CONSTRUCTION WATER DISCHARGES MONITORING PROGRAMME (CWDMP)

1 Purpose

The purpose of this CWDMP is to outline the construction related monitoring detail that will occur throughout the Project. The CWDMP includes details of processes and procedures that will be followed and confirms how this monitoring data will be used in the context of the Project to ensure effects are managed appropriately.

This CWDMP identifies:

- Monitoring locations;
- Monitoring methods;
- Baseline monitoring results;
- Development of management thresholds;
- Incident response; and
- Reporting.

2 Objectives

The primary objectives for this CWDMP are outlined as follows:

1. To provide information for making effective on-site decisions on necessary continuous improvement of erosion and sediment control measures (both structural and non structural).
2. To assist in understanding the outcome of on-site decisions to water quality and stream ecology, and support any determination of potential ecological effects from sediment discharged by the Project earthworks.

3 Water Quality Monitoring

3.1 Receiving Environments

Monitoring of Project discharges to receiving environments will be carried out as follows:

- Immediate Mangapepeke and Mimi catchments:
  - Event based inspections and grab sample monitoring at treatment pond outlets;
  - Baseline vs in Project comparative analysis of continuous stream monitoring at "downstream of project" sites;
  - Comparative analysis of upstream and downstream continuous turbidity monitoring within the Managapepeke and Mimi catchments; and
  - Comparative analysis of seasonal aquatic and macroinvertebrate monitoring.
- Wider Tongaporutu and Mimi catchments:
  - Comparative analysis of "control" sites with "downstream of project" sites.

3.2 Monitoring Process and Locations

The process for water quality monitoring locations during construction is illustrated in Annexure 1 of this CWDMP. The monitoring locations listed below and shown on Figure 3.1 will be used to sample discharges and sediment deposition from any resultant site run-off during construction and to assist with identifying any potential effects on the receiving environments. These are as follows:

- Control sites (i.e. not affected by construction discharges, but discharging to the wider catchment):
    - Mangapepeke Stream catchment: Site WQ1; and
    - Mimi Stream catchment: Site WQ4.

    Note – Site WQ1 is located within a separate subcatchment area to the site compromising a predominantly clearfelled, agricultural landscape with numerous existing erosion scarps and exposed ground and hence should not be used as a direct, control water quality comparison site to the earthworks subcatchment.
- Upstream sites:
    - Mangapepeke Stream catchment: Site EM1; and
    - Mimi Stream catchment: Site EM4.

    Note – If upstream monitoring sites above doesn't reflect the extent or stage of works, or is demonstrated to be unsuitable, written approval shall be sought from TRC to use an alternative upstream location, or to use baseline or control data as the comparison.
- Sites downstream of construction discharges:
    - Mangapepeke Stream catchment: Site WQ2; Mimi Stream catchment: Sites WQ3 and WQ5; and
    - Continuous turbidity sampling sites downstream of construction activities in the Mimi and Mangapepeke Streams, after reasonable mixing (location in close vicinity of WQ2 and WQ5, to be identified as CM1 and CM2).
- Sediment deposition at ecologically sensitive sites:
    - Site EM5 within the Mimi Wetland.

Commented [RD1]: As per comment on the conditions – Downstream site CM2 is on the main Mimi Stream below the site which has a significant upstream catchment including agricultural land and extensive areas of steep hill country. It will be difficult to attribute any changes in turbidity at this downstream site to the earthworks given the significant upstream catchmen i.e it is not a like for like comparison here. I recommend this site is relocated to site Ea26 immediately upstream of the Mimi confluence to ensure a direct comparison between upstream/downstream water quality within the tributary stream which discharges into the Mimi so the effects of the site works are clear.

- Ecological monitoring of fish and macroinvertebrate communities downstream of the Project earthworks and immediately below locations of Fill 12 and 13 (during construction), refer Freshwater Ecology Management Plan chapter of the Project Ecology and Landscape Management Plan (ELMP):
  Managapepeke catchment:
  - EM1 at site Ea10a (control);
  - EM3 at site u/s E4 (downstream of fill 12); and
  - EM2 at site E2 (downstream).

  Mimi catchment:
  - EM4 at site u/s Ea25 (control);
  - EM5, EM6 and EM7 at sites Ea25 and d/s E6 (downstream fill 13); and
  - EM8 at site Ea26 (downstream).

To allow comparison with baseline (and pre construction) water quality, monitoring of WQ2, WQ3 and WQ5 sites commenced in November 2017. In addition, continuous turbidity sampling sites CM1 and CM2 may be installed prior to construction to further support the comparative analysis.

Control sites WQ1 and WQ4 provide water quality data to assist with comparative analysis of Project and non-Project related discharges to the wider receiving environment.

Figure 3.1~~*Figure 3.1*~~ also shows the location of the weather monitoring station installed on site and illustrates the monitoring locations in the context of the overall Project alignment.

