	21.2	53.80	127	91.94	756	100.00		
0.0189	0.00	0.113	0.00	0.675	1.81	4.03	14.69	24.1	57.10	144	93.49	859	100.00		
0.0215	0.00	0.128	0.00	0.767	2.24	4.58	16.95	27.4	60.36	163	94.86	976	100.00		
0.0244	0.00	0.146	0.00	0.872	2.64	5.21	19.39	31.1	63.55	186	96.05	1110	100.00		
0.0278	0.00	0.166	0.00	0.991	3.00	5.92	21.99	35.3	66.68	211	97.09	1260	100.00		
0.0315	0.00	0.188	0.00	1.13	3.33	6.72	24.75	40.1	69.74	240	97.98	1430	100.00		
0.0358	0.00	0.214	0.00	1.28	3.68	7.64	27.67	45.6	72.73	272	98.72	1630	100.00		
0.0407	0.00	0.243	0.00	1.45	4.10	8.68	30.71	51.8	75.63	310	99.30	1850	100.00		
0.0463	0.00	0.276	0.00	1.65	4.65	9.86	33.86	58.9	78.43	352	99.70	2100	100.00		
0.0526	0.00	0.314	0.00	1.88	5.38	11.2	37.10	66.9	81.12	400	99.92	2390	100.00		

Analysis - Under

Malvern Instruments

Measurement Details

Sample Name	2755898.5
SOP File Name	HydroLV.cfg
Lab Number	2021244/5
Operator Name	hharveyw

Measurement Details

Analysis Date Time	5/11/2021 3:22:36 PM
Measurement Date Time	5/11/2021 3:22:36 PM
Result Source	Measurement

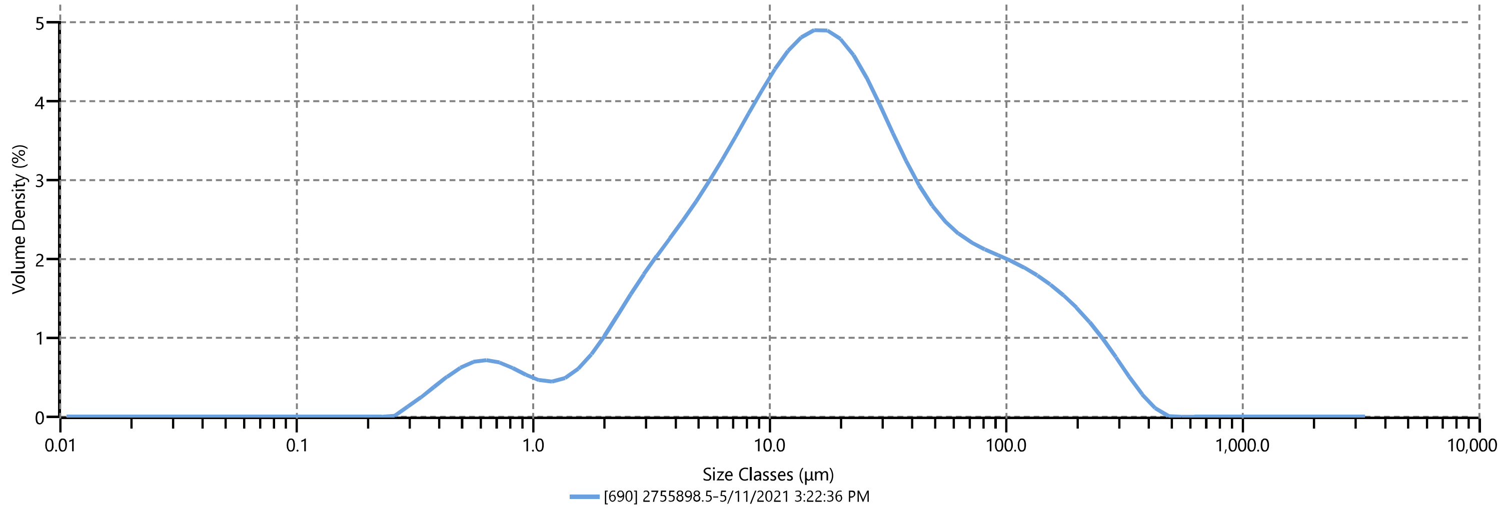
Analysis

Particle Name	Water
Particle Refractive Index	1.500
Particle Absorption Index	0.010
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.35 %
Laser Obscuration	15.94 %

Result

Concentration	0.0166 %
Span	6.634
Uniformity	1.964
Specific Surface Area	1076 m^2/kg
D [3,2]	5.57 µm
D [4,3]	39.9 µm
Dv (10)	2.79 µm
Dv (50)	16.6 µm
Dv (90)	113 µm
Volume Below (10) µm	34.52 %
Volume Above (2.5) µm	91.13 %

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.0597	0.00	0.357	0.32	2.13	7.47	12.7	41.65	76.0	84.75	454	100.00	2710	100.00
0.0114	0.00	0.0679	0.00	0.405	0.63	2.42	8.54	14.5	45.67	86.4	86.52	516	100.00	3080	100.00
0.0129	0.00	0.0771	0.00	0.460	1.06	2.75	9.84	16.4	49.76	98.1	88.23	586	100.00	3500	100.00
0.0147	0.00	0.0876	0.00	0.523	1.58	3.12	11.34	18.7	53.85	111	89.88	666	100.00		
0.0167	0.00	0.0995	0.00	0.594	2.16	3.55	13.04	21.2	57.85	127	91.46	756	100.00		
0.0189	0.00	0.113	0.00	0.675	2.76	4.03	14.93	24.1	61.67	144	92.95	859	100.00		
0.0215	0.00	0.128	0.00	0.767	3.34	4.58	17.01	27.4	65.26	163	94.35	976	100.00		
0.0244	0.00	0.146	0.00	0.872	3.86	5.21	19.28	31.1	68.56	186	95.64	1110	100.00		
0.0278	0.00	0.166	0.00	0.991	4.30	5.92	21.77	35.3	71.55	211	96.79	1260	100.00		
0.0315	0.00	0.188	0.00	1.13	4.69	6.72	24.49	40.1	74.25	240	97.79	1430	100.00		
0.0358	0.00	0.214	0.00	1.28	5.05	7.64	27.45	45.6	76.69	272	98.62	1630	100.00		
0.0407	0.00	0.243	0.00	1.45	5.46	8.68	30.66	51.8	78.92	310	99.25	1850	100.00		
0.0463	0.00	0.276	0.00	1.65	5.96	9.86	34.11	58.9	80.98	352	99.68	2100	100.00		
0.0526	0.00	0.314	0.11	1.88	6.62	11.2	37.78	66.9	82.91	400	99.91	2390	100.00		

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Client:	4SIGHT Consulting Limited	**Lab No:**	2755956	SPv1
Contact:	Marie Knue C/- 4SIGHT Consulting Limited PO Box 402053 Tutukaka 0153	**Date Received:**	04-Nov-2021	
		Date Reported:	12-Nov-2021	
		Quote No:	67532	
		Order No:	AA1146	
		Client Reference:	AA1146 Stormwater - Quarterly	
		Submitted By:	Marie Knue	

Sample Type: Saline

Sample Name:		SLY MH1 - Mixing Zone Site 1 Surface	SLY MH1 - Mixing Zone Site 2 Surface	SLY MH1 - Mixing Zone Site 3 Surface	SLY MH1 Site 1- Mixing Zone Composite	SLY MH1 - Mixing Zone Site 4 Mid Depth
Lab Number:		2755956.3	2755956.4	2755956.5	2755956.6	2755956.7
Individual Tests						
Turbidity	NTU	21	2.7	3.2	-	3.9
pH	pH Units	-	-	-	8.0	-
Salinity*		32	33	33	-	32
Total Suspended Solids	g/m^3	32	7	8	-	7
Dissolved Copper	g/m^3	0.0012	0.0013	0.0014	-	< 0.0010
Dissolved Lead	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Dissolved Zinc	g/m^3	0.005	< 0.004	< 0.004	-	-
Tannin*	g/m^3	-	-	-	1.9 [#1]	-

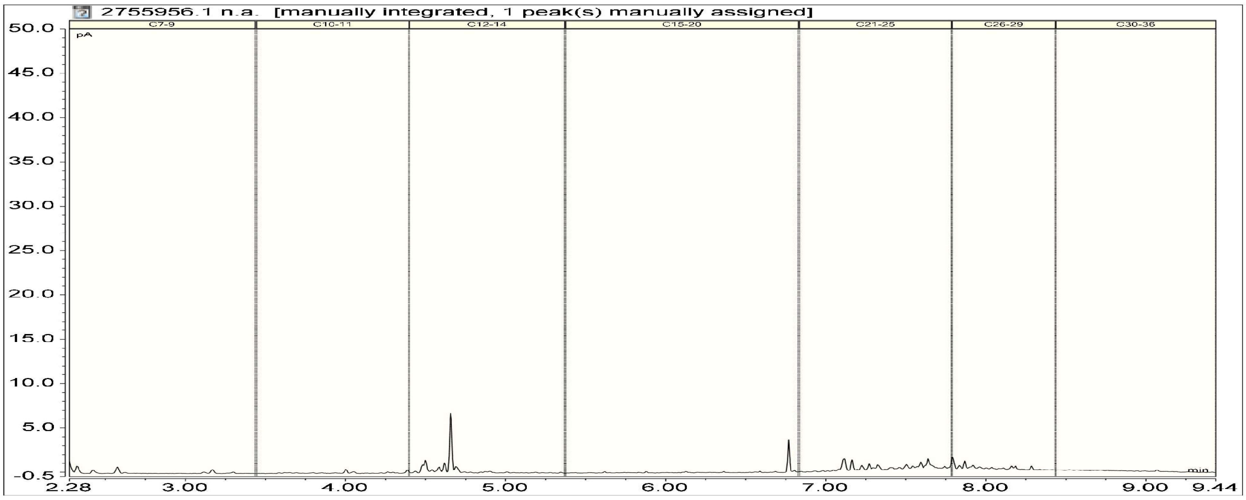
Sample Name:		SLY MH1 - Mixing Zone Site 5 Mid Depth	SLY MH1 - Background Site 1 Surface	SLY MH1 - Background Site 2 Surface	SLY MH1 - Background Site 3 Surface	
Lab Number:		2755956.8	2755956.9	2755956.10	2755956.11	
Individual Tests						
Turbidity	NTU	10.7	5.1	10.8	7.4	-
Salinity*		32	34	26	31	-
Total Suspended Solids	g/m^3	22	16	23	12	-
Dissolved Copper	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	-

Sample Type: Aqueous

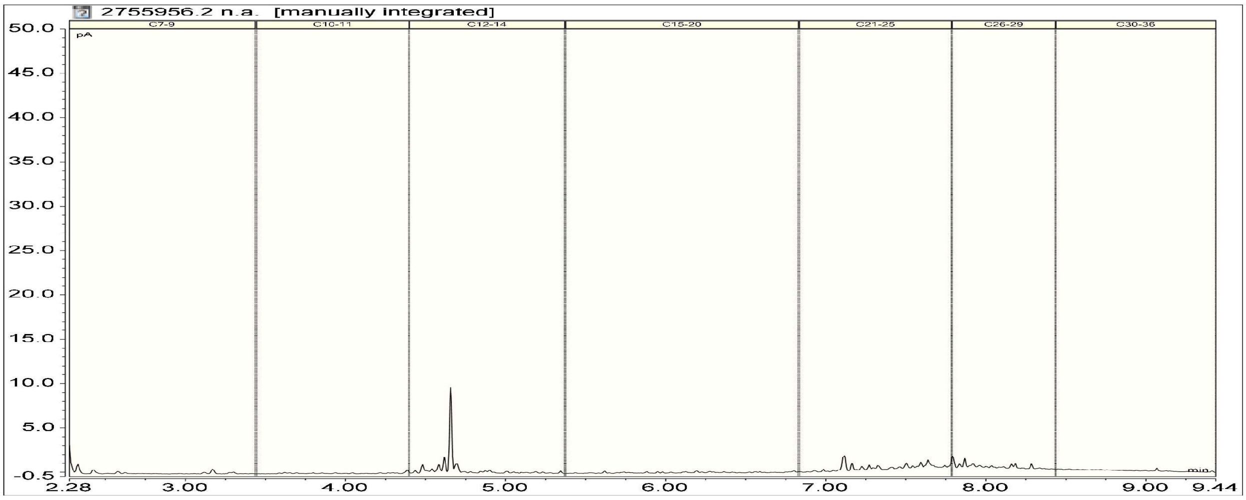
Sample Name:		SLY MH1 - Pipe	SLY MH11 - Pipe	SLY MH9	SLY Pst DSD	SLY Kaiti Beach Rd
Lab Number:		2755956.1	2755956.2	2755956.12	2755956.13	2755956.14
Individual Tests						
Turbidity	NTU	800	480	-	-	-
pH	pH Units	6.6	6.4	6.6	6.6	7.0
Volatile Suspended Solids	g/m^3	181	136	-	-	-
Total Suspended Solids	g/m^3	630	400	610	1,100	420
Dissolved Copper	g/m^3	0.0145	0.0026	0.032	0.026	0.0039
Dissolved Lead	g/m^3	0.00012	0.00026	-	-	0.00031
Dissolved Zinc	g/m^3	0.046	0.057	-	-	0.0189
Chemical Oxygen Demand (COD)	g O$_2$/m^3	680	750	-	-	-
Total Organic Carbon (TOC)	g/m^3	176	280	-	-	-
Tannin	g/m^3	59	88	-	-	-

Sample Type: Aqueous						
Sample Name:		SLY MH1 - Pipe	SLY MH11 - Pipe	SLY MH9	SLY Pst DSD	SLY Kaiti Beach Rd
Lab Number:		2755956.1	2755956.2	2755956.12	2755956.13	2755956.14
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	-	-	-
C10 - C14	g/m³	0.2	0.3	-	-	-
C15 - C36	g/m³	0.9	1.2	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	1.2	1.5	-	-	-

2755956.1
SLY MH1 - Pipe
Client Chromatogram for TPH by FID



2755956.2
SLY MH11 - Pipe
Client Chromatogram for TPH by FID



Analyst's Comments

#1 Severe matrix interferences required that a dilution be performed prior to analysis , resulting in a detection limit higher than that normally achieved for the Tannin analysis.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Saline

Test	Method Description	Default Detection Limit	Sample No

Sample Type: Saline

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Turbidity	Saline sample. Analysis by Turbidity meter. APHA 2130 B 23rd ed. 2017 (modified).	0.05 NTU	3-5, 7-11
pH	Saline water, pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	6
Salinity*	Conductivity Meter (WTW Cond 340i with nonlinear temperature compensation according to EN 27 888). APHA 2520 B 23rd ed. 2017.	0.2	3-5, 7-11
Total Suspended Solids	Saline sample. Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) 23rd ed. 2017.	3 g/m^3	3-5, 7-11
Dissolved Copper	Filtered sample, ICP-MS, ultratrace. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	3-5, 7-11
Dissolved Lead	Filtered sample, ICP-MS, ultratrace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	3-5
Dissolved Zinc	Filtered sample, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 23rd ed. 2017.	0.004 g/m^3	3-5

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Turbidity	Analysis by Turbidity meter. APHA 2130 B 23rd ed. 2017 (modified).	0.05 NTU	1-2
pH	pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-2, 12-14
Volatile Suspended Solids	Filtration (GF/C, 1.2 µm). Ashing 550°C, 30 min. Gravimetric. APHA 2540 E (modified) 23rd ed. 2017.	3 g/m^3	1-2
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) 23rd ed. 2017.	3 g/m^3	1-2, 12-14
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	1-5, 7-14
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-2, 12-14
Dissolved Lead	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-2, 14
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-2, 14
Chemical Oxygen Demand (COD), trace level	Dichromate/sulphuric acid digestion in Hach tubes, colorimetry. Trace Level method. APHA 5220 D 23rd ed. 2017.	6 g O_2/m^3	1-2
Total Organic Carbon (TOC)	Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC -TIC.The uncertainty of the calculated result is a combination of the uncertainties of the two analytical determinands in the subtraction calculation. Where both determinands are similar in magnitude, the calculated result has a significantly higher uncertainty than would normally be achieved if one of the results was significantly less than the other. In such cases, the elevated uncertainty should be kept in mind when interpreting the data. APHA 5310 C (modified) 23rd ed. 2017.	0.5 g/m^3	1-2
Tannin	Colorimetric with Folin phenol reagent, tannic acid used for calibration. APHA 5550 B (modified) 23rd ed. 2017.	0.10 g/m^3	1-2, 6
Total Petroleum Hydrocarbons in Water			
C7 - C9	Solvent extraction, GC-FID analysis. In-house based on US EPA 8015.	0.10 g/m^3	1-2
C10 - C14	Solvent extraction, GC-FID analysis. In-house based on US EPA 8015.	0.2 g/m^3	1-2
C15 - C36	Solvent extraction, GC-FID analysis. In-house based on US EPA 8015.	0.4 g/m^3	1-2

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Total hydrocarbons (C7 - C36)	Calculation: Sum of carbon bands from C7 to C36. In-house based on US EPA 8015.	0.7 g/m^3	1-2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 05-Nov-2021 and 12-Nov-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Carole Rodger-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

Appendix G:

COC Forms

Hill Laboratories
TRIED, TESTED AND TRUSTED

ANALYSIS REQUEST

R J Hill Laboratories Limited
28 Duke Street Hamilton 3204
Private Bag 3205
Hamilton 3240, New Zealand

T 0508 HILL LAB (44 555 22
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job No: **275 5898**
Date Recv: 04-Nov-21 06:38
Received by: Sarah Marsh
3127558987

Quote No 73295

Primary Contact Marie Knue 275741

Submitted By

Client Name 4SIGHT Consulting Limited 95478

Address PO Box 911310
Auckland 1142, New Zealand

Phone 09 303 0311 *Mobile*

Email

Charge To 4SIGHT Consulting Limited 95478

Client Reference AA1146-PSize-SLY

Additional Client Ref

Order No AA1146

Results To

Reports will be emailed to Primary Contact by default.
Additional Reports will be sent as specified below.

☑ *Email Primary Contact* ☐ *Email Submitter* ☐ *Email Client*

☑ *Email Other* stephanie@linnaeus.co.nz
kyrste @ linnaeus.co.nz
☐ *Other* libby@linnaeus.co.nz

Dates of testing are not routinely included in the Certificates of Analysis.
Please inform the laboratory if you would like this information reported.

CHAIN OF CUSTODY RECORD

Sent to Hill Laboratories
Date & Time: 3.11.21 15:30
Name: S. Brew
Signature: S. Brew
☑ *Tick if you require COC to be emailed back*

Received at Hill Laboratories
Date & Time:
Name:
Signature:

Condition
☐ *Room Temp* ☐ *Chilled* ☐ *Frozen*
Temp: 10

☐ Sample & Analysis details checked
Signature:

ADDITIONAL INFORMATION / KNOWN HAZARDS

Phone Marie on 020 4115 8065 if there are any issues.

Priority ☐ **Low** ☐ **Normal** ☑ **High**

☐ **Urgent** (ASAP, *extra charge applies, please contact lab first*)

Requested Reporting Date:

Quoted Sample Types

Surface Water (SURFACW|SW)

No.	*Sample Name*	*Sample Date/Time*	*Sample Type*	*Tests Required*
1	SLY MH1	↑ 8:35	SURFACW|SW	PSizeLaser_subWai
2	SLY MH11	8:21	SURFACW|SW	PSizeLaser_subWai
3	SLY MH9	8:47	SURFACW|SW	PSizeLaser_subWai
4	SLY Pst DSD	3.11.21 8:10 ~~8:47~~	SURFACW|SW	PSizeLaser_subWai
5	SLY Kaiti Beach Rd	↓ 9:00	SURFACW|SW	PSizeLaser_subWai
6				
7				
8				

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T **0508 HILL LAB** (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job Information Summary

Page 1 of 1

Client:	4SIGHT Consulting Limited	**Lab No:**	2755898
Contact:	Marie Knue C/- 4SIGHT Consulting Limited PO Box 402053 Tutukaka 0153	**Date Registered:**	04-Nov-2021 12:31 pm
		Priority:	High
		Quote No:	73295
		Order No:	AA1146
		Client Reference:	AA1146-PSize-SLY
		Add. Client Ref:	
		Submitted By:	Stephanie Brew
		Charge To:	4SIGHT Consulting Limited
		Target Date:	18-Nov-2021 4:30 pm

Samples

No	Sample Name	Sample Type	Containers	Tests Requested
1	SLY MH1 03-Nov-2021 8:35 am	Surface Water	SubWaikato1Lup	Particle size analysis
2	SLY MH11 03-Nov-2021 8:21 am	Surface Water	SubWaikato1Lup	Particle size analysis
3	SLY MH9 03-Nov-2021 8:47 am	Surface Water	SubWaikato1Lup	Particle size analysis
4	SLY Pst DSD 03-Nov-2021 8:10 am	Surface Water	SubWaikato1Lup	Particle size analysis
5	SLY Kaiti Beach Rd 03-Nov-2021 9:00 am	Surface Water	SubWaikato1Lup	Particle size analysis

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Particle size analysis	Malvern Laser Sizer particle size analysis from 0.05 microns to 3.4 mm. Samples are measured in volume %. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-5

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

ANALYSIS REQUEST

Job No:
275 5956
Date Recv: 04-Nov-21 07:18
Received by: Sarah Marsh
3127559561

R J Hill Laboratories Limited
28 Duke Street Hamilton 3204
Private Bag 3205
Hamilton 3240, New Zealand

T **0508 HILL LAB** (44 555
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Quote No 67532
Primary Contact Marie Knue 275741
Submitted By
Client Name 4SIGHT Consulting Limited 95478
Address PO Box 911310
Auckland 1142, New Zealand
Phone 09 303 0311 *Mobile*
Email
Charge To 4SIGHT Consulting Limited 95478
Client Reference AA1146 Stormwater - Quarterly
Additional Client Ref
Order No AA1146

Results To *Reports will be emailed to Primary Contact by default. Additional Reports will be sent as specified below.*

☐ *Email Primary Contact* ☐ *Email Submitter* ☐ *Email Client*
☐ *Email Other*
☐ *Other*

Dates of testing are not routinely included in the Certificates of Analysis. Please inform the laboratory if you would like this information reported.

CHAIN OF CUSTODY RECORD

Sent to Hill Laboratories
☑ *Tick if you require COC to be emailed back*
Date & Time: 3.11.21 15:30
Name: Kyrste Borton
Signature: Ky

Received at Hill Laboratories
Date & Time:
Name:
Signature:

Condition
☐ *Room Temp* ☐ *Chilled* ☐ *Frozen*
Temp: 10.6

☐ Sample & Analysis details checked
Signature:

ADDITIONAL INFORMATION / KNOWN HAZARDS

Phone Marie on 020 4115 8065 if there are any issues.

Priority ☐ **Low** ☐ **Normal** ☑ **High**
☐ **Urgent** (ASAP, *extra charge applies, please contact lab first*)

Requested Reporting Date:

Quoted Sample Types

Surface Water (SURFACW|SW);Seawater (SEAW|Sal)

No.	Sample Name	Sample Date/Time	Sample Type	Tests Required
1	SLY MH1 - Pipe		SURFACW|SW	TOC_L, CODTt, SS, Tan, Turb, pH|W, VSS, CuDt, PbDt, ZnDt, TPHOI_L
2	SLY MH11 - Pipe		SURFACW|SW	TOC_L, CODTt, SS, Tan, Turb, pH|W, VSS, CuDt, PbDt, ZnDt, TPHOI_L
3	SLY MH1 - Mixing Zone Site 1 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
4	SLY MH1 - Mixing Zone Site 2 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
5	SLY MH1 - Mixing Zone Site 3 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
6	SLY MH11 - Mixing Zone Site 1 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
7	SLY MH11 - Mixing Zone Site 2 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal
8	SLY MH11 - Mixing Zone Site 3 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal, PbDuSal, ZnDXuSal

No.	Sample Name	Sample Date/Time	Sample Type	Tests Required
9	SLY MH1 Site 1- Mixing Zone Composite		SEAW|Sal	Tan, pHsal
10	SLY MH11 Site 1 Mixing Zone Composite		SEAW|Sal	Tan, pHsal
11	SLY MH1 - Mixing Zone Site 4 Mid Depth		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
12	SLY MH1 - Mixing Zone Site 5 Mid Depth		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
13	SLY MH1 - Background Site 1 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
14	SLY MH1 - Background Site 2 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
15	SLY MH1 - Background Site 3 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
16	SLY MH11 - Background Site 1 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
17	SLY MH11 - Background Site 2 Surface		SEAW|Sal	TurbSal, Sal, SSsal, CuDXuSal
18	SLY MH9		SURFACW|SW	SS, pH|W, CuDt
19	SLY Pst DSD		SURFACW|SW	SS, pH|W, CuDt
20	SLY Kaiti Beach Rd		SURFACW|SW	SS, pH|W, CuDt, PbDt, ZnDt
21				
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Job Information Summary

Client:	4SIGHT Consulting Limited	**Lab No:**	2755956
Contact:	Marie Knue	**Date Registered:**	04-Nov-2021 1:45 pm
	C/- 4SIGHT Consulting Limited	**Priority:**	High
	PO Box 402053	**Quote No:**	67532
	Tutukaka 0153	**Order No:**	AA1146
		Client Reference:	AA1146 Stormwater - Quarterly
		Add. Client Ref:	
		Submitted By:	Marie Knue
		Charge To:	4SIGHT Consulting Limited
		Target Date:	11-Nov-2021 4:30 pm

Samples

No	Sample Name	Sample Type	Containers	Tests Requested
1	SLY MH1 - Pipe	Surface Water	UP1L, TPH250, TOC125, S100, UPte100	Total Suspended Solids; Tannin; Total Organic Carbon (TOC); Chemical Oxygen Demand (COD), trace level; Turbidity; pH; Volatile Suspended Solids; Dissolved Copper; Dissolved Lead; Dissolved Zinc; Total Petroleum Hydrocarbons in Water
2	SLY MH11 - Pipe	Surface Water	UP1L, TPH250, TOC125, S100, UPte100	Total Suspended Solids; Tannin; Total Organic Carbon (TOC); Chemical Oxygen Demand (COD), trace level; Turbidity; pH; Volatile Suspended Solids; Dissolved Copper; Dissolved Lead; Dissolved Zinc; Total Petroleum Hydrocarbons in Water
3	SLY MH1 - Mixing Zone Site 1 Surface	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Turbidity; Dissolved Copper; Dissolved Lead; Dissolved Zinc
4	SLY MH1 - Mixing Zone Site 2 Surface	Saline	UP1L, cUPte100	Salinity; Total Suspended Solids; Turbidity; Dissolved Copper; Dissolved Lead; Dissolved Zinc
5	SLY MH1 - Mixing Zone Site 3 Surface	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Turbidity; Dissolved Copper; Dissolved Lead; Dissolved Zinc
6	SLY MH1 Site 1- Mixing Zone Composite	Saline	UP250	Tannin; pH
7	SLY MH1 - Mixing Zone Site 4 Mid Depth	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; Turbidity; Dissolved Copper
8	SLY MH1 - Mixing Zone Site 5 Mid Depth	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; Turbidity; Dissolved Copper
9	SLY MH1 - Background Site 1 Surface	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; Turbidity; Dissolved Copper
10	SLY MH1 - Background Site 2 Surface	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; Turbidity; Dissolved Copper
11	SLY MH1 - Background Site 3 Surface	Saline	UP1L, UPte100	Salinity; Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; Turbidity; Dissolved Copper
12	SLY MH9	Surface Water	UP1L, UPte100	Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; pH; Dissolved Copper
13	SLY Pst DSD	Surface Water	UP1L, UPte100	Total Suspended Solids; Minimum charge for dissolved ICP-MS analysis; pH; Dissolved Copper
14	SLY Kaiti Beach Rd	Surface Water	UP1L, UPte100	Total Suspended Solids; pH; Dissolved Copper; Dissolved Lead; Dissolved Zinc

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Saline

Test	Method Description	Default Detection Limit	Sample No

Sample Type: Saline

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Turbidity	Saline sample. Analysis by Turbidity meter. APHA 2130 B 23rd ed. 2017 (modified).	0.05 NTU	3-5, 7-11
pH	Saline water, pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	6
Salinity	Conductivity Meter (WTW Cond 340i with nonlinear temperature compensation according to EN 27 888). APHA 2520 B 23rd ed. 2017.	0.2	3-5, 7-11
Total Suspended Solids	Saline sample. Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) 23rd ed. 2017.	3 g/m^3	3-5, 7-11
Dissolved Copper	Filtered sample, ICP-MS, ultratrace. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	3-5, 7-11
Dissolved Lead	Filtered sample, ICP-MS, ultratrace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	3-5
Dissolved Zinc	Filtered sample, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 23rd ed. 2017.	0.004 g/m^3	3-5

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Turbidity	Analysis by Turbidity meter. APHA 2130 B 23rd ed. 2017 (modified).	0.05 NTU	1-2
pH	pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-2, 12-14
Volatile Suspended Solids	Filtration (GF/C, 1.2 µm). Ashing 550°C, 30 min. Gravimetric. APHA 2540 E (modified) 23rd ed. 2017.	3 g/m^3	1-2
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) 23rd ed. 2017.	3 g/m^3	1-2, 12-14
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	1-5, 7-14
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-2, 12-14
Dissolved Lead	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-2, 14
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-2, 14
Chemical Oxygen Demand (COD), trace level	Dichromate/sulphuric acid digestion in Hach tubes, colorimetry. Trace Level method. APHA 5220 D 23rd ed. 2017.	6 g O_2/m^3	1-2
Total Organic Carbon (TOC)	Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC - TIC.The uncertainty of the calculated result is a combination of the uncertainties of the two analytical determinands in the subtraction calculation. Where both determinands are similar in magnitude, the calculated result has a significantly higher uncertainty than would normally be achieved if one of the results was significantly less than the other. In such cases, the elevated uncertainty should be kept in mind when interpreting the data. APHA 5310 C (modified) 23rd ed. 2017.	0.5 g/m^3	1-2
Tannin	Colorimetric with Folin phenol reagent, tannic acid used for calibration. APHA 5550 B (modified) 23rd ed. 2017.	0.10 g/m^3	1-2, 6
Total Petroleum Hydrocarbons in Water			
C7 - C9	Solvent extraction, GC-FID analysis. In-house based on US EPA 8015.	0.10 g/m^3	1-2
C10 - C14	Solvent extraction, GC-FID analysis. In-house based on US EPA 8015.	0.2 g/m^3	1-2

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
C15 - C36	Solvent extraction, GC-FID analysis. In-house based on US EPA 8015.	0.4 g/m³	1-2
Total hydrocarbons (C7 - C36)	Calculation: Sum of carbon bands from C7 to C36. In-house based on US EPA 8015.	0.7 g/m³	1-2

Appendix H:

Southern Logyard Results

Southern Logyard Results

Summary table of stormwater results

Parameter	Units	Trigger Levels for Assessing Effects			Quarter 2 (Apr/May/Jun)					Additional	
					23 May 2015					24 June 2015	
		Historic trigger levels (pre-Sept 2016)	Accepted s127 trigger levels (post Sept 2016)		MH1	MH11	MH9	Post DSD	Kaiti Beach Road Catchpit	MH1	MH11
cBOD$_5$	g/m^3	30	n/a		360	330	280	240	6	n/a	n/a
pH	-log(H$^+$)	6.7-8.5	n/a		6.8	6.5	6.6	6.4	8.0	n/a	n/a
TSS	g/m^3	150	300 (median) 450 (75%ile)		990	540	440	400	360	2300	1520
VSS	g/m^3	-	n/a		n/a	n/a	n/a	n/a	n/a	790	570
TPH	g/m^3	15	15		0.7	<0.7	2.5	<0.7	<0.7	n/a	n/a
			MH1	MH11							
Total Cu	g/m^3	0.0018	0.09	0.039	0.090	0.033	0.25	0.29	0.0105	n/a	n/a
Total Pb	g/m^3	0.0056	0.198	0.132	0.0172	0.0081	0.0095	0.0056	0.0054	n/a	n/a
Total Zn	g/m^3	0.015	0.69	0.45	0.29	0.146	0.25	0.184	0.081	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects			Bimonthly (July/August)					Bimonthly (September/October)				
					10 August 2015					30 October 2015				
		Historic trigger levels (pre-Sept 2016)	Accepted s127 trigger levels (post Sept 2016)		MH1	MH11	MH9	Post DSD	Kaiti Beach Road Catchpit	MH1	MH11	MH9	Post DSD	Kaiti Beach Road Catchpit
cBOD$_5$	g/m^3	30	n/a		360	400	250	320	18	620	710	530	440	53
pH	-log(H$^+$)	6.7-8.5	n/a		n/a	n/a	7.3	7.0	8.3	6.7	6.8	6.6	6.8	8.0
TSS	g/m^3	150	300 (median) 450 (75%ile)		860	810	1130	430	1750	520	410	940	350	1,110
VSS	g/m^3	-	n/a		250	220	n/a	n/a	n/a	240	190	n/a	n/a	n/a
TPH	g/m^3	15	15		1.0	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
			MH1	MH11										
Total Cu	g/m^3	0.0018	0.09	0.039	0.141	0.052	0.192	0.197	0.038	0.2	0.032	0.154	0.154	0.053
Total Pb	g/m^3	0.0056	0.198	0.132	0.0138	0.041	0.0184	0.0074	0.025	0.0071	0.0065	0.0111	0.0059	0.0.024
Total Zn	g/m^3	0.015	0.69	0.45	0.21	0.26	0.35	0.148	0.37	0.21	0.21	0.28	0.198	0.52

Parameter	Units	Trigger Levels for Assessing Effects			Bimonthly (November/December)					Bimonthly (January/February)				
					28 January 2016					5 April 2016				
		Historic trigger levels (pre-Sept 2016)	Accepted s127 trigger levels (post Sept 2016)		MH1	MH11	MH9	Post DSD	Kaiti Beach Road Catchpit	MH1	MH11	MH9	Post DSD	Kaiti Beach Road Catchpit
cBOD$_5$	g/m^3	30	n/a		330	300	220	300	5	153	25	129	143	17
pH	-log(H$^+$)	6.7-8.5	n/a		5.3	6.6	5.9	4.9	8.0	7.2	7.6	7.1	7.4	8.3
TSS	g/m^3	150	300 (median) 450 (75%ile)		110	88	130	110	480	420	184	410	670	1400
VSS	g/m^3	-	n/a		48	44	-	-	-	130	55	-	-	-
TPH	g/m^3	15	15		1.9	<0.7	1.4	2.6	<0.7	0.9	<1.4	0.9	<0.7	<0.7
			MH1	MH11										
Total Cu	g/m^3	0.0018	0.09	0.039	0.26	0.048	0.31	0.59	0.022	0.048	0.014	0.095	0.083	0.043
Total Pb	g/m^3	0.0056	0.198	0.132	0.0022	0.00168	0.0043	0.0026	0.0128	0.0065	0.0030	0.0063	0.0112	0.0198
Total Zn	g/m^3	0.015	0.69	0.45	0.161	0.061	0.173	0.199	0.145	0.151	0.085	0.195	0.26	0.39

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly					Quarterly					Quarterly				
				27 September 2016					16 February 2017					8 March 2017				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
pH	-log(H$^+$)	n/a		7.3	7.1	7.1	6.8	8.1	7.5	7.4	6.8	5.7	7.6	6.4	6.5	6.3	6.0	7.8
TSS	g/m^3	300 (median); 450 (75%ile)		730	490	480	240	194	300	194	200	420	2200	300	210	146	53	280
VSS	g/m^3	n/a		230	136	n/a	n/a	n/a	81	57	n/a	n/a	n/a	96	75	n/a	n/a	n/a
Turbidity	g/m^3	n/a		950	560	n/a	n/a	n/a	156	68	n/a	n/a	n/a	250	140	n/a	n/a	n/a
TPH	g/m^3	15		1.4	<0.7	n/a	n/a	n/a	<0.7	<0.7	n/a	n/a	n/a	1.5	0.9	n/a	n/a	n/a
COD	g/m^3	n/a		770	580	n/a	n/a	n/a	<300[1]	<300[1]	n/a	n/a	n/a	680	520	n/a	n/a	n/a
TOC	g/m^3	n/a		280	240	n/a	n/a	n/a	56	55	n/a	n/a	n/a	250	181	n/a	n/a	n/a
Tannin	g/m^3	n/a		124	88	n/a	n/a	n/a	18.4	19.8	n/a	n/a	n/a	108[2]	63	n/a	n/a	n/a
		MH1[3]	MH11[3]															
Dissolved Cu	g/m^3	0.09	0.039	0.0042	0.0014	0.0142	0.067	0.0044	<0.010	<0.010	0.0104	0.0184	0.0032	0.0133	0.0019	0.039	0.087	0.0027
Dissolved Pb	g/m^3	0.198	0.132	0.00011	<0.00010	n/a	n/a	<0.00010	<0.002	<0.002	n/a	n/a	0.00020	0.00018	0.00020	n/a	n/a	0.00013
Dissolved Zn	g/m^3	0.69	0.45	0.0114	0.0152	n/a	n/a	0.0026	<0.10	<0.10	n/a	n/a	0.0057	0.038	0.063	n/a	n/a	0.0029

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[1] Severe matrix interferences on samples for Total COD required that a dilution be performed prior to analysis, resulting in a detection limit higher than that normally achieved. Samples were tested using a MERCK Merckoquant Chloride Test Strip which indicated that the samples contained greater than or equal to 3000 mg/L Chloride. The Total COD method is not suitable for samples containing greater than 2000 mg/L Chloride and hence the need to dilute the samples prior to analysis.

[2] Severe matrix interferences required that a dilution be performed prior to analysis of samples 1737193/1&6, resulting in a detection limit higher than that normally achieved for the Tannin analysis.

[3] Metal trigger levels are ANZECC 2000 Marine 90% and 95% marine environment protection levels for dissolved metals with 30 times dilution applied to MH1 (northern discharge) and MH11 (southern discharge) respective

Parameter	Units	Trigger Levels for Assessing Effects		Monthly					Quarterly					Monthly				
				4 April 2017					12 May 2017					7 July 2017				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
pH	-log(H$^+$)	n/a		n/a	n/a	n/a	n/a	n/a	6.3	5.7	6.1	6.8	7.8	n/a	n/a	n/a	n/a	n/a
TSS	g/m^3	300 (median);450 (75%ile)		2,200	630	840	1,920	720	330	420	450	440	1,270	2,100	2,400	1,440	800	760
VSS	g/m^3	n/a		580	164	n/a	n/a	n/a	122	151	n/a	n/a	n/a	680	630	n/a	n/a	n/a
Turbidity	g/m^3	n/a		1,310	370	n/a	n/a	n/a	260	360	n/a	n/a	n/a	2,200	2,700	n/a	n/a	n/a
TPH	g/m^3	15		n/a	n/a	n/a	n/a	n/a	<0.7	1.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
COD	g/m^3	n/a		770	580	n/a	n/a	n/a	710	1,230	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TOC	g/m^3	n/a		280	240	n/a	n/a	n/a	270	470	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Tannin	g/m^3	n/a		124	88	n/a	n/a	n/a	107	178	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		MH1	MH11															
Dissolved Cu	g/m^3	0.09	0.039	n/a	n/a	n/a	n/a	n/a	0.0103	0.0033	0.072	0.079	0.0043	n/a	n/a	n/a	n/a	n/a
Dissolved Pb	g/m^3	0.198	0.132	n/a	n/a	n/a	n/a	n/a	0.00020	0.00026	n/a	n/a	<0.00010	n/a	n/a	n/a	n/a	n/a
Dissolved Zn	g/m^3	0.69	0.45	n/a	n/a	n/a	n/a	n/a	0.053	0.093	n/a	n/a	0.0048	n/a	n/a	n/a	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly					Quarterly					Quarterly				
				28 September 2017					14 December 2017					2 February 2018				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
pH	-log(H$^+$)	n/a		6.9	6.2	6.5	6.5	7.6	6.7	5.7	6.0	6.3	7.8	5.6	5.8	5.8	5.8	7.1
TSS	g/m^3	300 (median);450 (75%ile)		580	360	410	700	340	650	800	690	620	730	230	350	220	136	600
VSS	g/m^3	n/a		200	128	n/a	n/a	n/a	170	320	n/a	n/a	n/a	65	117	n/a	n/a	n/a
Turbidity	g/m^3	n/a		680	280	n/a	n/a	n/a	1,080	1,450	n/a	n/a	n/a	210	270	n/a	n/a	n/a
TPH	g/m^3	15		0.8	2.1	n/a	n/a	n/a	0.9	1.2	n/a	n/a	n/a	<0.7	<0.7	n/a	n/a	n/a
COD	g/m^3	n/a		900	1230	n/a	n/a	n/a	1,180	2,400	n/a	n/a	n/a	670	800	n/a	n/a	n/a
TOC	g/m^3	n/a		290	510	n/a	n/a	n/a	270	540	n/a	n/a	n/a	240	270	n/a	n/a	n/a
Tannin	g/m^3	n/a		68	154	n/a	n/a	n/a	97	196	n/a	n/a	n/a	74	88	n/a	n/a	n/a
		MH1	MH11															
Dissolved Cu	g/m^3	0.09	0.039	0.0126	0.0044	0.027	0.032	0.0046	0.0077	0.0027	0.0114	0.0162	0.0025	0.004	<0.01	0.033	0.049	0.0035
Dissolved Pb	g/m^3	0.198	0.132	0.00022	0.00020	n/a	n/a	<0.00010	0.00011	0.00017	n/a	n/a	<0.00010	<0.0005	<0.002	n/a	n/a	0.00039
Dissolved Zn	g/m^3	0.69	0.45	0.029	0.096	n/a	n/a	0.0043	0.077	0.23	n/a	n/a	0.0051	0.115	0.06	n/a	n/a	0.053

Parameter	Units	Trigger Levels for Assessing Effects	Monthly					Monthly					Monthly				
			9 February 2018					9 March 2018					11 April 2018				
			MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
pH	-log(H$^+$)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSS	g/m^3	300 (median); 450 (75%ile)	380	460	181	177	490	480	600	510	164	930	440	3300	250	158	600
VSS	g/m^3	n/a	122	146	n/a	n/a	n/a	121	189	n/a	n/a	n/a	144	2900	n/a	n/a	n/a
Turbidity	g/m^3	n/a	450	510	n/a	n/a	n/a	520	660	n/a	n/a	n/a	410	500	n/a	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly					Monthly					Quarterly				
				11 June 2018					14 August 2018					30 August 2018				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
Turbidity	g/m^3	n/a		3100	3000	n/a	n/a	n/a	2900	3600	n/a	n/a	n/a	2000	1070	n/a	n/a	n/a
pH	-log(H$^+$)	n/a		7.4	7.5	7.1	7.8	8.2	n/a	n/a	n/a	n/a	n/a	7.2	6.7	7	7	8.2
VSS	g/m^3	n/a		570	510	n/a	n/a	n/a	189	510	n/a	n/a	n/a	400	360	n/a	n/a	n/a
TSS	g/m^3	300 (median); 450 (75%ile)		2400	2800	1750	1910	910	910	1930	3200	2800	2600	1500	1200	850	450	370
COD	g/m^3	n/a		1180	940	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	950	1300	n/a	n/a	n/a
TOC	g/m^3	n/a		280	240	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	270	250	n/a	n/a	n/a
Tannin	g/m^3	n/a		84	69	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	105^1	81^1	n/a	n/a	n/a
TPH	g/m^3	15		< 0.7	< 0.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	< 0.7	< 0.7	n/a	n/a	n/a
		MH1	MH11															
Dissolved Cu	g/m^3	0.09	0.039	0.003	0.0093	0.064	0.01	0.0018	n/a	n/a	n/a	n/a	n/a	0.0143	0.0034	0.028	0.029	0.0012
Dissolved Pb	g/m^3	0.198	0.132	0.00014	< 0.00010	n/a	n/a	< 0.00010	n/a	n/a	n/a	n/a	n/a	0.00012	< 0.00010	n/a	n/a	< 0.00010
Dissolved Zn	g/m^3	0.69	0.45	0.017	0.0055	n/a	n/a	0.0013	n/a	n/a	n/a	n/a	n/a	0.023	0.058	n/a	n/a	0.0013

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[1] [illegible]

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly					Monthly					Quarterly				
				20 December 2018					16 January 2019					25 February 2019				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
Turbidity	g/m³	n/a		3600	4000	-	-	-	2,000	1,460	-	-	-	520	200	-	-	-
pH	-log(H⁺)	n/a		7.2	6.5	6.9	6.4	7.6	-	-	-	-	-	7	6.9	6.8	6.6	8.2
VSS	g/m³	n/a		600	670	-	-	-	440	290	-	-	-	178	88	-	-	-
TSS	g/m³	300 (median); 450 (75%ile)		2100	2600	1580	860	1450	1,270	910	1,270	600	1,560	510	280	290	250	720
COD	g/m³	n/a		1200	1800	-	-	-	-	-	-	-	-	690	340	-	-	-
TOC	g/m³	n/a		310	500	-	-	-	-	-	-	-	-	250	92	-	-	-
Tannin	g/m³	n/a		105	111	-	-	-	-	-	-	-	-	106[1]	46	-	-	-
TPH	g/m³	15		0.8	0.9	-	-	-	-	-	-	-	-	1.6	< 0.7	-	-	-
		MH1	MH11															
Dissolved Cu	g/m³	0.09	0.039	0.005	0.0028	0.006	0.004	0.0052	-	-	-	-	-	0.0111	< 0.010	0.022	0.0162	0.0018
Dissolved Pb	g/m³	0.198	0.132	0.00016	< 0.00010	-	-	0.00024	-	-	-	-	-	0.00016	< 0.002	-	-	< 0.00010
Dissolved Zn	g/m³	0.69	0.45	0.025	0.07	-	-	0.0153	-	-	-	-	-	0.022	0.07	-	-	0.0043

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly					Monthly					Monthly				
				24 July 2019					09 September 2019					12 November 2019				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
Turbidity	g/m³	n/a		360	1040	-	-	-	4800	2000	-	-	-	4200	710	-	-	-
pH	-log(H⁺)	n/a		7.5	7.2	6.9	7.2	8.2	-	-	-	-	-	-	-	-	-	-
VSS	g/m³	n/a		142	260	-	-	-	370	430	-	-	-	920	16	-	-	-
TSS	g/m³	300 (median); 450 (75%ile)		410	950	940	520	500	2100	1790	1480	550	460	2700	50	920	1820	107
COD	g/m³	n/a		380	1190	-	-	-	-	-	-	-	-	-	-	-	-	-
TOC	g/m³	n/a		107	220	-	-	-	-	-	-	-	-	-	-	-	-	-
Tannin	g/m³	n/a		23	77	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH	g/m³	15		< 0.7	< 0.7	-	-	-	-	-	-	-	-	-	-	-	-	-
		MH1	MH11															
Dissolved Cu	g/m³	0.09	0.039	< 0.010	< 0.010	0.0194	0.036	0.0016	-	-	-	-	-	-	-	-	-	-
Dissolved Pb	g/m³	0.198	0.132	< 0.002	< 0.002	-	-	0.00025	-	-	-	-	-	-	-	-	-	-
Dissolved Zn	g/m³	0.69	0.45	0.02	0.03	-	-	0.0074	-	-	-	-	-	-	-	-	-	-

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[1] Severe matrix interferences required that a dilution be performed prior to analysis of samples 2130929/1,2&6, resulting in a detection limit higher than that normally achieved for the Tannin analysis.

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly					Quarterly					Quarterly				
				15 October 2020					16 February 2021					September 2021 - Quarterly				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Rd	MH1	MH11	MH9	Post DSD	Kaiti Beach Road
Turbidity	g/m³	n/a		3,300	3,700	-	-	-	530	750	-	-	-	900	3000		-	-
pH	-log(H⁺)	n/a		7.3	6.7	7.0	6.6	7.6	6	5.6	6	6.3	7.6	6.8	6.8	6.6	6.6	7.9
VSS	g/m³	n/a		650	830	-	-	-	300	360	-	-	-	460	620	-	-	-
TSS	g/m³	300 (median); 450 (75%ile)		1,880	2,700	1,870	1,610	1,070	720	820	860	680	500	1280	1920	1010	840	280
COD	g/m³	n/a		1,880	2,200	-	-	-	1,180	1,220	-	-	-	1020	1280	-	-	-
TOC	g/m³	n/a		350	440	-	-	-	240	380	-	-	-	350	270	-	-	-
Tannin	g/m³	n/a		78	111	-	-	-	106	182	-	-	-	117	174	-	-	-
TPH	g/m³	15		1	1	-	-	-	2.4	2.4	-	-	-	3.3	3.6	-	-	-
		MH1	MH11															
Dissolved Cu	g/m³	0.09	0.039	0.0036	0.0045	0.0104	0.0160	0.002	0.0082	0.0022	0.022	0.039	0.0019	0.0041	0.0031	0.023	0.028	0.0018
Dissolved Pb	g/m³	0.198	0.132	<0.0001	<0.0001	-	-	0.0001	<0.0002	0.00016	-	-	<0.0001	0.00011	0.00025	-	-	0.00024
Dissolved Zn	g/m³	0.69	0.45	0.0170	0.057	-	-	0.0134	0.101	0.116	-	-	0.0083	0.1	0.054	-	-	0.0055

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly				
				3 November 2021				
				MH1	MH11	MH9	Post DSD	Kaiti Beach Rd
Turbidity	g/m³	n/a		800	480	-	-	-
pH	-log(H⁺)	n/a		6.6	6.4	6.6	6.6	7
VSS	g/m³	n/a		181	136	-	-	-
TSS	g/m³	300 (median); 450 (75%ile)		630	400	610	1100	420
COD	g/m³	n/a		680	750	-	-	-
TOC	g/m³	n/a		176	280	-	-	-
Tannin	g/m³	n/a		59	88	-	-	-
TPH	g/m³	15		1.2	1.5	-	-	-
		MH1	MH11					
Dissolved Cu	g/m³	0.09	0.039	0.0145	0.0026	-	-	-
Dissolved Pb	g/m³	0.198	0.132	0.00012	0.00026	-	-	-
Dissolved Zn	g/m³	0.69	0.45	0.046	0.057	-	-	-

Summary table of marine results

Parameter	Units	Trigger Levels for Assessing Effects				Quarter 1 (Jan/Feb/March)			
						15 March 2015			
		Historic trigger levels (pre-Sept 2016)		Accepted s127 trigger levels (post Sept 2016)		MH1 S1	MH1 S2	MH11 S1	MH11 S2
cBOD$_5$	g/m^3	30		n/a		220	210	270	250
pH	$-log(H^+)$	6.7-8.5		6.7-8.5		6.3	6.4	6.3	6.3
TSS	g/m^3	150		n/a		80	75	65	67
VSS	g/m^3	-		n/a		n/a	n/a	n/a	n/a
TPH	g/m^3	15		n/a		<0.7	0.7	<0.7	<0.7
		90%	95%	MH1	MH11				
Total Cu	g/m^3	0.003	0.0013	0.003 or background	0.0013 or background	0.043	0.043	0.0083	0.0089
Total Pb	g/m^3	0.0066	0.0044	0.0066 or background	0.0044	0.00180	0.00177	0.0028	0.0035
Total Zn	g/m^3	0.023	0.015	0.023	0.015	0.099	0.093	0.074	0.095

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly						
				8 March 2017						
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
pH	$-log(H^+)$	6.7-8.5		n/a	n/a	n/a	7.9	n/a	n/a	n/a
TSS	g/m^3	n/a		38	23	27	n/a	14	9	12
Tannins	g/m^3	n/a		n/a	n/a	n/a	<10[1]	n/a	n/a	n/a
Turbidity	NTU	n/a		5.1	12.1	14.7	n/a	5.7	2.8	4.5
Salinity	ppt	n/a		30	30	31	n/a	25	32	32
		MH1	MH11							
Dissolved Cu	g/m^3	0.003 or background	0.0013 or background	0.0016	0.0018	0.0024	n/a	0.0011	0.0012	<0.0010
Dissolved Pb	g/m^3	0.0066 or background	0.0044	<0.0010	<0.0010	0.0012	n/a	n/a	n/a	n/a
Dissolved Zn	g/m^3	0.023	0.015	0.007	0.012	0.008	n/a	n/a	n/a	n/a

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[1] Severe matrix interferences required that a dilution be performed prior to analysis of samples 1737193/1&6, resulting in a detection limit higher than that normally achieved for the Tannin analysis.

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			8 March 2017							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
TSS	g/m³	n/a	31	51	27	32	27	19	41	53
Turbidity	NTU	n/a	5.8	17.1	15.4	7.9	9.6	8.5	13.8	18.0
Salinity	ppt	n/a	34	34	34	35	34	35	34	35

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				12 May 2017								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
pH	-log(H⁺)	6.7-8.5		n/a	n/a	n/a	8.0	n/a	n/a	n/a	n/a	n/a
TSS	g/m³	n/a		16	19	5	n/a	7	6	7	6	7
Tannins	g/m³	n/a		n/a	n/a	n/a	<1.0	n/a	n/a	n/a	n/a	n/a
Turbidity	NTU	n/a		11.6	13.6	3.5	n/a	3.4	3.5	3.9	2.1	2.8
Salinity	ppt	n/a		34	34	34	n/a	34	34	34	34	34
		MH1	MH11									
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	0.0016	<0.0010	<0.0010	n/a	<0.0010	0.0012	0.0012	0.0016	0.0013
Dissolved Pb	g/m³	0.0066	0.0044	<0.0010	<0.0010	<0.0010	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Zn	g/m³	0.023	0.015	0.010	<0.004	<0.004	n/a	n/a	n/a	n/a	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			7 July 2017							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
TSS	g/m³	n/a	60	62	19	16	7	11	89	43
Turbidity	NTU	n/a	33	56	16.1	8.1	4.2	8.6	59	31
Salinity	ppt	n/a	27	27	27	35	36	34	14.9	35

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				28 September 2017								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
pH	$-\log(H^+)$	6.7-8.5		n/a	n/a	n/a	8.0	n/a	n/a	n/a	n/a	n/a
TSS	g/m^3	n/a		34	34	40	n/a	37	48	38	31	43
Tannins	g/m^3	n/a		n/a	n/a	n/a	6	n/a	n/a	n/a	n/a	n/a
Turbidity	NTU	n/a		1.76	2.4	7.3	n/a	4.4	3.7	2.2	2.1	6.4
Salinity	ppt	n/a		34	34	35	n/a	35	35	32	35	35
		MH1	MH11									
Dissolved Cu	g/m^3	0.003 or background	0.0013 or background	<0.001	<0.001	<0.001	n/a	<0.001	<0.001	<0.001	<0.001	<0.001
Dissolved Pb	g/m^3	0.0066	0.0044	<0.001	<0.001	<0.001	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Zn	g/m^3	0.023	0.015	0.004	<0.004	0.005	n/a	n/a	n/a	n/a	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				14 December 2017								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
pH	$-\log(H^+)$	6.7-8.5		n/a	n/a	n/a	8.0	n/a	n/a	n/a	n/a	n/a
TSS	g/m^3	n/a		38	28	32	n/a	36	33	47	41	25
Tannins	g/m^3	n/a		n/a	n/a	n/a	<5	n/a	n/a	n/a	n/a	n/a
Turbidity	NTU	n/a		6.0	1.97	1.70	n/a	2.2	2.1	4.8	7.0	2.4
Salinity	ppt	n/a		35	36	36	n/a	35	35	35	32	35
		MH1	MH11									
Dissolved Cu	g/m^3	0.003 or background	0.0013 or background	<0.001	<0.001	<0.001	n/a	<0.001	<0.001	<0.001	<0.001	<0.001
Dissolved Pb	g/m^3	0.0066	0.0044	<0.001	<0.001	<0.001	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Zn	g/m^3	0.023	0.015	<0.004	0.005	<0.004	n/a	n/a	n/a	n/a	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly										
				2 February 2018										
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Sites 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface	MH11 Background Site 1 Surface	MH11 Background Site 2 Surface
pH	-log(H⁺)	6.7-8.5		n/a	n/a	n/a	7.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSS	g/m³	n/a		52	91	5	n/a	8	<3	4	3	3	<3	<3
Tannins	g/m³	n/a		n/a	n/a	n/a	<5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Turbidity	NTU	n/a		40	71	2.7	n/a	4.8	1.32	1.32	1.65	1.46	0.77	0.58
Salinity	ppt	n/a		32	31	35	n/a	35	35	35	35	35	35	35
		MH1	MH11											
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	0.0038	<0.0010	<0.0010	n/a	0.0013	<0.001	<0.001	0.0026	<0.001	<0.001	<0.001
Dissolved Pb	g/m³	0.0066	0.0044	<0.0010	<0.0010	<0.0010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Zn	g/m³	0.023	0.015	0.01	0.007	<0.004	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			9 February 2018							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
TSS	g/m³	n/a	14	18	18	10	13	11	15	11
Turbidity	NTU	n/a	7.9	10	8.2	5.2	5.4	4.9	4.9	5.4
Salinity	ppt	n/a	35	34	34	35	35	35	34	35

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			9 March 2018							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
TSS	g/m³	n/a	12	20	19	15	10	8	10	21
Turbidity	NTU	n/a	6.4	11.8	10.9	7.2	3.3	3.6	4	13.3
Salinity	ppt	n/a	34	34	34	34	34	35	34	33

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			11 April 2018							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
TSS	g/m³	n/a	29	27	31	51	33	21	20	41
Turbidity	NTU	n/a	16.9	15.2	17.6	16.2	16.5	12.3	11.5	21
Salinity	ppt	n/a	34	34	33	34	34	35	34	34

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly										
				11 June 2018										
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface	MH11 Background Site 1 Surface	MH11 Background Site 2 Surface
pH	-log(H⁺)	6.7-8.5		n/a	n/a	n/a	8.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TSS	g/m³	n/a		10	11	64	n/a	23	63	12	39	43	10	11
Tannins	g/m³	n/a		n/a	n/a	n/a	2.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Turbidity	NTU	n/a		6.9	6.7	58	n/a	12.8	50	6.9	22	30	6.9	6.7
Salinity	ppt	n/a		33	33	32	n/a	33	33	33	31	32	33	33
		MH1	MH11											
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	< 0.0010	< 0.0010	< 0.0010	n/a	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Pb	g/m³	0.0066	0.0044	< 0.0010	< 0.0010	< 0.0010	n/a	n/a	n/a	n/a	n/a	n/a	< 0.0010	< 0.0010
Dissolved Zn	g/m³	0.023	0.015	< 0.004	< 0.004	< 0.004	n/a	n/a	n/a	n/a	n/a	n/a	< 0.004	< 0.004

Parameter	Units	Trigger Levels for Assessing Effects	Monthly									
			14 August 2018									
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface	MH11 - Background Site 1 Surface	SLY MH11 Background Site 2 Surface
TSS	g/m³	n/a	20	3	4	5	4	6	4	5	4	< 3
Turbidity	NTU	n/a	21	2.2	3.6	2	1.92	3.2	3.3	2.6	3.1	2.4
Salinity	ppt	n/a	31	32	32	32	33	32	32	32	30	30

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				30 August 2018								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	NTU	n/a		44	19.8	8.4	n/a	3	4.9	1.31	13.9	3.9
pH	-log(H⁺)	6.7-8.5		n/a	n/a	n/a	7.8	n/a	n/a	n/a	n/a	n/a
Salinity	ppt	n/a		33	34	33	n/a	35	35	33	32	34
TSS	g/m³	n/a		198	117	41	n/a	40	39	35	43	50
Tannins	g/m³	n/a		n/a	n/a	8[1]	n/a	n/a	n/a	n/a	n/a	n/a
		MH1	MH11									
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	< 0.0010	0.0014	n/a	< 0.0010	< 0.0010	< 0.0010	0.0016	< 0.0010	< 0.0010
Dissolved Pb	g/m³	0.0066	0.0044	< 0.0010	< 0.0010	n/a	n/a	n/a	n/a	n/a	n/a	< 0.0010
Dissolved Zn	g/m³	0.023	0.015	0.005	0.015	n/a	n/a	n/a	n/a	n/a	n/a	0.005

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly														
				20 December 2018														
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 & 2 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface	MH11 Mixing Zone Site 1 Surface	MH11 Mixing Zone Site 2 Surface	MH11 Mixing Zone Site 3 Surface	MH11 Mixing Zone Composite	MH11 Background Site 1 Surface	MH11 Background Site 2 Surface
Turbidity	NTU	n/a		47	210	10.5	n/a	4.1	15.6	2.4	2.3	3.2	1.29	14.4	8.7	n/a	0.96	1.59
pH	-log(H⁺)	6.7-8.5		n/a	n/a	n/a	8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8.1	n/a	n/a
Salinity	ppt	n/a		34	32	35	n/a	35	35	35	35	34	35	35	35	n/a	35	35
TSS	g/m³	n/a		100	200	15	n/a	11	22	8	12	8	5	20	16	n/a	6	48
Tannins	g/m³	n/a		n/a	n/a	n/a	6.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.4	n/a	n/a
		MH1	MH11															
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	< 0.0010	< 0.0010	0.0014	n/a	< 0.0010	0.0012	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	n/a	< 0.0010	< 0.0010
Dissolved Pb	g/m³	0.0066	0.0044	< 0.0010	< 0.0010	< 0.0010	n/a	n/a	n/a	n/a	n/a	n/a	< 0.0010	< 0.0010	< 0.0010	n/a	n/a	n/a
Dissolved Zn	g/m³	0.023	0.015	0.007	0.017	0.007	n/a	n/a	n/a	n/a	n/a	n/a	< 0.004	< 0.004	< 0.004	n/a	n/a	n/a

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[1] [illegible]

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			16 January 2019							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	g/m³	n/a	17.4	3.2	2.8	19.7	3.1	2.6	2.8	3.2
Salinity	NTU	n/a	34	35	34	34	35	35	35	34
TSS	ppt	n/a	22	7	6	24	8	9	9	8

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				25 February 2019								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	NTU	n/a		7.2	7.5	6.5	-	8.7	7.3	7.6	8.7	7
pH	-log(H⁺)	6.7-8.5		-	-	-	8.1	-	-	-	-	-
Salinity	ppt	n/a		32	32	30	-	32	33	33	33	32
TSS	g/m³	n/a		15	16	13	-	16	16	19	18	14
Tannins	g/m³	n/a		-	-	-	4.6[12]	-	-	-	-	-
		MH1	MH11									
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	0.003	< 0.0010	0.0013	-	< 0.0010	< 0.0010	0.001	0.0013	0.0016
Dissolved Pb	g/m³	0.0066	0.0044	< 0.0010	< 0.0010	< 0.0010	-	-	-	-	-	-
Dissolved Zn	g/m³	0.023	0.015	0.009	< 0.004	0.008	-	-	-	-	-	-

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[12] Severe matrix interferences required that a dilution be performed prior to analysis of samples 2130929/1,2&6, resulting in a detection limit higher than that normally achieved for the Tannin analysis.

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				24 July 2019								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	NTU	n/a		7.2	26	53	-	5.4	17.8	7.9	3.2	2.5
pH	-log(H⁺)	6.7-8.5		-	-	-	8	-	-	-	-	-
Salinity	ppt	n/a		34	33	32	-	34	34	33	33	33
TSS	g/m³	n/a		16	38	63	-	14	22	11	6	7
Tannins	g/m³	n/a		-	-	-	< 5[13]	-	-	-	-	-
		MH1	MH11									
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	< 0.0010	< 0.0010	0.0015	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Pb	g/m³	0.0066	0.0044	< 0.0010	< 0.0010	< 0.0010	-	-	-	-	-	-
Dissolved Zn	g/m³	0.023	0.015	< 0.004	< 0.004	< 0.004	-	-	-	-	-	-

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			09 September 2019							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	g/m³	n/a	25	10.8	10	12.6	6.3	9.4	8	9.6
Salinity	NTU	n/a	32	30	30	32	32	33	31	30
TSS	ppt	n/a	30	14	20	30	19	23	14	18

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[13] Severe matrix interferences required that a dilution be performed prior to analysis of this sample, resulting in a detection limit higher than that normally achieved for the Tannin analysis.

Parameter	Units	Trigger Levels for Assessing Effects	Monthly							
			12 November 2019							
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	g/m³	n/a	2.5	3.9	3.6	1.42	1.48	3	1.9	1.81
Salinity	NTU	n/a	23	22	17.7	35	34	29	32	28
TSS	ppt	n/a	10	11	12	9	7	13	9	11

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				15 October 2020								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	NTU	n/a		17.9	9.6	4.4	-	6.2	7.7	4	5.8	7.1
pH	-log(H⁺)	6.7-8.5		-	-	-	8	-	-	-	-	-
Salinity	ppt	n/a		33	33	31	-	34	34	34	32	28
TSS	g/m³	n/a		22	8	8	-	10	15	8	10	11
Tannins	g/m³	n/a		-	-	-	5[14]	-	-	-	-	-
		MH1	MH11									
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	0.0034	<0.001	0.001	-	0.0013	0.0011	0.0048	0.0090	0.0054
Dissolved Pb	g/m³	0.0066	0.0044	<0.001	<0.001	<0.001	-	-	-	-	-	-
Dissolved Zn	g/m³	0.023	0.015	0.007	<0.004	0.025	-	-	-	-	-	-

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[14] Severe matrix interferences required that a dilution be performed prior to analysis , resulting in a detection limit higher than that normally achieved for the Tannin analysis.

Parameter	Units	Trigger Levels for Assessing Effects		Quarterly								
				16 February 2021								
				MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Mixing Zone Site 1 3 Composite	MH1 Mixing Zone Site 4 Mid Depth	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface
Turbidity	NTU	n/a		21	15.5	2.3	-	9.1	7.1	2.6	5.4	4
pH	-log(H⁺)	6.7-8.5		-	-	-	8	-	-	-	-	-
Salinity	ppt	n/a		34	35	36	-	35	35	36	36	34
TSS	g/m³	n/a		45	34	5	-	19	18	7	5	5
Tannins	g/m³	n/a		-	-	-	<5	-	-	-	-	-
		MH1	MH11									
Dissolved Cu	g/m³	0.003 or background	0.0013 or background	<0.001	0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Dissolved Pb	g/m³	0.0066	0.0044	<0.001	<0.001	<0.001	-	-	-	-	-	-
Dissolved Zn	g/m³	0.023	0.015	<0.004	0.059	<0.004	-	-	-	-	-	-

Parameter	Units	Trigger Levels for Assessing Effects	Quarterly														
			September 2021 - Quarterly														
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Site 1- Mixing Zone Composite	MH1 Mixing Zone Site 4 Mid Dept	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface	MH11 Mixing Zone Site 1 Surface	MH11 Mixing Zone Site 2 Surface	MH11 Mixing Zone Site 3 Surface	MH11 Site 1 Mixing Zone Composite	MH11 Background Site 1 Surface	MH11 Background Site 2 Surface
Turbidity	NTU	n/a	1.6	2.6	1.92	-	2.1	2.6	3.5	6.7	6.3	1.86	1.05	1.32	-	1.61	1.21
pH	-log(H⁺)	6.7-8.5	-	-	-	8.1	-	-	-	-	-	-	-	-	8.1	-	-
Salinity	ppt	n/a	34	34	35	-	35	35	34	33	35	34	33	32	-	33	32
TSS	g/m³	n/a	36	42	39	-	37	62	43	42	96	41	42	34	-	32	40
Tannins	g/m³	n/a	-	-	-	1.3	-	-	-	-	-	-	-	-	1.7	-	-
Dissolved Cu	g/m³	0.003 (MH1) 0.0013 (MH11)	<0.0010	<0.0010	<0.0010	-	0.0013	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	<0.0010	<0.0010
Dissolved Pb	g/m³	0.0066 (MH1) 0.0044 (MH11)	<0.0010	<0.0010	<0.0010	-	-	-	-	-	-	<0.0010	<0.0010	<0.0010	-	-	-
Dissolved Zn	g/m³	0.023 (MH1) 0.015 (MH11)	<0.004	<0.004	<0.004	-	-	-	-	-	-	<0.005	<0.005	<0.004	-	-	-

Parameter	Units	Trigger Levels for Assessing Effects	Quarterly														
			November 2021 - Quarterly														
			MH1 Mixing Zone Site 1 Surface	MH1 Mixing Zone Site 2 Surface	MH1 Mixing Zone Site 3 Surface	MH1 Site 1- Mixing Zone Composite	MH1 Mixing Zone Site 4 Mid Dept	MH1 Mixing Zone Site 5 Mid Depth	MH1 Background Site 1 Surface	MH1 Background Site 2 Surface	MH1 Background Site 3 Surface	MH11 Mixing Zone Site 1 Surface	MH11 Mixing Zone Site 2 Surface	MH11 Mixing Zone Site 3 Surface	MH11 Site 1 Mixing Zone Composite	MH11 Background Site 1 Surface	MH11 Background Site 2 Surface
Turbidity	NTU	n/a	21	2.7	3.2	-	3.9	10.7	5.1	10.8	7.4	n/a	n/a	n/a	n/a	n/a	n/a
pH	-log(H^+)	6.7-8.5	8	8.1	8	8	8.1	8.1	8.1	8	8	n/a	n/a	n/a	n/a	n/a	n/a
Salinity	ppt	n/a	32.2	33.3	33.3	32.8	32.6	32.9	34.5	26.9	31.1	n/a	n/a	n/a	n/a	n/a	n/a
TSS	g/m^3	n/a	32	7	8	-	7	22	16	23	12	n/a	n/a	n/a	n/a	n/a	n/a
Tannins	g/m^3	n/a	-	-	-	1.9	-	-	-	-	-	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Cu	g/m^3	0.003 (MH1) 0.0013 (MH11)	0.0012	0.0013	0.0014	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Pb	g/m^3	0.0066 (MH1) 0.0044 (MH11)	<0.0010	<0.0010	<0.0010	-	-	-	-	-	-	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Zn	g/m^3	0.023 (MH1) 0.015 (MH11)	0.005	<0.004	<0.004	-	-	-	-	-	-	n/a	n/a	n/a	n/a	n/a	n/a

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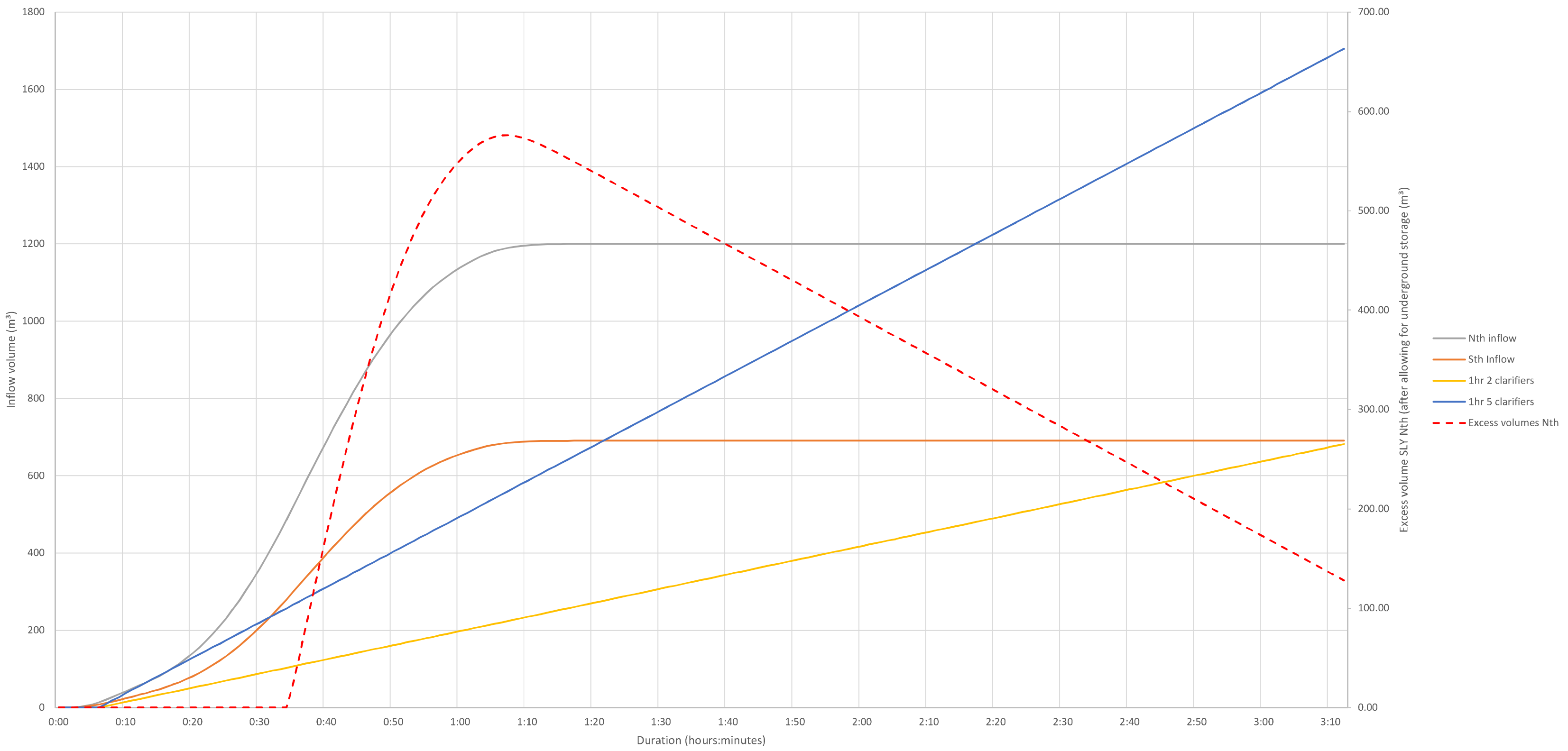
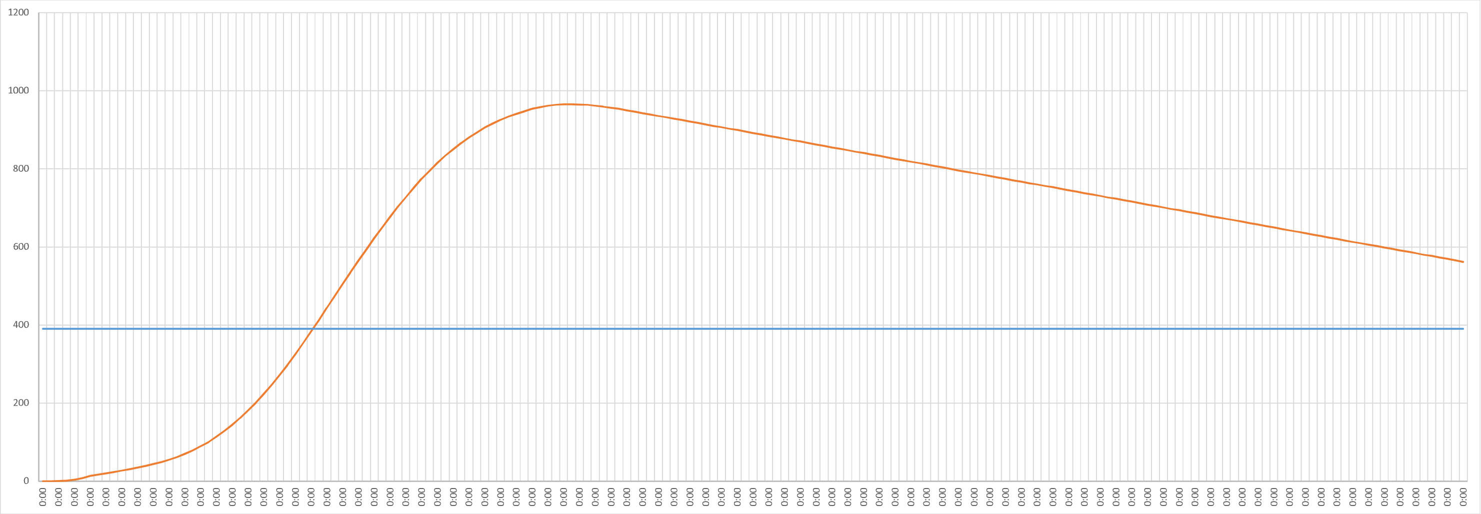
Appendix 5

Volume Charts

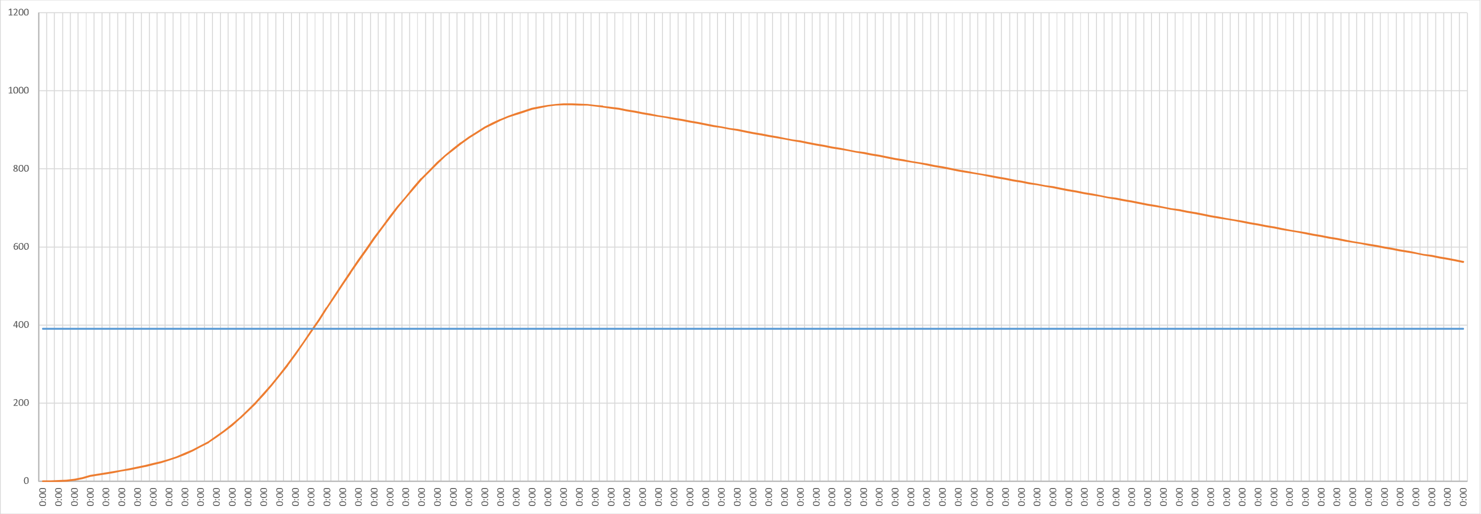


Cumulative volume comparison - 1hr 21mm storm


Cumulative volume comparison - 2hr 21mm storm
Inflow volume (m³)
3000
2500
2000
1500
1000
500
0
Excess volume SLY Nth (after allowing for underground storage (m³)
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0:00
0:20
0:40
1:00
1:20
1:40
2:00
2:20
2:40
3:00
3:20
3:40
4:00
4:20
4:40
Duration (hours:minutes)
Nth inflow
Sth Inflow
2hr 2 clarifiers
2hr 5 clarifiers
Excess volumes Nth


1200
1000
800
600
400
200
0
0:00


Cumulative volume comparison - 4hr 21mm storm
Inflow volume (m³)
2500
2000
1500
1000
500
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
Duration (hours:minutes)
Excess volume SLY Nth (after allowing for underground storage (m³)
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Nth inflow
Sth Inflow
2hr 2 clarifiers
2hr 5 clarifiers
Excess volumes Nth


1200
1000
800
600
400
200
0
0:00

Appendix 6

Opus ULY Stormwater Treatment Reports

7 June 2011
Ross Muir
Insight (Gisborne) Limited
P O Box 986
Gisborne 4040

2S0531.41

Dear Ross

Gisborne Log Yard Extension – Treatment of Stormwater Runoff

1. Background

Eastland Port Limited propose to increase the size of the upper log yard at Crawford Road. The existing fertiliser store building is to be removed, the site regraded and most of the 2.6 ha site used for log storage. Initially the yard will be unsealed but it is understood that within 2-3 years a heavy duty pavement of 350 mm Asphaltic concrete will be constructed.

The expanded site will require stormwater treatment to minimise the impact of logyard runoff on the adjacent Kopuawhakapata Stream, to which the (currently untreated) stormwater from the yard discharges.

2. Standard of Stormwater Discharge

The Gisborne District Council will require discharge consent for the stormwater. Based upon similar recent consents issued by GDC (Specifically that for Dunstan Road log yard), I expect that treatment will need to achieve the instream wter quality targets 10m downstream of the discharge as shown in Table 1:

Table 1: Expected downstream water quality limits

Parameter	Concentration (10m below discharge point in Kopuawhakapata Stream)
pH	6.5 – 8.5
Suspended Solids	Not more than 100mg/l above upstream level
BOD	20 g/m^3
Total Petroleum Hydrocarbons	15 g/m^3
Total Tannins	-
Total Nitrogen	0.4 g/m^3
Dissolved Oxygen	Not less than 80% of total saturation

Runoff from logyards is typically characterised by:

- high (500 g/m^3 or more up to 1500 g/m^3) suspended solids – comprising mud and fine organic matter from logs and vehicles
- large quantities of bark and wood detritus
- sand and fine gravel

- Elevated BOD (100-200 g/m^3) – from sap discharges from fresh cut logs, resin acids and fine organic debris
- Potential for hydrocarbons from oil & hydraulic fluid leaks from trucks and loading machinery
- Dark colour – from tannins leaching from bark
- Elevated nitrogen – from organic matter in the logs

Sealing of logyards is very helpful in reducing contaminant concentrations in stormwater runoff, especially of suspended sediment. A sealed yard is able to be swept and kept much cleaner than an unsealed yard. However on the other hand, a sealed yard reacts faster to rainfall than a metalled yard and gives higher peak runoff. A sealed yard will exhibit more of a "first flush" response, with high initial concentrations of contaminants followed by runoff clearing as the yard is washed clean. In contrast an unsealed yard will discharge sediment throughout the rain event.

3. Hydraulic runoff characteristics of the yard

The total area of the yard is to be 2.59 ha. The site is 320 m long and up to 110 m across with a 3% crossfall on the short dimension and a 1.2% grade in the long dimension (Drawing 3/962/13/5314 sheets 2 &8). Runoff will thus be rapid, especially so when the yard is sealed.

The time of concentration for the site was calculated as follows:
The greatest flow path across the site is 110m at 3% - time of 6 minutes.
250m drainage channel at 1% - time of 5 minutes.
The use of a 10 minute Time of Concentration is therefore considered appropriate.

The 10% AEP (ie 1 in 10 yr year return event) rainfall for a 10 minute duration storm is 10.9 mm. (2040 climate change figure, from *"Design Rainfalls – Gisborne District"*, Opus report March 2010). Using the rational formula for small urban catchment peak flow calculation the peak flow rate in the 10% AEP event would be 400l/s. Longer rainfall durations will give lower peak intensities but greater overall volumes of runoff. Peak flow rate is the critical factor for design of pipes and debris collector style treatment devices, while storm volume is more critical for treatment ponds.

Assuming 100% runoff (a conservative but not unrealistic assumption for a sealed yard), the 10% AEP/10 minute storm would generate 282 m^3 of runoff.

4. Treatment Options

A treatment system will be required that will remove the key contaminants identified in Section 2 above. As a minimum this will require:

- Screening or trapping of floating wood debris
- Sand and stone traps for coarse sediment
- Skimming of oils & fuels
- Settling for finer sediments

And possibly:

- Biological treatment for nitrogen, BOD and colour

4.1 Settling Ponds

Settling ponds would be the first choice for logyard treatment where room permits. Ponds are sized to provide sufficient retention to settle fine sediments and would include sand traps, screens and an oil boom.

However the Upper Logyard site is constrained for room and it is understood all (or as much as possible) of the site is needed for log storage. There is no convenient offsite location for treatment ponds either. Ponds have therefore not been considered further.

4.2 Discharge to Sewer

Discharge to sewer would be a possible option. This would have the advantage of providing biological treatment of BOD and colour. However the sewers would not be able to accept the peak volumes of runoff from the large unsealed area and a large detention pond would be needed to store runoff for release to sewer at a lesser rate. This option has not been pursued.

4.3 Stormwater treatment devices

A range of proprietary devices are available for treatment of stormwater runoff from commercial yards and sealed carparks. Typically these are based upon a vortex flow configuration to remove sediment and will incorporate baffles to collect hydrocarbons. Units are typically sized for a certain flow to pass through the treatment unit and higher flows from more intense rains to bypass the treatment device. This suits the "first flush" response of sealed yards. These units are effective at removing coarse sediment (coarse silts and sands), debris and oils. They are less effective for finer silts, clays will pass through and provide minimal removal for soluble contaminants (BOD, Colour and tannins).

Units based upon filtration are also available. These are more suited to removal of heavy metals and fine sediment from areas with high vehicle use. Filtration units would not be suitable for the high suspended sediment loads off a logyard unless preceded by another sediment removal step.

Vortex units used for stormwater treatment include the Hynds "Downstream Defender", Humes "CDS" and others. We understand that the Lower Port logyard is to install downstream defenders and so for consistency on the site we have adopted these.

5. Proposed Treatment System

The proposed strategy for the Gisborne log yard stormwater treatment is to maximise retention of stormwater on site within the area limitations and slowly release treated water to get maximum dilution in the Kopuawhakapata Stream.

The Kopuawhakapata Stream has a longer hydraulic response time (1 hour plus) than the logyard. In short duration intense rainfalls the runoff from the logyard will discharge to the stream in advance of the stream rising from rainfall. Slowing the release of stormwater from the site maximises the opportunities for treatment and also improves the dilution available in the stream.

The proposed treatment system is to provide settling and treatment to the runoff by:

a) Retention in the collector drain against the bund on the Crawford Rd side of the site. This drain is 200m long. It is proposed to incorporate two settling pits into the drain. These will be concrete and provided with a ramp to allow easy access for removal of sediment by front end loader. The downstream end of the pit will have a timber weir with a low level pipe. The effect of these pits will be to provide some intermediate storage to attenuate flowpeaks and by trapping coarse sediment reduce the load on the main treatment device. 35l/s will flow through the 150mm Ø pipe drains, and the balance over the top of the timber weirs, with a total of 100l/s discharging from the site (10 minute, 10y return event).

b) Treatment in a Hynds "Downstream Defender" unit located outside the site bund adjacent Crawford Road.

The unit chosen (downstream defender 2550mm) has the following characteristics;

Table 2: Downstream Defender

Option	Cost ($)	Effectiveness/ performance criteria	Maintenance frequency & description	Indicative annual maintenance cost
Hynds Downstream Defender 2550mm diameter unit (with onsite storage)	$45,000 + $15,000 install	• Design flow = 200l/s • Capacity = 425l • 1990l oil storage capacity • 4.05m^3 sediment storage capacity • 90% solids removal	Initially 6 monthly inspection, and removal of oil & solids, then (likely annual)	Approx $5000 year 1, Approx $2250 thereafter (2010 pricing)

The "Downstream Defender" offers good floating and heavy solids, oil and sediment removal & storage for reasonable capital cost, and the lowest ongoing maintenance costs of the options profiled.

A conservative sizing of the unit is proposed to maximise solids removal and hydraulic capacity. The location of the discharge into the relatively small Kopuawhakapata Stream places severe demand upon the treatment device as there is minimal dilution for the log yard runoff, compared with for example the Port Logyard where discharge is to the harbour. However a mitigating factor for the discharge is that the point of discharge to the stream is only several hundred meters upstream from the harbour.

6. Impact on Stream

The 10 year Kopuawhakapata Stream peak discharge is 8.7m^3/s. As the time of concentration is longer than the log yard the peak level in the stream will generally be after the log yard. Making a conservative assumption that when the log yard reaches peak discharge flow will be 2m^3/s in the stream and rising:

Dilution of 100 l/s into 2m^3/s is <u>20 times</u>

At 20 times dilution the following discharge levels would be allowable assuming the discharge limits in Table 1:

Table 3: allowable discharge levels

Parameter	Upstream level in Stream	Required Level (10 m below discharge in Kopuawhakapata Stream)	Allowable level in discharge (at 20x dilution)	Typical discharge parameters before treatment	Typical parameters after treatment
Suspended Solids		100mg/l above background	Up to 2000mg/l	1,000mg/l	100mg/l (90% removal in vortex unit)
BOD	2.28 mg/l	20 mg/l	340 mg/l	200mg/l	200mg/l (negligible removal assumed)
Total Petroleum Hydrocarbons	No data – assume very low < 1mg/l	15	300 mg/l		<50 mg/l
Total Tannins	No data	-			
Total Nitrogen	No data	0.4	8 mg/l	Not available	Negligible removal assumed
Dissolved Oxygen		Not less than 80%			Discharge will be well aerated by falling 10m to stream, with minimal travel time to discharge to harbour

With the Kopuawhakapata Stream at peak 10 yr flow of 8.7 m3/s the available dilution is 80 times and the effects from the logyard discharge proportionately less.

On the basis of the above monitoring information the proposed treatment regime will be sufficient to meet the assumed discharge requirements for suspended solids, BOD and oils. Further treatment options may be required if the council imposes discharge standards more strict than those in Table 1.

7. Recommended Monitoring

Monitoring of the discharge quality from the log yard and the receiving water quality is recommended. This will confirm the effects, track the efficiency of the site maintenance and identify if further treatment contingency measures are required.

Monitoring is recommended in 4 rain events per year as in Table 4. Rain events should be selected to cover a range of runoff and stream conditions including:

- Moderate rainfall of 5-10 mm/hr with stream at low flows
- Heavy rainfall >10mm/hr with elevated stream flow

Site	Parameters	Comment
Logyard discharge from second settling basin	Suspended solids BOD TPH TN Colour	To ascertain effectiveness of settling basins
Logyard discharge below downstream defender (point of discharge to stream)	Suspended solids pH BOD TPH TN Colour	To determine contaminant load to stream
Kopuawhakapata Stream 10 m upstream of discharge	Suspended solids pH BOD TPH TN Colour Dissolved oxygen	Upstream levels in stream
Kopuawhakapata Stream 20 m downstream of discharge	Suspended solids pH BOD TPH TN Colour Dissolved oxygen	Increment in contaminant loads due to discharge

Table 4 : Recommended Monitoring

In addition to the performance monitoring of Table 4. It is recommended that a more detailed analysis of a rain event be undertaken, with samples taken at 15 minute intervals through an event of duration 1 hour or more. This will establish the first flush quality. This testing should be undertaken after the yard is sealed.

8. Contingency

Monitoring data from the logyard is not currently available on the levels of nitrogen and colour in the discharge. It is anticipated that with elevated flows in the stream there will be more than adequate dilution in the stream to ensure the water quality limits are met. However there may be circumstances of low stream flow and localised rainfall around the log yard where small discharges from the site may enter the stream with less than satisfactory dilution.

A possible contingency measure which could be applied in the event of monitoring indicating a problem would be to install a pump ahead of the "Downstream Defender" and pump (or divert by gravity if falls allow) the base flow from the yard to sewer.

Peter Askey
PRINCIPAL ENVIRONMENTAL ENGINEER, CPEng

Upper Logyard Development

Stormwater Treatment

Eastland Port Ltd

Upper Logyard Development

Stormwater Treatment

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Contents

1 INTRODUCTION

1.1 Proposed Development

Eastland Port Ltd propose to redevelop and extend the existing log storage area known as the "Upper Logyard" on Crawford Road. Currently this area includes a log store area, a disused fertiliser store (under demolition) and some general hardstand areas.

When complete the new log yard will occupy an area of 2.9 hectares.

1.2 Existing Stormwater Discharge

Currently stormwater from the Upper Logyard discharges at two locations to the adjacent Kopuawhakapata Stream. The upper discharge point is via a concrete flume, this also collects road water off Crawford Road.

Photo 1 : Upper discharge point from Crawford Rd and the Upper Logyard

The lower discharge point is via a pipe from cess pits at the main logyard entrance to a discharge manhole beside the creek. Until recently (March 2012) this manhole was blocked but has now been cleaned out.

Photo 2 : Main Upper Logyard discharge to Kopuawhakapata Stream

1.3 Stormwater Management Proposals

Consent applications for the Upper Logyard development were submitted in October 2011. The Application proposed to continue to discharge stormwater from the new logyard to the Kopuawhakapata Stream via the lower discharge point, with upgraded reticulation.

Stormwater was proposed to be collected in a channel with intermediate settling basins and weirs located on the logyard site immediately behind the Crawford Rd bund. These basins were intended to:

- Provide retention of flow to reduce peak discharge rates
- Provide settling of coarse sediments, with sand traps for clean out
- Incorporate booms for capture of floating debris and oils

It was then proposed to pass the stormwater through a Hynds "Downstream Defender^{TM}" vortex style treatment device prior to discharge to the stream. This was initially selected for consistency with the treatment regime recently installed on the Southern Port logyard.

However following further detailed characterisation of the logyard runoff carried out subsequent to the Application it is now proposed to amend the stormwater treatment as described below.

2 STORMWATER CHARACTERISATION

2.1 Upper Logyard Stormwater Characterisation

Samples were taken of the "raw" runoff from the upper logyard. These would be representative of the situation when the yard is unsealed, and would represent a "worst case" for a sealed yard.

Four samples were taken over a 1 hour period following moderate rainfall on the 4 July 2012 in which 24 mm of rain had fallen over the preceding 12 hours averaging around 2mm/hr.

Samples were taken of water flowing directly from an unsealed log storage area. The samples were analysed for turbidity, Volatile suspended solids, Total suspended solids, settleable solids, BOD_5 (total and dissolved), total phenols and Tannin.

Results are presented in Appendix 1. Key features of note are:

- Turbidities and suspended solids were very high, ranging from 6,000 to 22,000 – g/m^3
- Volatile suspended solids were around 22% of total suspended solids, reflecting the high organic load in the runoff
- BOD_5 was high, ranging from 250 to 640 gO_2/m^3. The dissolved fraction ranged from 54 -94%, and increased as the storm progressed
- Phenols were relatively low and would only require 2-3 times dilution to reach water quality guidelines
- Tannin levels were high as indicated by the red colour of the stormwater (Photo 2)

In addition a particle size analysis was undertaken on the suspended solids (Appendix 2). This shows that the suspended solids are very fine, with around 25% clay fraction (ie < 2um) and around 90% under 100um.

2.2 Sampling of Kopuawhakapata stream

The stream and existing runoff from the Upper Logyard were sampled during rainfall on 1 August. Samples were taken at 4.00 pm after a 6.9mm rainfall that commenced at 11.00 am. The stream was already running full after previous rain, with an estimated flow of 700-1,000 l/s. Both discharge points were flowing strongly. Samples were taken from:

- The Kopuawhakapata stream upstream of the upper discharge (concrete flume) (KUS)
- The concrete flume. Note this also includes road runoff from Crawford Road (Photo 1) (D1)

- The stream downstream of the flume but upstream of the lower discharge at a point where the first discharge appeared visually to be fully mixed. (KMS)
- The second discharge manhole beside the stream (Photo 2) (D2)
- The stream some 30m downstream of the lower discharge where the water was fully mixed. (KDS)

The samples were analysed for turbidity, TSS and $TBOD_5$. The results are included as Appendix 3.

Of note from the results:

- Stream Turbidity and TSS are similar and increase with each discharge. TSS increases by 2.7 times from upstream to downstream
- The overall increment in TSS is 98 g/m^3
- BOD_5 is low upstream but substantially increased after the discharges
- The BOD_5 in the stream downstream of the upper discharge point was higher than in the discharge itself. This result appears anomalous and so was checked with the laboratory and the result confirmed. It is expected the result reflects the instantaneous nature of the grab samples
- The upstream discharge point stormwater is more dilute reflecting the road water contribution
- The downstream discharge quality is similar to that from the July sampling from the logyard itself. TSS and BOD are slightly lower than the July in yard sample, probably reflecting dilution with clean road water and water from the fertiliser store roof

The observed impacts in the stream from the moderate rainfall of 1 August are very close to or exceed the Dunstan Road consent conditions of:

i. TSS downstream < 100 g/m^3 increment over upstream

ii. BOD_5 downstream < 20 gO_2/m^3.

Clearly with an increase in unsealed logyard area at the Upper Logyard the increased volume of runoff would cause the discharge to consistently exceed the Dunstan Rd conditions if it were of a similar quality to that observed to date.

2.3 Extended Settling Tests

Following on from the 1st August sampling a further series of settling tests were undertaken on 4th October (Appendix 3) with the objective of better defining the settling characteristics of the stormwater and hence treatment requirements. A representative sample of stormwater was taken from the upper logyard near the entrance and allowed to settle with the following tests undertaken at intervals ranging from 60 minutes out to 120 hrs:

- Settleable solids
- Turbidity, TSS, $TBOD_5$ on the supernatant water
- A fuller characterisation of the supernatant water including VSS, phenols, tannins and resin acids for the 24 hr supernatant water

The TSS for this sample was 1,820 g/m^3 and so somewhat less than the earlier results. The reason for this is unclear, but could relate to placing of new gravel on the yard several weeks prior.

Figures 1 & 2 below shows the variation in TSS, Settleable solids, BOD_5 and Turbidity with time. The graph shows that most settling takes place within 12-24 hrs with little further improvement in supernatant clarity beyond that.

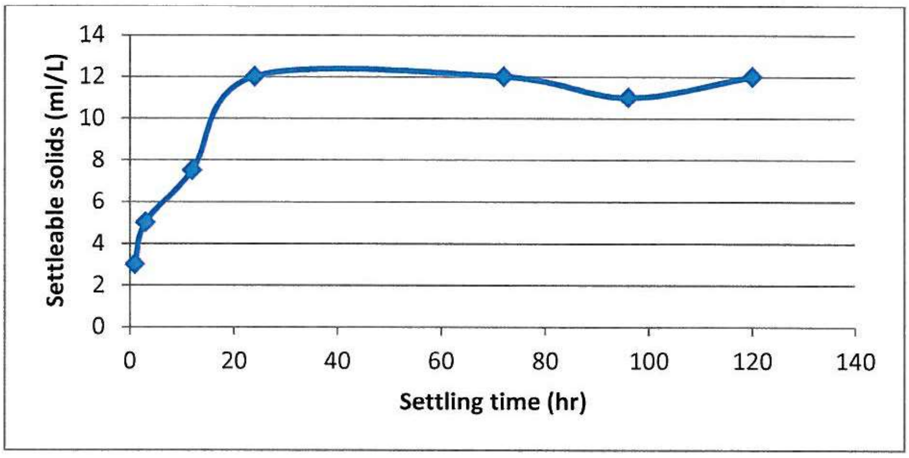

Figure 1 : Settleable solids with time

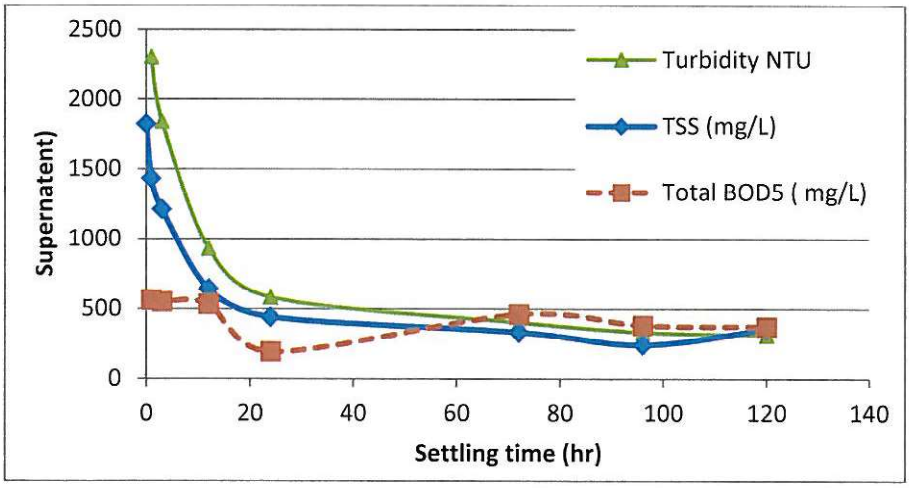

Figure 2 : Supernatant quality with time

BOD_5 is showing a gradual decrease over time as some of the organic material settles. The 24 hr BOD result does appear to be anomalous and may relate to a variation arising from the laboratory sampling procedure.

The settling results provide useful data for the design of stormwater treatment and the assessment of effects of the discharge. The residence time of the stormwater in the stream before mixing with the harbour basin is less than 24 hrs. The sediment remaining in suspension after 24 hrs is very fine and settles only very slowly. Therefore this fraction would not settle in the stream after discharge and most will remain in suspension in the harbour basin and be dispersed with the mixing of the tidal inflow and outflow. Note that some gradual flocculation of the clay particulates in contact with seawater would be expected.

The treatment device therefore needs to provide the equivalent of 12-24 hrs settling to ensure removal of the readily settleable solids.

The residual sludge (settleable solids) at 24 hrs has a TSS concentration of 24,000 g/m^3 (2.4% solids). This is a thin slurry that will require further thickening for ultimate disposal (Section 4.4).

3 DESIGN STORM

3.1 Design Storm

The selection of the design storm for stormwater treatment purposes requires a balancing of a number of considerations including:

- Rainfall depth, duration and frequency (return period)
- Ecological impacts in the receiving water. For high return period events when the receiving water will be flowing at elevated levels then a short term stormwater discharge of poor quality will have little impact. Whereas frequent discharges of the same stormwater at low stream levels would be harmful.
- "First flush" effects – ie runoff in the initial period of a storm carries a greater concentration of contaminants
- Capacity of treatment device.
- Available storage to retain flow and then feed at a lesser rate to the treatment system

Guidance for stormwater treatment for the design water quality (as opposed to conveyance) storm is provided in the 2010 NZTA document *"Stormwater Treatment Standard for State Highway Infrastructure"*. This recommends that stormwater treatment be provided for the 90%ile storm volume, ie 90% of storm events will have a rainfall depth of less than the design figure. The Standard includes maps of the 90%ile rainfall which plots for Gisborne as 21mm. It is noted that the 90%ile storm typically is close to the 1 hr/2yr return period rainfall and this can be used to estimate the water quality storm. For Gisborne area this is (2040 projections) 21.5mm, which is in close agreement. Adoption of the 90%ile rain event generally means that around 80% of the annual rainfall would be treated, this will vary with the distribution of rainfall from year to year. Note that the 90%ile water quality storm is not tied to a particular duration. This means that for shorter durations the return period of the storm increases (eg 21mm is a 5 year return period event at 30 min duration and over a 100 year event at 10 minute duration). Conversely as duration increases then the return period for the 21mm reduces.

Assuming a catchment area of 2.9ha then the design water quality storm volume is 29,000 m^2 x 21mm = 609 m^3. Note this is slightly conservative as it assumes 100% runoff.

This is used as the basis for evaluation of treatment options below.

4 PROPOSED STORMWATER TREATMENT

4.1 Design Constraints

The following factors influence the stormwater treatment:

- The need to maximise log storage area in what is a limited site area, hence the need for a system with a small footprint
- High and variable suspended solids loads
- The BOD_5 content

4.2 Lamella Settlers

Considering the constraints above, a lamella plate clarifier is proposed for the stormwater treatment.

Lamella (inclined plate) settlers are a means of uprating clarifier performance and allow a much higher surface loading rate than for a simple clarifier tank. This is as settling particles have a much smaller distance to settle before they encounter a surface. An indicative loading rate would be around 5-10 m/hr, subject to specific assessment.

A nominal treatment capacity of 50 m^3/hr is proposed. This will be sufficient to clear the design (90th %ile) storm volume in approximately 12 hrs.

For a 50 m^3/hr unit this would require 10 m^2 of surface area. The units are modular and the capacity can be provided in 1 or more individual tank units.

A lamella clarifier could be purpose built or alternatively one of a number of package style plants (such as the "Siltbuster") could be used. The unit(s) will work best and be most cost effective if provided with a substantial upstream buffer volume of close to the design water quality storm. This buffer storage will itself provide some opportunity for settling and reduce load on the clarifiers. The proposed layout for the logyard stormwater is as shown in Appendix 5.

4.3 Clarifier performance

A lamella clarifier can achieve high removal efficiencies (90% or more) of particles down to around 25 um. Note that the particle size distribution shows around 70% of the logyard runoff sediment is below this. The remaining sediment will be slowly settling, and unlikely to settle in the flowing water environment of the stream.

The previous assessment was that to ensure an increment in the stream of < 100 g/m^3 of TSS between the upstream and downstream discharge points then the maximum allowable TSS in the discharge would need to be 1,000 g/m^3 (based upon a 20 times dilution). This is well within the capability of a lamella clarifier treatment.

4.4 Solids removal

Any treatment process that is effective at removing solids from the stormwater will generate a solids residual stream requiring disposal. Dewatering prior to disposal would be recommended to minimise volumes.

Settling solids are collected in hopper bottom tanks in the base of the lamella units. In addition a larger in ground tank would be provided (30-50,000 l capacity) to provide storage for solids. From there solids would be either dewatered on site or removed off site for disposal elsewhere.

Solids will also collect in the drain and settling pits, from where they will be removed as necessary in dry weather with a front end loader (excavator for the drain).

4.5 Buffer storage

The design water quality storm is 600 m^3. It is proposed to include a third weir, widen the drain and enlarge the settling pits to achieve the required retention volume on the Upper Logyard site.

4.6 Storms in Excess of the Design Water Quality Storm

In large events that generate a volume in excess of the 20 mm runoff some, albeit reduced, treatment would still be provided:

- Once the buffer storage was filled water would discharge direct from the settling pits. This water would still be receiving some detention and consequent settling in the drain and settling pits
- The lamella clarifiers would be still treating the design throughput of 50 m^3/hr.

Given that the first 600 m^3 of the event has been captured, the "first flush" is being fully treated. Discharge later in the storm event will come after the worst of the contaminants have been washed from the yard and will discharge when the stream is in high flow with large dilution.

5 ALTERNATIVES CONSIDERED

5.1 Alternative treatment systems

5.1.1 Vortex type devices

From the observed stormwater quality and in particular the fine particulates and high $BOD_{5,}$ vortex style stormwater treatment devices will not be capable of removing sufficient contaminants to meet in stream requirements. These are gross pollutant removal devices generally effective down to around the coarse silt range of 150 um. Almost all of the solids are below this size (Appendix 3). Given the very high loading of fine solids it is not expected that additional sand filtration after a vortex unit would be effective.

5.1.2 Settlement basins

(a) Earthen embankment ponds

Simple settlement ponds would be a common solution for stormwater treatment from high silt load sites such as quarries and logyards. Operationally they are simple but do require large areas to be effective.

For settlement ponds with no chemical flocculation a depth of 0.5 -1.5 m would be allowed. Typically at least 3 ponds would be required, each sized for the design storm volume. The ponds would have an inlet weir to spread inflow across the width and an outlet decanter. Several ponds are required so one can be settling and draining leaving capacity for further storms. A number of days would be anticipated to be required to achieve complete removals of the fine particulates in the log yard stormwater. Specific settling trials are required to establish removal times and hence number and size of ponds. Access would be provided for a bob cat or similar and periodically sediment would need to be removed.

Assuming 3 ponds each of 600 m^3 effective volume, and allowing for side batters and access around the ponds then a total area of some $3,000m^2$ would be required. This is a sizeable area in the context of the Upper logyard site and we understand it is not Eastland Port's preference to constrain the log store to this extent. Accordingly this option is not feasible.

5.1.3 Clarifiers

Where solids loads are high and space is at a premium then stormwater can be treated through a clarifier. Tanks are sized on the basis of surface loading rate. The surface loading rate could range from approximately 0.5 -1.5 m/hr depending upon the nature of the solids and whether settling is chemically assisted.

Clarifiers can be rectangular or circular. They incorporate an inflow arrangement to smooth flow and an outflow launder weir. Settled solids are removed from the base by scrapers in a flat bottom clarifier or from the centre cone of a hopper bottom tank.

Any clarifier will work best under a relatively stable inflow. For this reason it would be best provided with an upstream storage basin and have the stormwater fed (pump or gravity) at a relatively constant rate to the clarifier. Flows in excess of the design storm would be bypassed. Without an upstream flow buffer then the clarifier has to be sized for the peak flow and will be subject to widely varying inflow rates, making effective settling difficult to achieve.

If a buffer storage is used to capture the design storm volume (600 m^3) and then feed that to treatment over say 12 hrs at 50 m^3/hr then the clarifier needs to be 100 m^2 (say 11.3m diameter).

An alternative option would be to capture all the design storm volume (600 m^3) into a concrete basin (eg a circular precast concrete tank such as a Hynds "Megapond" or similar). This would be used to batch settle the storm volume, settling the stormwater for 12-24 hrs (as evidenced by the settling tests, Section 2.3) and then decanting the supernatant water. The residual sludge volume, which would be quite large (50-100m^3), would then require further thickening and dewatering.

No advantage is seen in this approach over the lamella clarifiers. In particular the footprint of the treatment system is larger.

5.2 Alternative treatment locations

A review was undertaken of alternative locations for a stormwater treatment facility. A possible site was identified on land owned by Eastland Port Ltd on the north side of Crawford Rd, adjacent the substation. While a treatment facility could be fitted on the site the location has no buffer zone to neighbouring residential property and accordingly was not pursued.

Piping the stormwater down to the main logyard area provides no advantage and would compromise the available storage area at that location.

Locating stormwater treatment on the Upper Logyard site where it will be at the source of the water and effectively screened by the earthen bund to be built alongside Crawford Road is the appropriate location.

5.3 Alternative Discharge Locations

Alternative locations for the discharge of stormwater would be:

(a) Direct to the marina basin. This does not materially alter the level of treatment that is required of the stormwater. It would require new pipelines under Hirini Road and the Wharf.

(b) To the open harbour in the vicinity of the main logyard discharge. With more dilution and mixing at this location possibly the discharge quality standards could be less. However a long length of pipe (c 800m) is required

(c) Discharge to sewer. This was discussed with Gisborne District Council, however there is no spare capacity for the stormwater in the sewers from the Kaiti area.

None of the above alternatives are considered to provide significant environmental or cost advantage over the proposed Kopuawhakapata Stream discharge point.

6 CONCLUSION

The Port is severely constrained for space and wishes to maximise the log storage area in the Upper logyard. This means that large passive settling basins are not a viable option. Treatment options that minimise the footprint, such as a plate settler, are favoured from this regard.

To achieve a cost effective and operationally robust treatment of the stormwater some retention of the flow is required. This means providing capacity to capture the design water quality storm and allow it to be fed at a slower rate through the treatment system.

At this consenting phase of the project it is not necessary to fully design the stormwater treatment. However it is necessary to be able to demonstrate that a suitable method is available and practical within the constraints of the site which will achieve a level of treatment consistent with the requirements of the receiving water. A combination of on site retention of buffer flows followed by lamella clarifiers will achieve this.

The following proposals are therefore put forward as a basis for the consent:

That:

i. A Design water Quality Storm based on the 90%ile rain event be adopted, equivalent to runoff from 21mm rainfall

ii. On site retention of minimum 600m^3 of runoff be provided

iii. That treatment capacity be provided with a through put of 50m^3/hr sufficient to clear the design storm volume over 12 hrs.

References

"*Design Rainfalls for Gisborne District*", Opus Consultants March 2010

"*Stormwater Treatment Standard for State Highway Infrastructure*", NZTA, May 2010

Appendix 1

Results from Upper logyard sampling 4 July 2012

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

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Hamilton 3240, New Zealand

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Email mail@hill-labs.co.nz
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ANALYSIS REPORT

Client:	OPUS International Consultants	**Lab No:**	1023338 SPv2
Contact:	Mr P Askey	**Date Registered:**	05-Jul-2012
	C/- OPUS International Consultants	**Date Reported:**	18-Jul-2012
	PO Box 800	**Quote No:**	
	WHAKATANE 3158	**Order No:**	
		Client Reference:	Stormwater Samples of Gisb
		Submitted By:	Mr P Askey

Sample Type: Aqueous

Sample Name:		1	2	3	4	Composite of 1 + 2 + 3 + 4
Lab Number:		1023338.1	1023338.2	1023338.3	1023338.4	1023338.5
Turbidity	NTU	22,000	14,300	13,500	7,100	-
Volatile Suspended Solids	g/m³	4,900	3,500	3,900	1,460	-
Total Suspended Solids	g/m³	22,000	14,700	15,500	6,000	-
Settleable Solids*	mL/L	200	250	164	32	-
Dissolved Total Biochemical Oxygen Demand (TBOD₅)	g O_2/m^3	134	176	510	550	-
Total Biochemical Oxygen Demand (TBOD₅)	g O_2/m^3	250	260	540	640	-
Total Phenols	g/m³	-	-	-	-	0.87
Tannin	g/m³	-	-	-	-	250

Analyst's Comments

Appendix No.1 - Particle Size Report - 1023338

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Samples**
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21st ed. 2005.	0.05 NTU	1-4
Volatile Suspended Solids	Filtration (GF/C, 1.2 µm). Ashing 550°C, 30 min. Gravimetric. APHA 2540 E 21st ed. 2005.	3 g/m³	1-4
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m³	1-4
Settleable Solids*	Volumetric using an Imhoff cone. Settled 1 hr. APHA 2540 F 21st ed. 2005.	0.5 mL/L	1-4
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-4
Dissolved Total Biochemical Oxygen Demand (TBOD₅)	Filtered sample, Incubation 5 days, DO meter, no nitrification inhibitor added, no dilutions, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B 21st ed. 2005.	2 g O_2/m^3	1-4
Total Biochemical Oxygen Demand (TBOD₅)	Incubation 5 days, DO meter, no nitrification inhibitor added, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B 21st ed. 2005.	2 g O_2/m^3	1-4
Total Phenols	In-line distillation, segmented flow colorimetry. NB: Does not detect 4-methylphenol. Bran + Luebbe Method No. 127-71W. APHA 5530 B, C & D (modified) 21st ed. 2005.	0.002 g/m³	5
Tannin	Colorimetric with Folin phenol reagent, tannic acid used for calibration. APHA 5550 B 21st ed. 2005.	0.10 g/m³	5

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Appendix 2

Results of Particle Size Distribution

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

MASTERSIZER 2000

Department of Earth & Ocean Sciences
School of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

Result Analysis Report

Sample Name: #1023338/1	**SOP Name:**	**Measured:** Monday, 16 July 2012 4:35:49 p.m.
Sample Source & type:	**Measured by:** rodgers	**Analysed:** Monday, 16 July 2012 4:35:50 p.m.
Sample bulk lot ref: 2012094/1	**Result Source:** Measurement	

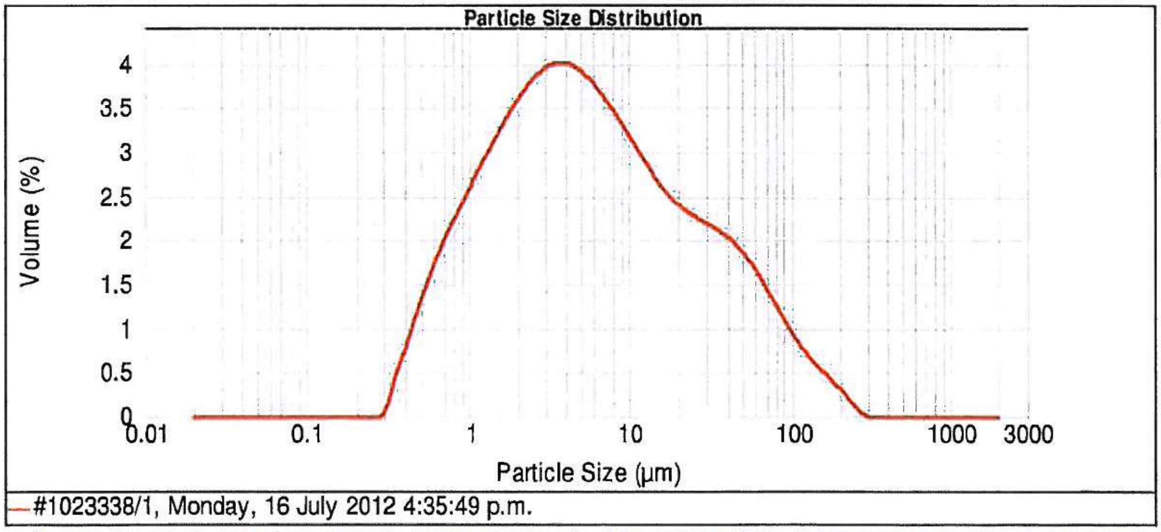
Particle Name: Effluent	**Accessory Name:** Hydro 2000G (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.560	**Absorption:** 0.2	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 17.50 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 1.262 %	**Result Emulation:** Off

---

Concentration: 0.0072 %Vol	**Span :** 9.052	**Uniformity:** 2.87	**Result units:** Volume
Specific Surface Area: 2.37 m²/g	**Surface Weighted Mean D[3,2]:** 2.530 um	**Vol. Weighted Mean D[4,3]:** 17.311 um	

d(0.1): **0.920** um   **d(0.5):** **5.253** um   **d(0.9):** **48.470** um

---



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	0.980	11.04	37.000	86.47	105.000	97.14	300.000	100.00	840.000	100.00
0.060	0.00	2.000	25.40	44.000	88.77	125.000	98.04	350.000	100.00	1000.000	100.00
0.120	0.00	3.900	42.29	53.000	91.08	149.000	98.75	420.000	100.00	2000.000	100.00
0.240	0.00	7.800	59.57	63.000	93.00	177.000	99.29	500.000	100.00		
0.490	2.13	15.600	73.37	74.000	94.56	210.000	99.69	590.000	100.00		
0.700	6.00	31.000	83.99	88.000	95.98	250.000	99.93	710.000	100.00		

Operator notes:

Result Analysis Report

Sample Name:
#1023338/2

Sample Source & type:

Sample bulk lot ref:
2012094/2

SOP Name:

Measured by:
rodgers

Result Source:
Measurement

Measured:
Monday, 16 July 2012 4:46:25 p.m.

Analysed:
Monday, 16 July 2012 4:46:26 p.m.

Particle Name:
Effluent

Particle RI:
1.560

Dispersant Name:
Water

Accessory Name:
Hydro 2000G (A)

Absorption:
0.2

Dispersant RI:
1.330

Analysis model:
General purpose

Size range:
0.020 to 2000.000 um

Weighted Residual:
1.093 %

Sensitivity:
Normal

Obscuration:
14.09 %

Result Emulation:
Off

Concentration:
0.0069 %Vol

Specific Surface Area:
1.91 m²/g

Span :
8.748

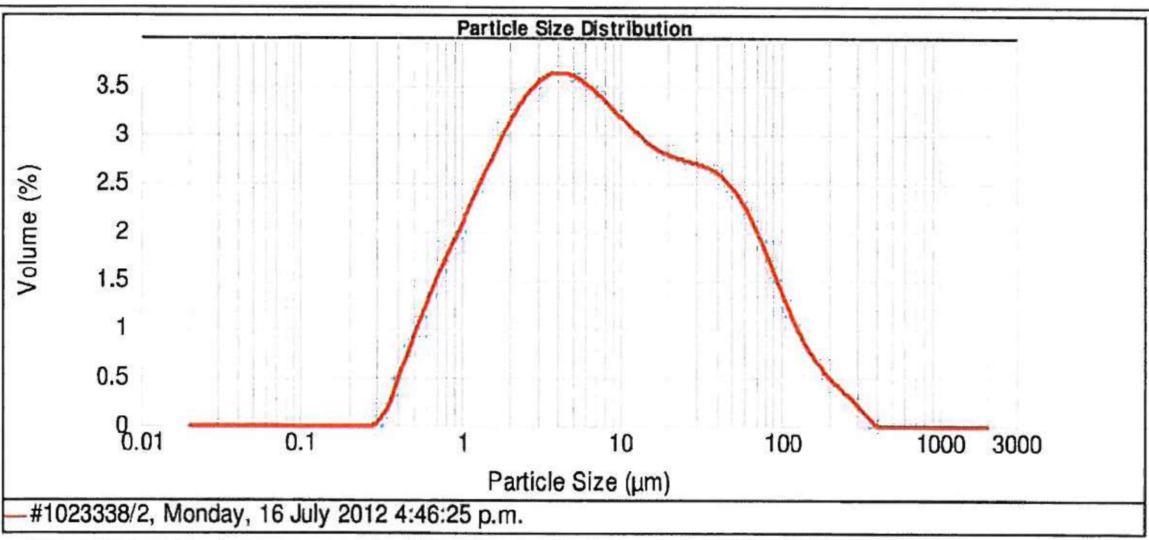
Surface Weighted Mean D[3,2]:
3.142 um

Uniformity:
2.84

Vol. Weighted Mean D[4,3]:
23.924 um

Result units:
Volume

d(0.1): 1.128 um **d(0.5):** 7.400 um **d(0.9):** 65.864 um



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	0.980	8.02	37.000	80.81	105.000	95.25	300.000	99.79	840.000	100.00
0.060	0.00	2.000	20.07	44.000	83.76	125.000	96.56	350.000	99.95	1000.000	100.00
0.120	0.00	3.900	35.11	53.000	86.78	149.000	97.58	420.000	100.00	2000.000	100.00
0.240	0.00	7.800	51.16	63.000	89.37	177.000	98.35	500.000	100.00		
0.490	1.27	15.600	65.26	74.000	91.55	210.000	98.95	590.000	100.00		
0.700	4.08	31.000	77.72	88.000	93.56	250.000	99.42	710.000	100.00		

Operator notes:

THE UNIVERSITY OF
WAIKATO
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MASTERSIZER 2000

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The University of Waikato
Private Bag 3105
Hamilton, New Zealand

Result Analysis Report

Sample Name:
#1023338/3

SOP Name:

Measured:
Monday, 16 July 2012 4:51:50 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Monday, 16 July 2012 4:51:51 p.m.

Sample bulk lot ref:
2012094/3

Result Source:
Measurement

Particle Name:
Effluent

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.560

Absorption:
0.2

Size range:
0.020 to 2000.000 um

Obscuration:
14.43 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.067 %

Result Emulation:
Off

Concentration:
0.0081 %Vol

Span :
9.303

Uniformity:
3.06

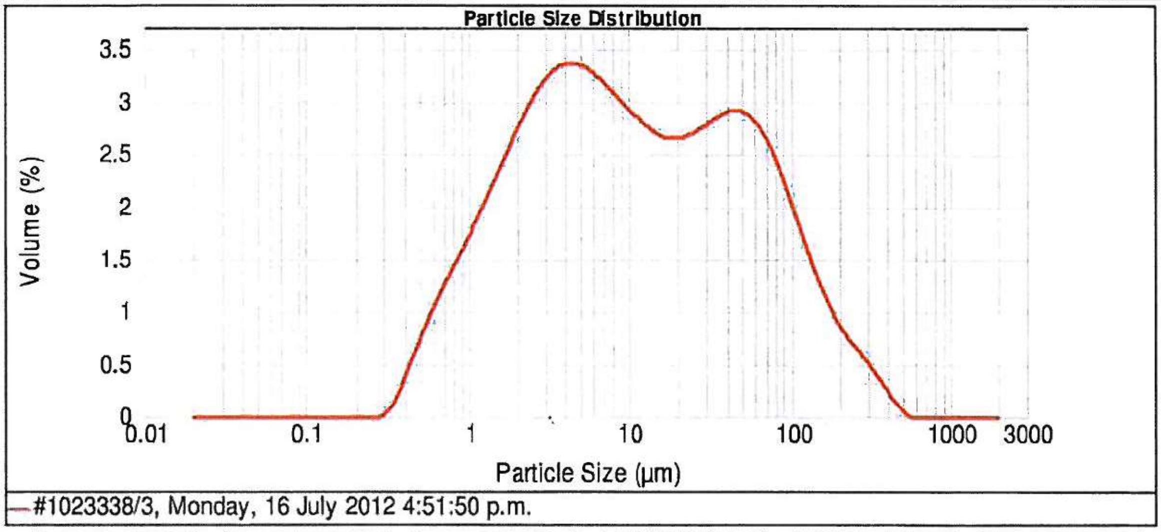
Result units:
Volume

Specific Surface Area:
1.65 m²/g

Surface Weighted Mean D[3,2]:
3.632 um

Vol. Weighted Mean D[4,3]:
34.022 um

d(0.1): 1.288 um **d(0.5): 9.916** um **d(0.9): 93.530** um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	6.65	37.000	73.56	105.000	91.54	300.000	99.04	840.000	100.00
0.060	0.00	2.000	16.87	44.000	76.84	125.000	93.54	350.000	99.50	1000.000	100.00
0.120	0.00	3.900	30.44	53.000	80.37	149.000	95.16	420.000	99.85	2000.000	100.00
0.240	0.00	7.800	45.28	63.000	83.57	177.000	96.43	500.000	99.99		
0.490	1.05	15.600	58.23	74.000	86.37	210.000	97.46	590.000	100.00		
0.700	3.38	31.000	70.28	88.000	89.12	250.000	98.32	710.000	100.00		

Operator notes:

Department of Earth & Ocean Sciences
School of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

Result Analysis Report

Sample Name:
#1023338/4

Sample Source & type:

Sample bulk lot ref:
2012094/4

SOP Name:

Measured by:
rodgers

Result Source:
Measurement

Measured:
Monday, 16 July 2012 4:57:21 p.m.

Analysed:
Monday, 16 July 2012 4:57:22 p.m.

Particle Name:
Effluent

Particle RI:
1.560

Dispersant Name:
Water

Accessory Name:
Hydro 2000G (A)

Absorption:
0.2

Dispersant RI:
1.330

Analysis model:
General purpose

Size range:
0.020 to 2000.000 um

Weighted Residual:
1.137 %

Sensitivity:
Normal

Obscuration:
13.17 %

Result Emulation:
Off

Concentration:
0.0079 %Vol

Specific Surface Area:
1.53 m²/g

Span :
10.673

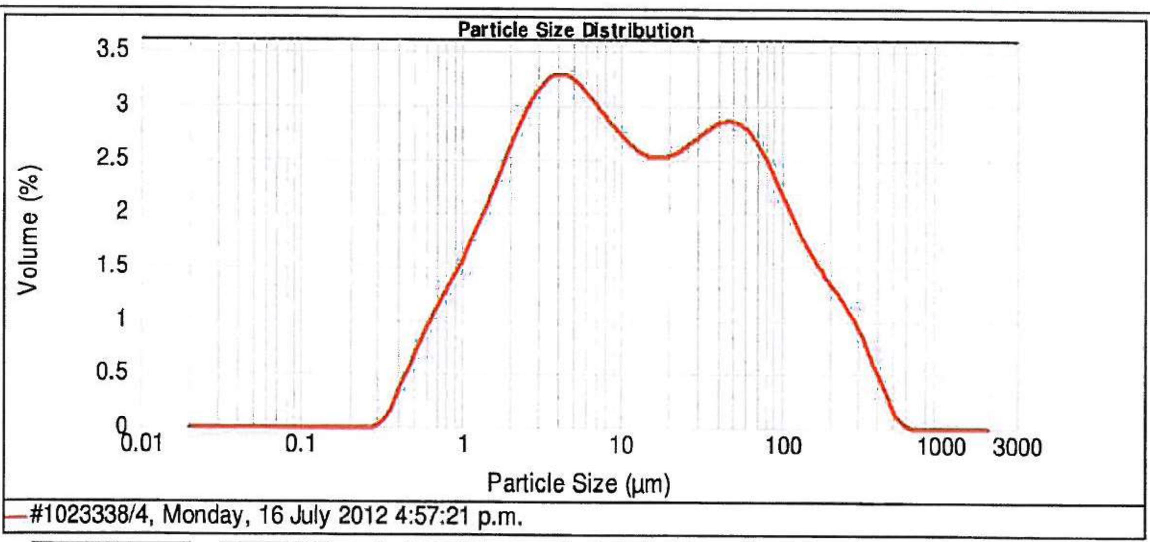
Surface Weighted Mean D[3,2]:
3.932 um

Uniformity:
3.39

Vol. Weighted Mean D[4,3]:
43.517 um

Result units:
Volume

d(0.1): **1.400** **um**   **d(0.5):** **11.620** **um**   **d(0.9):** **125.419** **um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	5.89	37.000	69.65	105.000	87.70	300.000	97.95	840.000	100.00
0.060	0.00	2.000	15.36	44.000	72.85	125.000	89.96	350.000	98.81	1000.000	100.00
0.120	0.00	3.900	28.56	53.000	76.32	149.000	91.96	420.000	99.52	2000.000	100.00
0.240	0.00	7.800	42.84	63.000	79.49	177.000	93.71	500.000	99.80		
0.490	0.91	15.600	54.92	74.000	82.30	210.000	95.26	590.000	100.00		
0.700	2.98	31.000	66.46	88.000	85.11	250.000	96.68	710.000	100.00		

Operator notes:

Appendix 3

Results from stream sampling 1 August 2012

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	OPUS International Consultants	**Lab No:**	1032333 SPv1
Contact:	Mr P Askey	**Date Registered:**	02-Aug-2012
	C/- OPUS International Consultants	**Date Reported:**	13-Aug-2012
	PO Box 800	**Quote No:**	
	WHAKATANE 3158	**Order No:**	
		Client Reference:	Stormwater ex Stream and L
		Submitted By:	Mr P Askey

Sample Type: Aqueous

Sample Name:		KUS 01-Aug-2012 4:00 pm	D1 01-Aug-2012 4:00 pm	KMS 01-Aug-2012 4:00 pm	D2 01-Aug-2012 4:00 pm	KDS 01-Aug-2012 4:00 pm
Lab Number:		1032333.1	1032333.2	1032333.3	1032333.4	1032333.5
Turbidity	NTU	60	1,510	77	10,300	132
Total Suspended Solids	g/m³	58	1,120	73	5,400	156
Total Biochemical Oxygen Demand ($TBOD_5$)	g O_2/m³	2	41	66	250	50

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21st ed. 2005.	0.05 NTU	1-5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5μm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m³	1-5
Total Biochemical Oxygen Demand ($TBOD_5$)	Incubation 5 days, DO meter, no nitrification inhibitor added, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B 21st ed. 2005.	2 g O_2/m³	1-5

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Appendix 4

Results from Logyard sampling and settling tests 4th October 2012

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Eastland Port Ltd	**Lab No:**	1055010 SPv2
Contact:	Marty Bayley 172 Carnarvon Street GISBORNE 4010	**Date Registered:**	04-Oct-2012
		Date Reported:	25-Oct-2012
		Quote No:	51624
		Order No:	6488
		Client Reference:	
		Submitted By:	Marty Bayley

Sample Type: Aqueous

Sample Name:		Logyard original sample	Logyard (settling for 1 hr)	Logyard (settling for 3 hrs)	Logyard (settling for 12 hrs)	Logyard (settling for 24 hrs)
Lab Number:		1055010.1	1055010.2	1055010.3	1055010.4	1055010.5
Individual Tests						
pH	pH Units	6.2	-	-	-	-
Volatile Suspended Solids	g/m³	510	-	-	-	-
Total Suspended Solids	g/m³	1,820	-	-	-	-
Settleable Solids*	mL/L	-	3.0	5.0	7.5	12.0
Total Phenols	g/m³	2.5	-	-	-	-
Tannin	g/m³	240	-	-	-	-
Resin and Fatty Acids in Water by GC-MS						
Abietic acid*	g/m³	0.036	-	-	-	-
Arachidic acid (C20:0)*	g/m³	< 0.0010	-	-	-	-
Behenic acid (C22:0)*	g/m³	< 0.0010	-	-	-	-
12-Chlorodehydroabietic acid*	g/m³	< 0.0010	-	-	-	-
14-Chlorodehydroabietic acid*	g/m³	< 0.0010	-	-	-	-
Dehydroabietic acid*	g/m³	0.32	-	-	-	-
Dichlorodehydroabietic acid*	g/m³	< 0.0010	-	-	-	-
Isopimaric acid*	g/m³	0.0128	-	-	-	-
Lignoceric acid (C24:0)*	g/m³	< 0.0010	-	-	-	-
Linoleic acid (+ other C18:2 acids)*	g/m³	0.0027	-	-	-	-
Myristic acid (C14:0)*	g/m³	< 0.0010	-	-	-	-
Neoabietic acid*	g/m³	0.0077	-	-	-	-
Oleic acid (+ other C18:1 acids)*	g/m³	0.0074	-	-	-	-
7-Oxodehydroabietic acid*	g/m³	0.177	-	-	-	-
Palmitic acid (C16:0)*	g/m³	0.0028	-	-	-	-
Palustric acid*	g/m³	0.0063	-	-	-	-
Pimaric acid*	g/m³	0.027	-	-	-	-
Sandaracopimaric acid*	g/m³	0.0045	-	-	-	-
Stearic acid (C18:0)*	g/m³	0.0019	-	-	-	-

Sample Name:		Logyard (settling for 72 hrs)	Logyard (settling for 96 hrs)	Logyard (settling for 120 hrs)	Logyard (settling for 1 hr) supernatant	Logyard (settling for 3 hrs) supernatant
Lab Number:		1055010.6	1055010.7	1055010.8	1055010.10	1055010.11
Individual Tests						
Turbidity	NTU	-	-	-	2,300	1,840
Total Suspended Solids	g/m³	-	-	-	1,430	1,210
Settleable Solids*	mL/L	12.0	11.0	12.0	-	-
Total Biochemical Oxygen Demand (TBOD$_5$)	g O_2/m³	-	-	-	560	550

Sample Type: Aqueous

Sample Name:		Logyard (settling for 12 hrs) supernatant	Logyard (settling for 24 hrs) supernatant	Logyard (settling for 72 hrs) supernatant	Logyard (settling for 96 hrs) supernatant	Logyard (settling for 120 hrs) supernatant
Lab Number:		1055010.12	1055010.13	1055010.14	1055010.15	1055010.16
Individual Tests						
Turbidity	NTU	930	580	400	330	310
Volatile Suspended Solids	g/m³	-	133	-	-	-
Total Suspended Solids	g/m³	640	440	330	240	350
Total Biochemical Oxygen Demand (TBOD$_5$)	g O$_2$/m³	530	191	460	380	370
Total Phenols	g/m³	-	2.6	-	-	-
Tannin	g/m³	-	176	-	-	-
Resin and Fatty Acids in Water by GC-MS						
Abietic acid*	g/m³	-	0.023	-	-	-
Arachidic acid (C20:0)*	g/m³	-	< 0.0010	-	-	-
Behenic acid (C22:0)*	g/m³	-	< 0.0010	-	-	-
12-Chlorodehydroabietic acid*	g/m³	-	< 0.0010	-	-	-
14-Chlorodehydroabietic acid*	g/m³	-	< 0.0010	-	-	-
Dehydroabietic acid*	g/m³	-	0.31	-	-	-
Dichlorodehydroabietic acid*	g/m³	-	< 0.0010	-	-	-
Isopimaric acid*	g/m³	-	0.0090	-	-	-
Lignoceric acid (C24:0)*	g/m³	-	< 0.0010	-	-	-
Linoleic acid (+ other C18:2 acids)*	g/m³	-	0.0043	-	-	-
Myristic acid (C14:0)*	g/m³	-	< 0.0010	-	-	-
Neoabietic acid*	g/m³	-	0.0044	-	-	-
Oleic acid (+ other C18:1 acids)*	g/m³	-	0.0019	-	-	-
7-Oxodehydroabietic acid*	g/m³	-	0.180	-	-	-
Palmitic acid (C16:0)*	g/m³	-	0.0027	-	-	-
Palustric acid*	g/m³	-	0.0031	-	-	-
Pimaric acid*	g/m³	-	0.0180	-	-	-
Sandaracopimaric acid*	g/m³	-	0.0035	-	-	-
Stearic acid (C18:0)*	g/m³	-	0.0021	-	-	-

Sample Name:		Logyard (settling for 24 hrs) sludge				
Lab Number:		1055010.17				
Individual Tests						
Total Solids (TS)	g/m³	24,000	-	-	-	-

Analyst's Comments

At the client's request each sample was left to settle for longer than the 1 hour specified in the APHA 2540F method. Each sample was left for the stated time in the sample names, and the supernatant was collected after each time period with tests performed on it (samples 1055010.10-16). The settled solids were collected from the 24hour sample and a total solid analysis was performed on it (sample 1055010.17).

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Sample preparation by Waters General section*	Sample preparation as per requirement.	-	2-8
Resin and Fatty Acids in Water by GC-MS*	Liquid / liquid extraction, GPC cleanup (if required), ethylation, GC-MS FS analysis	-	1, 13
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21st ed. 2005.	0.05 NTU	10-16
pH	pH meter. APHA 4500-H+ B 21st ed. 2005.	0.1 pH Units	1
Volatile Suspended Solids	Filtration (GF/C, 1.2 µm). Ashing 550°C, 30 min. Gravimetric. APHA 2540 E 21st ed. 2005.	3 g/m³	1, 13
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m³	1, 10-16

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Settleable Solids*	Volumetric using an Imhoff cone. Settled 1 hr. APHA 2540 F 21st ed. 2005.	0.5 mL/L	2-8
Total Solids (TS)	Gravimetric. APHA 2540 B 21st ed. 2005.	10 g/m³	17
Total Biochemical Oxygen Demand (TBOD$_5$)	Incubation 5 days, DO meter, no nitrification inhibitor added, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B 21st ed. 2005.	2 g O_2/m³	10-16
Total Phenols	In-line distillation, segmented flow colorimetry. NB: Does not detect 4-methylphenol. Bran + Luebbe Method No. 127-71W. APHA 5530 B, C & D (modified) 21st ed. 2005.	0.002 g/m³	1, 13
Tannin	Colorimetric with Folin phenol reagent, tannic acid used for calibration. APHA 5550 B 21st ed. 2005.	0.10 g/m³	1, 13

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

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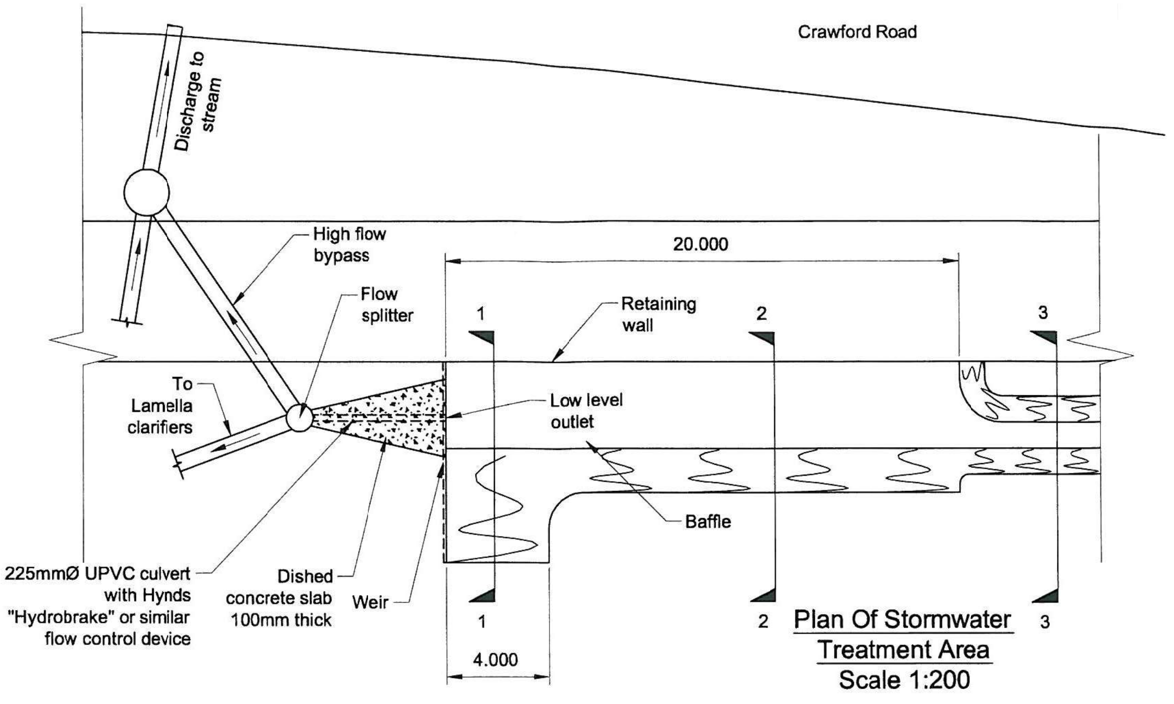
Peter Robinson

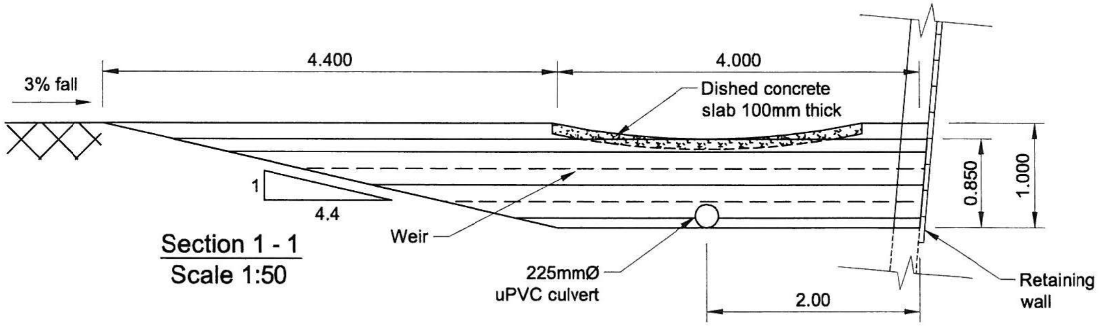
Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Appendix 5

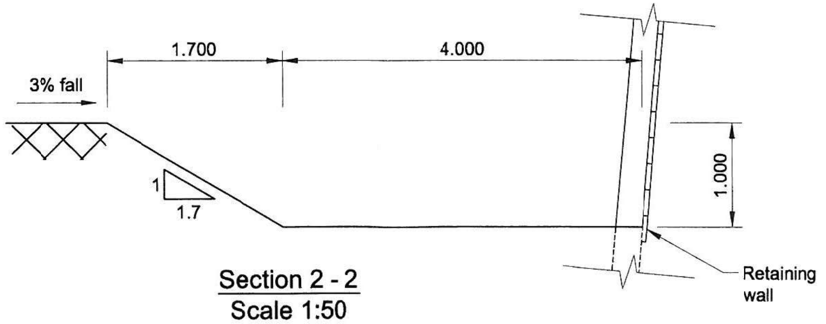
Proposed Layout of Logyard Stormwater Treatment



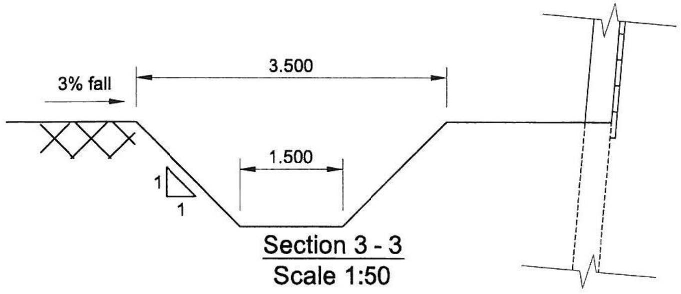
Plan Of Stormwater Treatment Area
Scale 1:200



Section 1 - 1
Scale 1:50



Section 2 - 2
Scale 1:50



Section 3 - 3
Scale 1:50

RESOURCE CONSENT APPLICATION

R1	Basin & Drain widths increased by 0.5m	AW	05-11-12

Eastland Port

OPUS
Gisborne Office
PO Box 49
Gisborne 4040, NZ
+ 64 6 8685199

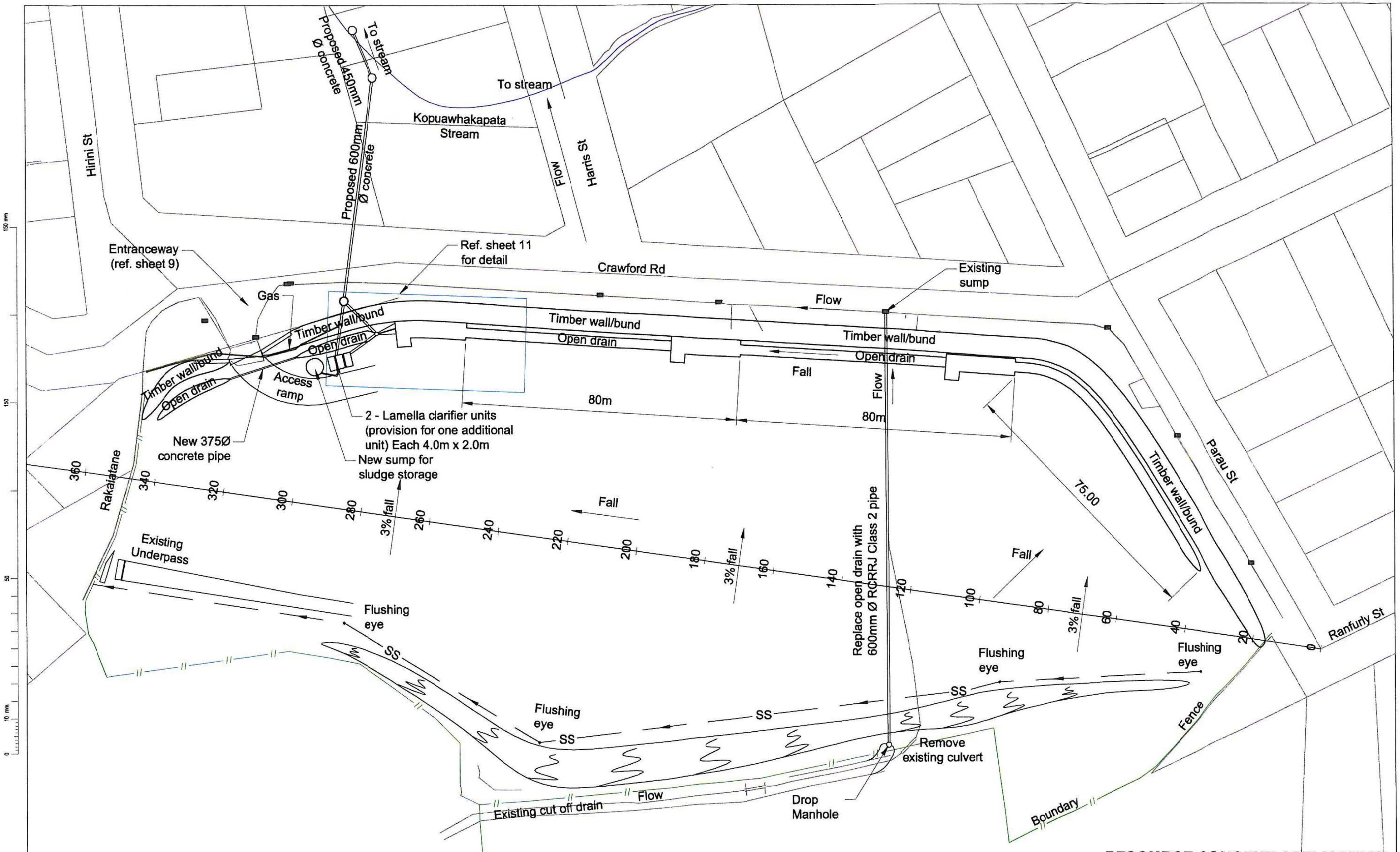
EASTLAND PORT LIMITED
UPPER LOG YARD

SECTION DETAIL OF BAFFLES

Drawn	Designed	Approved	Revision Date
RC	AW	ANDY WILLIAMSON	11/11/10

Project No.	Scale	Drawing No.	Sheet No.	Revision
2S0531.41.011GG	AS SHOWN	3 / 962 / 13 / 5314	11	R1

Original Sheet Size A3 [420x297] Plot Date 03/12/10 @ 11:09 g:\0ther\2s0531-41 eil upper log yard\drawings\3_962_13_5314_ 00r0-1.dwg - 11R0



RESOURCE CONSENT APPLICATION

R1	Basin added, Drain lengthened, Sludge units added	AW	05-11-12

Eastland Port

OPUS

Gisborne Office
PO Box 49
Gisborne 4040, NZ
+ 64 6 8685199

Drawn	Designed	Approved	Revision Date
RC	AW	ANDY WILLIAMSON	11/11/10

Project No.	Scale
2S0531.41.011GG	1:1000 (A3)

Project
EASTLAND PORT LIMITED
UPPER LOG YARD DEVELOPMENT

Sheet
PLAN
PROPOSED DEVELOPMENT

Drawing No.	Sheet No.	Revision
3/962/13/5314	03	R1

Appendix 7

ULY SWTP Optimisation Report

Eastland
Port

Upper Log Yard

Storm Water Treatment Plant Optimisation

Contents

1 Introduction

This document intends to discuss the steps taken in optimising Eastland Port’s Upper Log Yard Storm Water Treatment Plant by adding additional automation of the chemical dosing system.

The Upper Log Yard (ULY) has a footprint of 2.8 hectares with a capacity to hold 31,000 tonnes of logs. Bark and other woody debris gathers on the paved ground of the yard as a result of handling and transport activities. The debris varies in size from large pieces of bark to a finer dust due to crushing from the heavy machinery on site. When it rains, the surface water carries the bark matter into the storm water treatment system.

In the ULY there is a storm water system consisting of a screening process, a pumping station, and two lamella clarifiers. Storm water is captured via a perimeter drainage system before passing through a coarse screen and being pumped into two lamella clarifiers before discharge into Kopuawhakapata Stream to the north of the site.

Consent was granted to Eastland Port by the Gisborne District Council for the redevelopment of the ULY including the storm water treatment system in November 2013. The consent acknowledged the storm water treatment plan provided for lamella clarifiers to be utilised. The consent also specified five sampling sites to analyse the discharging water against the compliance limits.

Automation of the chemical dosing and desludging systems was installed in March 2018 with various trials and adjustments since. Since the implementation of automation the chemical dosage rates have dropped with the amount of chemical optimised for the plant inflow.

Figure 1 Eastland Port Upper Log Yard Location

2 Resource Consent Conditions

The upper log yard storm water treatment plant discharges treated storm water into the Kopuawhakapata Stream under Gisborne District Council (GDC) resource consent numbers LR-2011-105808-00 and DW-2011-105049-00.

Water quality monitoring is required as part of the consent conditions, this is sampled from five locations.

- Site 1 – Logyard discharge from the second settling basin (swale)
- Site 2 – Logyard discharge from lamella clarifier outflow
- Site 3 – Kopuawhakapata Stream 20m downstream of discharge point to stream
- Site 4 - Kopuawhakapata Stream 10m upstream of discharge
- Site 5 – The inner harbour within 20m of the Kopuawhakapata Stream outlet to the marina

The numerical conditions of the consent are outlined in Table 1 below.

Table 1: Upper Log Yard Consent Conditions

Parameter	Units	EMP trigger limits
pH	-log(H^+)	6.5 – 8.5
Temperature	°C	Not more than 3°C above background
Dissolved Oxygen	g/m^3	Not less than 4
TPH	g/m^3	15
TSS	g/m^3	Not more than 100 g/m^3 above background
Settleable Solids	g/m^3	n/a
VSS	g/m^3	n/a
Total Nitrogen	g/m^3	0.4
Soluble Inorganic Nitrogen	g/m^3	0.4
cBODs	g/m^3	20 above background
Dehydrobietic Acid	g/m^3	0.025
Total Phenols	g/m^3	0.72
Total Tannins	g/m^3	n/a
Dissolved Copper	g/m^3	0.0025 average of 4 quarterly samples
Dissolved Zinc	g/m^3	0.031 average of 4 quarterly samples
Hardness	g/m^3	n/a
Absorbance at 440nm	AU cm^{-1}	n/a

3 System Description

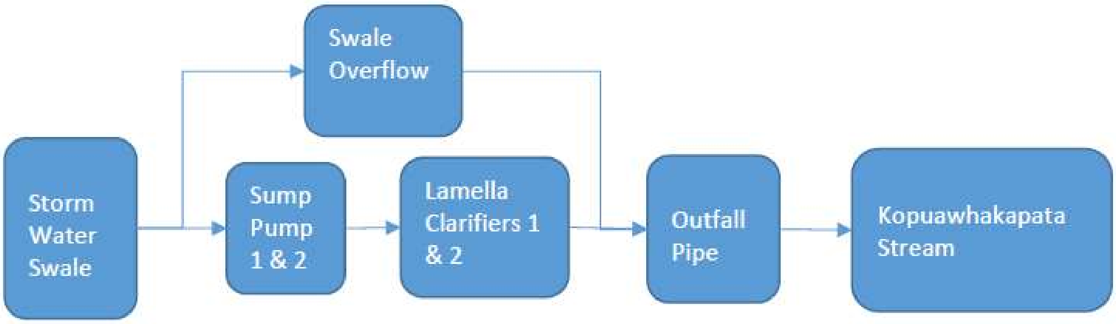
3.1 Original Installed System Overview

The storm water treatment process plant compromises the following steps:

1. Water from the log yard enters the swale where it moves slowly through a series of screening gates where larger material sinks to the bottom or is retained by the gates
2. It is stored in the swale until a predetermined level is reached to allow a significant run period of the treatment plant. These levels are set by the plant operator on the HMI screen
3. From the swale the water is piped underground to the pump chamber
4. Within the pump chamber are two pumps (duty/standby) which are enabled from a level switch and controlled by the PLC to ramp to an operator selected speed
5. From the pump chamber water is piped up through non-return valves and into the plant piping network
6. An inline flow meter determines the volumetric flow through the plant
7. The inflow enters the two lamella clarifiers which are installed in parallel where the dirt particles settle to the sump and clean water exits the top
8. The clean water is discharged over the top of the clarifiers into a common pipe. From the pipe the water drops through a series of risers and laterals and is discharged into Kopuawhakapata Stream to the north of the site
9. The clarifier underflow (sludge) is periodically removed with an air diaphragm pump and discharged into a geotextile bag. This is typically completed at the end of a rain event when the lamellas are reasonably full with sludge.
10. The water from the geotextile bags is collected and discharged in the same pipework as the clarifiers.

The design flow path through the storm water treatment plant is as shown in Figure 2 below.

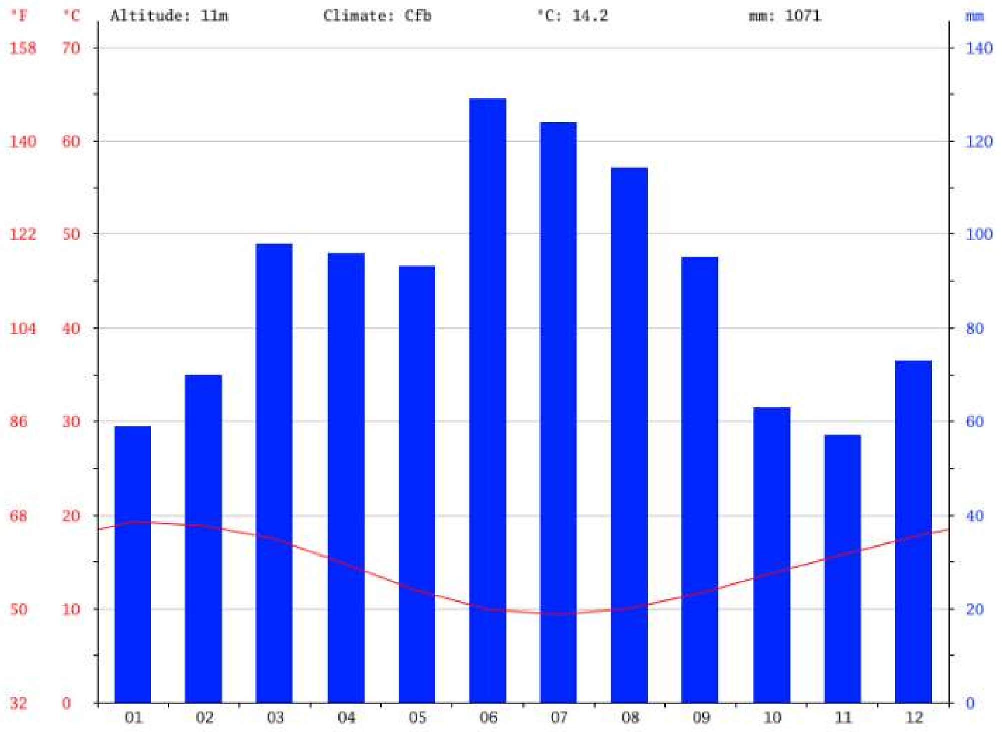
Figure 2 Upper Log Yard Storm Water Treatment Plant Initial Design Process Flow



3.2 Storm Water Flow and Sediment Load

The plant has been designed for a design storm of 21.0mm, extending for any duration i.e. 10 minutes, 1 hour or 10 hours. During 2017 there was a total rainfall of 1071mm, this is shown in Figure 3 below.

Figure 3 Climate Graph, Weather by Month Gisborne (https://en.climate-data.org/location/1039/)



This rainfall translates into approximately 29,988m^3 of storm water to be processed through the upper log yard storm water treatment plant per annum. Using WorleyParsons mass balance from the new Wharf Side Log Yard Project the plant flow for a 21.0mm rain event through the upper log yard plant is summarised in Table 2.

Table 2: Upper Log Yard Plant Flows

Input	Value	Unit	Reference
Stormwater area	28000	m^2	
Design Storm	21.0	mm	Stormwater Treatment Standard for State Highway Infrastructure (NZTA, 2010)
Time for Stormwater to be processed	12.0	hours	OPUS Stormwater Report 15 Aug2012
Inlet TSS	3500	g/m^3	OPUS Stormwater Report 15 Aug2012
Outlet TSS	20	g/m^3	WorleyParsons Mass Balance
Design Storm Volume	588	m^3	
Desired Recoverable Solids	1500	g/m^3	301311-11154-WW-REP-0001-0-Jar Testing Results Summary
Recoverable Solids	882	kg	

The above values indicate significant solids loading in the stormwater entering the Upper Log Yard treatment plant.

During the summer months rainfall can be infrequent and can be generally categorised as short, sharp showers. During the winter months the upper log yard experiences prolonged periods of rain that are frequent.

4 Chemical Dosing Implementation and Automation

4.1 Initial Chemical Dosing

It was found that the original installation while effective was not capable of removing the solids as intended with gravity settlement alone. A significant amount of sediment remained suspended and was carried through to the plant discharge. Jar testing was completed on a range of coagulants and flocculants to determine the ideal combination and dose strengths for the plants' infeed composition.

From this jar testing it was determined that Polyaluminum Chloride would be used as the coagulant and CrystalFloc as the flocculent. The report 301311-11154-WW-REP-0001-0-Jar Testing Results Summary. WorleyParsons. 20Jun2017 is attached in the appendices. This outlines the methodology and results undertaken as part of this process. The Safety Data Sheets (SDS) for both chemicals are attached in the appendices.

Prior to Filtec automation of the chemical system each chemical was mixed via its own 1,000L bulk container (IBC) into dilute ratios recommended by the chemical supplier, IXOM. These ratios are as provided in Table 3:

Table 3: Initial Chemical Dilution Ratios

Product	IBC Chemical (L)	IBC Water (L)	Ratio v/v%
CrystalFloc	2.5	500	0.5%
PACL	20	100	20.0%

The trial dosing pump supplied by IXOM was a dual headed electric diaphragm pump so two chemicals could be dosed in at the same time from the same pump. The pump stroke speed was controlled by a manual dial mounted on the pump. The pump was interlocked with the plant sump pump so would run when the plant was operating. The PACL pump diaphragm contained a slightly larger volume than the CrystalFloc pump diaphragm as shown below in Table 4:

Table 4: Chemical Dosing Pump Volumes

Crystal Floc Dosing Pump Vol. per Stroke	0.001198 L/stroke
PACL Dosing Pump Vol. per Stroke	0.001302 L/stroke

Both chemicals where then piped from the diaphragm pump into the main line. PACL was injected first upstream of the flow meter. CrystalFloc was then injected just prior to the main plant pipework entering the ground. The diaphragm dosing pump stroke control is shown below in Figure 4.

Figure 4 IXOM Temporary Diaphragm Dosing Pump Stroke Control

While the diaphragm pump had a set flow rate the main plant pumps did not. These pumps ran off a speed percentage from 60% thru to 90% and this was input by the operator. Both pumps operated differently due to differences in pipework. Sump pump one would run at $30m^3$/hr at 70% whereas sump pump two would run at $22m^3$/hr at 70% with the same level in the swale. The swale also affected the plant flow rate as the fuller the swale the larger the flow for the same pump speed. This higher plant flow observed with a fuller swale is due to the head pressure differential between the lamella clarifier discharge and water height in the swale.

With this large variability in the plant volumetric flow it resulted in the chemical dose ratio varying greatly from an ideal mixture to extremely dilute.

This chemical dosing system had varying results as discussed above because of the application rates however was enough to prove the concept that chemical dosing significantly increased the removal of solids from the discharge. Once this had been proven Eastland Port went about installing automation of this chemical dosing system along with automating the desludge cycle at the same time.

4.2 Filtec Automation – February/March 2018

Filtec installed an automated chemical dosing system. This included the following key pieces of equipment:

- Polyblend system – This creates a dilute blend of Crystal Floc on demand which is then stored in a day tank. Once neat CrystalFloc is added this slowly begins to lose its reactiveness
- Digital Dosing Pump for PACL
- Digital Dosing Pump for Main Crystal Floc
- Digital Dosing Pump for Desludge Crystal Floc
- Inline static mixer to ensure PACL was homogeneously mixed into the incoming storm water

Below is a high-level summary of how the system operates:

1. System reaches high/start level in the swale, this is an operator input on the HMI screen
2. Dilute Crystalfloc day tank level is checked to ensure above the minimum level, if not polyblend creates dilute crystalfloc until level in the day tank reaches the minimum level
3. Polyblend continues to create dilute crystalfloc unit the day tank reaches the stop level. At the same time one of the sump pumps ramps up to the operator inputed speed
4. Both the PACL and Crystalfloc dosing pumps are enabled on a 4-20mA run signal driven by the inline flow meter
5. The dosing pumps ramp up/down to match to incoming storm water flow. The dosing ratio for each chemical is set by the operator on the HMI screen
6. When the system reaches a predetermined time set by the operator on the HMI the desludge cycle commences, this is further covered below
7. The sump pump stops when the swale reaches the low/stop level, this is also an operator input on the HMI
8. When the sump pump stops both the dosing pumps are disabled
9. The system goes into standby mode

4.3 Changes to Filtec Automation and Chemical Dosing – April 2018 thru October 2018

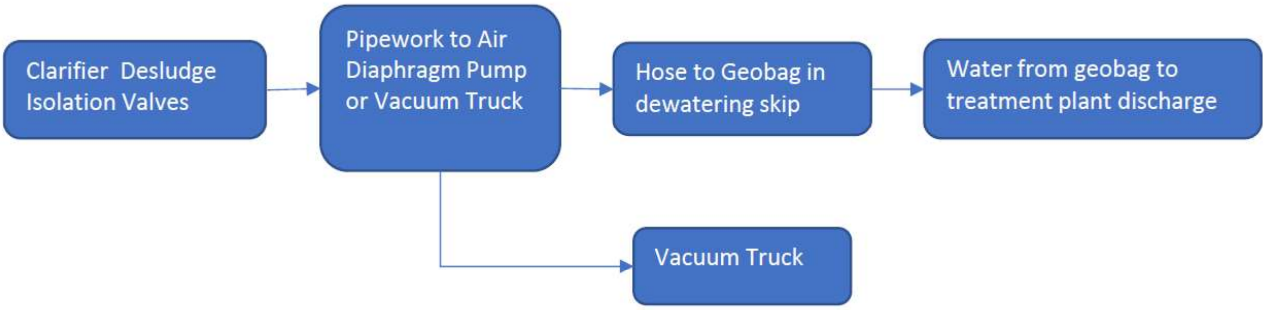
There have been several changes to the automation and tuning of the system since this was first installed. This mainly involved the spanning of the two dosing pumps as it was found the flow range was too small with the dosing pump maxing out at a plant inflow of 20m^3/hr. This is further discussed in section seven.

5 Desludge System Modifications and Automation

5.1 Original System

The original desludge system consisted of pipework, air diaphragm pump, geobag and dewatering skip.

Figure 5 Upper Log Yard Initial Desludge Process Flow



The pipework attached to the desludge valves is shown below in Figures 6 and 7.

Figure 6 and 7 Initial Desludge Discharge Pipework

5.2 Filtec Modifications and Automation – February/March 2018

The objective of the desludge system was to automate this to ensure sludge was removed for the clarifiers as this was generated. This has two affects, one is it allows for the lamella to function to its full capacity instead of filling with sludge and secondly minimises the compaction of the sludge. It was observed when the clarifier was fully drained down that with the head of water the remaining sludge had compressed into a hard clay like sludge which required high pressure water and a shovel to remove.

Several types of level measurement were reviewed as part of this process as one of the primary objectives was to control the sludge depth within each lamella. Unfortunately, Filtec were unable to find a suitable instrument to detect this depth so a time based desludge cycle was adopted.

This newly installed system still utilised the existing geobags and dewatering skip however contained the following equipment:

- Each clarifier has new pipework installed from the desludge outlets on the lamellas, these are fed to a common desludge pump
- Each lamella has an actuated isolation valve on the desludge line to allow each lamella to be desludged separately, or if one unit was taken offline for maintenance.
- There is a progressive cavity pump (desludge pump) that draws the sludge out of the two suction points in each lamella. This pump is protected by a flow switch on the inlet and overpressure switch on the discharge line
- Prior to the pump additional polymer is added to the sludge line to aid in dewatering the sludge further. This flow rate is set manually on the dosing pump.

The desludge cycle was interlocked with the main sump pump and programmed on a 60-minute timer. The operator could select the desludge time per lamella from 1 minute through to 28 minutes. It was found that the desludge needed to run for approximately 20 – 25 minutes per lamella to keep up.

Initially (January 2018) the geobag was installed in a caged skip this worked great to capture the treated water from the bag which was discharged into the plant outfall. Unfortunately, once we had sorted the desludge cycle we found that the original single bag design that was in the skip no longer had a large enough surface area to allow for efficient dewatering. i.e. this could not keep up with the incoming sludge and the desludge pump would trip on high pressure. Two significantly larger geobags were installed on the ground and the clean water from the bags was left on to drain back into the swale.

For the geobags various weaves of the fabric were trialled, two geobags of each material would be ordered at a time. Each fabric had a different permeability which affected how easily the bags blocked or dewatered. We have settled on a product supplied by Cirtex in Tauranga, this is called Envirosieve Gt50/50.

5.3 Changes to Filtec Automation – April 2018 thru December 2018

Initially on a 60 minute cycle installed as part of automation with the ability to input the desludge per lamella from 1 minute to 28 minutes. Since implementing this it was observed this did not work as intended with the sludge within the lamella still accumulating and not effectively being removed by the pump. The pump still seems to be removing a disproportionate amount of water compared to sludge regardless of the pump run time. The pipework was pulled apart and it was discovered that the automated valves were 45° out of alignment which resulted in the sludge being held back in the lamella and pipework.

The automation was changed to allow each lamella desludge valve to be isolated from the HMI screen.

Additionally, the timing loop was changed from a one hour loop to a time input between cycles. This allowed for the desludge cycle time to be dropped and the cycle frequency to be greatly increased from the one cycle per hour.

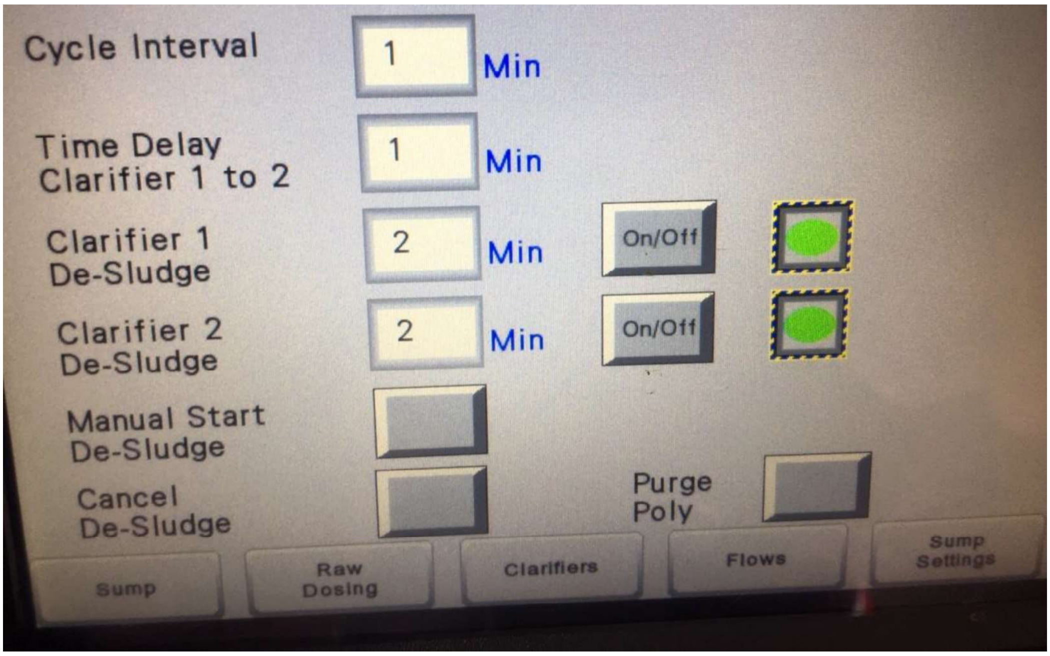
The desludge cycle was reprogrammed to have the following steps

1. Initial time before desludge – programmable 1 – 20 minutes
2. Desludge Clarifier 1 – programmable 1-15 minutes
3. Pause between clarifiers – programmable 1 -20 minutes
4. Desludge Clarifier 2 – programmable 1 – 15 minutes

- Manual desludge button which enables one full desludge cycle (steps 1-4) to be complete while the plant is not running
- Cancel desludge button which stops the desludge cycle
- Isolation button for each lamella

Below is the current HMI desludge screen.

Figure 8 Desludge Cycle HMI Page



Cycle Interval 1 Min

Time Delay Clarifier 1 to 2 1 Min

Clarifier 1 De-Sludge 2 Min

Clarifier 2 De-Sludge 2 Min

These changes resulted in a marked improvement to the system however it was found the sludge would be extracted for a short period of time before just pumping clear water. After consultation with Filtec they suggested this could be “ratholing” which is where a hole in the sludge layer forms and allows for the less viscous water layer above to flow through the desludge system.

Filtec suggested running the desludge cycle in short sharp bursts, for example one minute per lamella at a pump speed of 50Hz. This had an improvement however still resulted in water entering the desludge system after around the first 20 seconds.

Eastland Port then experimented with reducing the pump speed until only sludge was drawn through the system. It was found at approximately 30Hz the system extracted good sludge and managed to retain a low sludge level in the clarifiers.

With the original installed pipework the two discharge valves off the lamellas were not equally piped as shown below. This had the result of creating preferential flow for the shortest pipe run and this would then remove the sludge down to a water level however there was still a significant amount of sludge still in the clarifier as indicated in the sketch below.

The pipework has since been modified to be of equal length, this has resulted in significant improvement and an equal lowering of the sludge level within the lamellas. Figure 9 below shows the new pipe layout.

Figure 9 New Desludge Pipework Layout

With the desludge pump speed and pipework changes it was found that the volume of sludge being removed from the system meant that we could reduce to one geobag that was installed in the skip. This allowed the water to be repiped to the outfall as opposed to on the ground and back into the swale.

6 Chemical Application Rates and Optimisation

6.1 Liquipac (POLYALUMINIUM CHLORDIE)

Initial dose rates were based on the jar tests performed by IXOM when chemical was first introduced to the plant, these were roughly followed with advice from Filtec.

Once automation was installed PACL was initially diluted to an 20% v/v solution

More field testing was complete on the incoming plant feed at various dose rates

It was observed that sufficient blending of the dilute PACL that at 70L/hr (max pump speed) that the plant could operate at approximately 20m^3/hr

A decision was made to go to neat dosing this had two affects, minimised the requirement of chemical handling and the dosing pump was capable of holding the correct dose rate over a larger range of up to 35m^3/hr

At present Eastland Port are optimising the PACL storage to allow for a 48-hour rain event where an operator would not be required to attend to the plant over the weekend unless an alarm was sent to their phone.

From neat dosing a series of testing was undertaken to determine the required application rate for the solids to drop out within a predetermined time. The initial dose rate used was 0.7L/m^3 however this could reduce by approximately 40% with further testing and the installation of additional piping to allow for a longer residence time prior to the CrystalFloc being injected into the stormwater line. The PACL reaction is a combination of concentration and time. At present we have a higher concentration to compensate for the minimal contact time of the chemical.

6.2 CrystalFloc B400 (Polymer)

Polymer is significantly more difficult than the PACL in that this is first dilute at a predetermined ratio and sent to a day storage tank. From this tank it is dosed into the plant infeed line via the static mixer.

This process involved working with the initial dose rates provided by IXOM and Filtec, determining the span that we want to accurately dose into the incoming plant line. Then work back to determine the required dilution in the day tank

The day tank needs to be drained every five days if not used otherwise the dilute polymer coagulates and is unable to be pumped. A level sensor in the day tank has been installed to minimise the chemical mixed up. The low level is approximately 2 litres and the stop fill level is approximately 16 litres, at this level the polyblend system is capable of keeping up with the plant infeed at the highest determined flow rate of 40m^3/hr.

6.3 Chemical Dosing Optimisation

The intent of optimising the chemical dosing is to minimise consumption and discharge into the Kopuawhakapata stream however the dose still needs to be at a level to enable effective use over a range of solids content entering the plant. Multiple trials and continuous testing during rain events over the past 9 months has help establish well defined dose rates.

Initially PACL was switched to neat dosing at 0.7L/m^3 as discussed in section 6.1. This produced a thick jelly like consistency sludge. From this point the PACL application rate was taken down in 0.1L/m^3 steps down to 0.3L/m^3. It was found that this 0.3 value was great for low solids applications however when heavy rain events were experienced or higher flow rates through the plant it was observed that there was solids carry over into the discharge. A rate of 0.5L/m^3 was settled on in November and has been operating well since. This rate of 0.5L/m^3 while slightly high for some applications seems to cover the variability in conditions without overdosing the system.

Crystalfloc is diluted into the day tank at a ratio of 0.1% volume/volume with water. From the day tank this was initially dosed into the stormwater line at a ratio of 1.4L/m^3. The Crystalfloc dose rate followed the same trend as the PACL with similar observations. A final value of 0.4L/m^3 was settled on in November and has been operating consistently since.

6.4 Future Improvements for Chemical Dosing

The next stage for chemical dosing is to review the wharfside logyard design which has a longer contact time for both the PACL and Polymer. This plant will determine if additional contact time actually results in a further reduction in chemical application rates.

Once the Wharfside log yard is sealed this will then provide a true representation of the debris flushed off the upper logyard in a rain event whereas at present mud is tracked up through the wharf side logyard.

7 Plant Discharges

7.1 Typical Discharge Prior to Filtec Automation

Prior to the implementation of the automation system the plant was just run during the rain event with periodic desludging. This resulted in a less than clear discharge as is evident in the water sampling analysis.

Sludge was periodically removed from the lamellas manually via the air diaphragm pump as stated above. This had a tendency to block resulting in having to remove and unblock the pump prior to continuing with the desludge.

7.2 Discharge Post Automation

Since automation has been installed and the desludge system continuously improved as discussed above this has resulted in a relatively clear discharge for the duration of operations. The reliability of this system is continuing to improve with the additional chemical storage capacity and minimisation of chemical to establish the same effectiveness.

As per the attached water sampling reports it is evident that the discharge has continued to improve over the last year with the odd bad result where problems have arisen within the plant operation.

In terms of resource consent conditions these are being met. The majority of contaminants are captured in the sludge which is further dewatered and removed from site.

7.3 Foaming in Discharge

Foaming is an issue Eastland Port has struggled with since the plant has been operating. It was evident from previous discharges that foam is generated from the logyard storm water. This foam has the potential to cause a nuisance by not breaking down at the discharge point and being carried down the stream to where the stream crosses Hirini Street. This may cause public concern due to its visibility both at the discharge location and further down the stream.

From multiple trials Eastland Port have undertaken we have determined this foam is caused by the run off from the logyard and can be exuberated by three main factors. One is the amount of time that the stormwater sits in the swale and the organic matter begins to break down, this has been observed to create natural foaming. Secondly, if the chemical addition is incorrect in particular if PACL is not used this results in an ineffective application. Solids then flow into the discharge along with the foam build up. The third and most significant is the energy imparted on the discharge from the top of the lamella to the discharge into the stream. This energy comes from the conversion of gravity potential energy into kinetic energy making the flow very turbulent. This is especially noticeable at the large drops in the discharge pipe network around the manhole risers.

Foam generation varies significantly during a rain event. For example, during an 8 hour operation the first 2 hours can be a clear discharge then 4 hours of bad foaming followed by 2 hours of clear discharge again.

The foam tends to develop in two forms, the first is a “wet” bubble that readily dissipates quickly, if discharged into the stream this will only be observed for several meters. The second foam is a “dry” bubble this tends to be a dense dry foam that accumulates and needs to be mechanically broken down or dissipates over several days. Dry foam sometimes becomes solid enough it is able to span the Kopuawhakapata Stream. An example of wet bubble foaming observed at the Kopuawhakapata Stream is shown below in figure 10.

Figure 10 Foaming Discharge

Discharge foaming is further discussed in 4Sight's memo attached in the appendices.

7.4 Steps taken to reduce foaming

Numerous steps have been taken to try and reduce the foam on the discharge. Initially a water spray was used in the discharge riser to try and break down the foam generated before it entered the lateral pipework flowing to the stream. This has had a reasonable effect on the wet bubble foam however the dry bubble tends to accumulate and not disperse with the water spray.

Eastland Port reduced the process speed of the water treatment plant, initially the discharge flow rate was 30m^3/hr. At this higher flow rate significant turbulence was generated which contributed to the foaming issue. Eastland Port dropped the flow rate to 10m3/hr however this resulted in an extended processing time and the crystalfloc tended to bind together as opposed to dispersing in the water. Eventually a flow rate of 20m^3/hr was settled on, this seems to be a good compromise at the moment with minimising the energy imparted on the discharge while still ensuring adequate mixing of chemicals.

Lastly, in October a geotextile "sock" and sieve in the discharge riser was installed as shown in the figure below. The sock attempted to remove the energy imparted onto the water from the drop in the riser and the sieve minimise the foam exiting the riser. Therefore, any foam build up in the stream was main caused by the pipework downstream of the plants main discharge pipe.

Figure 11 Discharge Rising Main With Foam Controls

7.5 Resource Consent Compliance

Over the past two years quarterly water sampling has been completed by 4Sight Consulting to ensure Eastland Port's compliance with the Resource Consent conditions outlined above in section 2. These reports are provided in the appendices.

Eastland Port has on average continually improved the discharge over the previous two years with this final foaming issue still persevering. In terms of TSS which is the other visual indicator on the discharge the latest report from October 2018 stated "TSS at Site 3 (240g/m^3) complied with the trigger limit of not more than 100 g/m^3 above background (230 g/m^3). TSS results are shown in Figure 1. Importantly, the discharge TSS (24 g/m^3) was only about 10% of the background value of 230 g/m^3. The discharge TSS was the lowest recorded in sampling to date."

8 Recommended Next Steps

8.1 Discharge Foaming

IXOM have recommended an antifoamer called XIAMETER AFE-1520 Antifoam Emulsion. This product is classified as ecotoxic in concentrations greater than 100 mg/L as per the attached SDS sheet attached in appendix 4. There was another option called FOAMTROL AF1440 however this is a carcinogen therefore this was ruled out of future consideration.

IXOM have recommended and we have completed to following trial to determine the desired application rate for this chemical into the storm water plant.

1. Dilute the "neat" chemical down to a concentration of 20% v/v i.e. 50ml neat chemical per 200ml of water.
2. Obtain a 20L sample of foam and water
3. Using a 1ml syringe dropwise add dilute product utile foam collapse is observed
4. Results should be clear of foam

The results we determined from these bucket trials was 0.3ml dilute solution collapsed the foam found in the 20L samples. This equates to 15ml per m3 of foamy water.

The application of this chemical would be dosed into the common outfall pipe where lamella two discharges. The dose rate would be metered by a small dose pump which is interlocked with the plant starting and stopping.

Eastland Port would start at this initial dose rate of 15ml/m3 and reduce or increase this until a satisfactory result has been achieved. The objective of this is to minimise the chemical used while ensuring no foaming is present in the discharge.

8.2 Desludge Operation

With the desludge system now operating efficiently it will now be a matter of tuning the desludge timing over a number of rain events. Ideally when the Wharf Side Log Yard Plant is implemented this desludge control will be operated off level control as opposed to a timer. If successful, this would be retrofitted into the Upper Log Yard Plant.

Until the WLY haul road has been sealed (March 2019) it is difficult to determining the final/average solids loading through the plant as dirt and debris are currently tracked up from the WLY by maffie trucks during ship loading.

8.3 Plant Control Methodology

During the installation of the Wharf Side logyard the ULY plant control will be updated and adjusted. At present the pumps are controlled by a pump speed rather than flow. This results in the plant operating a various flow rates depending on the level in the swale. As part of the Wharfside Logyard control methodology the plant sump pumps will be controlled by volumetric flow rate with the pump ramping up/down to maintain this flow. If the swale continues to fill to a higher level the plant flow would increase to the next set point. This would be an operator input with the ability to adjust these levels and speeds once commissioned. Below is an example of the swale levels to plant flow rate:

Table 5: Upper Log Yard Proposed Plant Flow Rates

Description	Swale Level (%)	Plant Flow Rate (m^3/hr)
Plant Start Level	60	20.0
Plant Initial Ramp	70	25.0
Plant Secondary Ramp	75	30.0
Plant Breach Level	80	40.0
Plant Stop Level	50	20.0