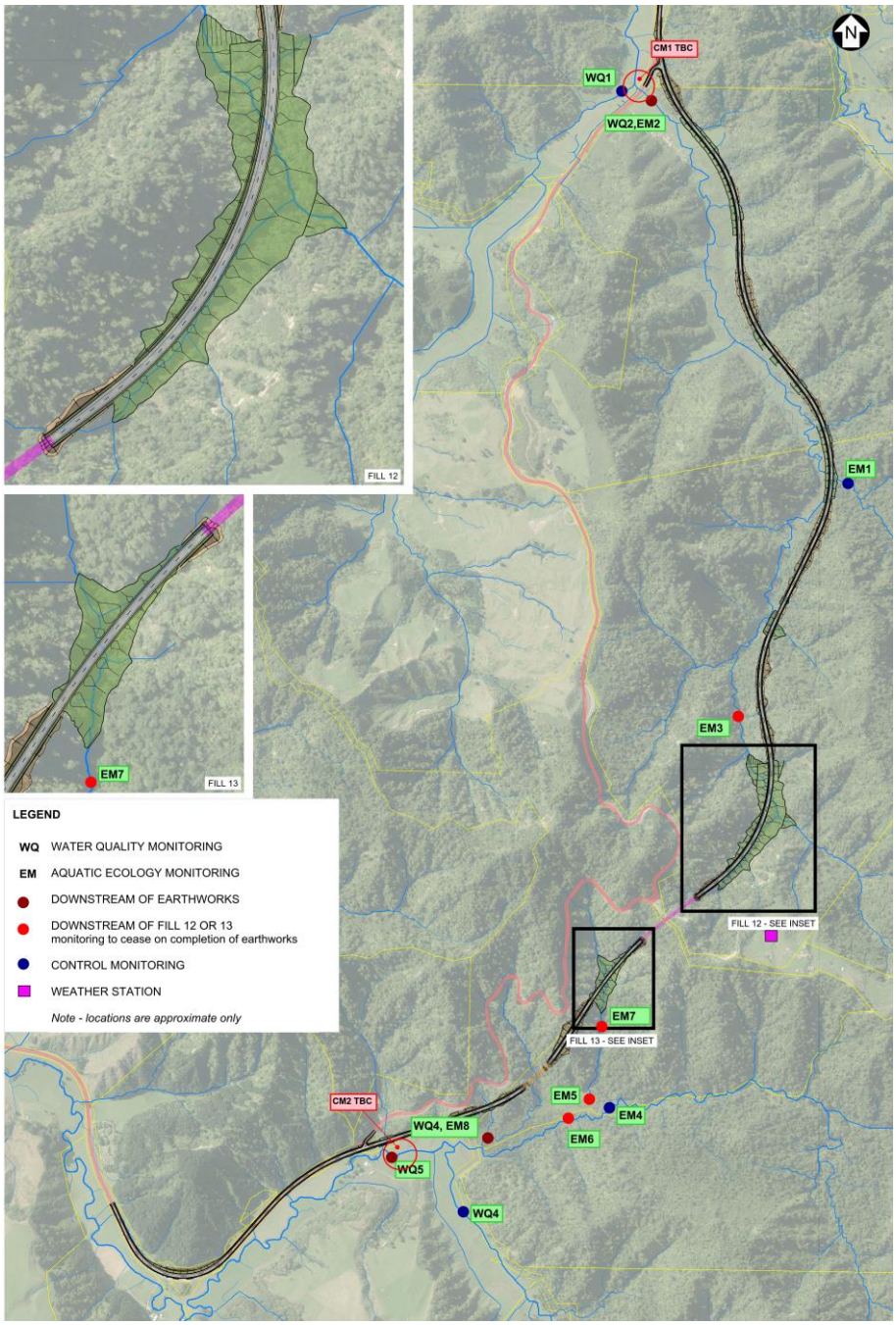

Figure 3.1 – Sampling Locations

4 Erosion and Sediment Control Measure Monitoring

In addition to the catchment sampling, water quality from both inflow and outflow locations from a selection of sediment retention ponds (SRPs) will be monitored during construction.

Monitoring of construction related discharges shall commence at the start of the bulk earthworks phase and shall finish when relevant Project areas are stabilised and the erosion and sediment control devices have been decommissioned.

Table 4-1 outlines the sampling methods and frequency at each monitoring location as identified in Sections 3 above.

As an initial trigger, rainfall greater than 25 mm in a 24 hour period and 15 mm in a 1 hour period will instigate a sampling round. This is referred to as a Trigger Event.

Sampling shall be undertaken in accordance with the techniques outlined below and in Sections 4.1- 4.7 of this CWDMP.

- To monitor construction related effects, both pH and turbidity shall be monitored using calibrated field probes.
- At least one sample (field measurement) shall be taken at each monitoring location (as per Table 4-1) during a trigger event. More than one sample may be required to ensure a representative measurement is obtained if high variability occurs. In this circumstance, the sample number will represent what is required for the monitoring person to be satisfied a representative sample has been obtained.
- Calibration of field probes shall be carried out by collecting grab samples on a 3 monthly basis for lab testing of pH and turbidity. Water samples shall be collected in laboratory supplied containers, and transferred to an accredited laboratory under chain of custody.
- Total suspended solids (TSS) shall be tested at the same time as the calibration samples to establish TSS and turbidity relationships. Turbidity records can then be more accurately converted to TSS using these relationships for assisting with assessment of any potential effects.

Table 4.1 – Sampling details

Monitoring Location	Purpose	Sampling Parameters	Sampling method	Frequency (may be revised as additional monitoring information becomes available)
Control Sites WQ 1 and WQ4	Monitor changes to water quality downstream of construction discharges. Provides for a project wide and catchment wide understanding of rest of catchment water quality	• Turbidity and pH. • TSS at 3 monthly intervals	Stream level triggered sampling at each site with stream level sampling point related to trigger event.	• Stream level calibrated to trigger event of 15mm/hr and 25 mm in a 24 hour period. • Frequency will be rain dependent throughout construction period.
Stream Sampling Stream sites WQ2, WQ3 and WQ5	Monitor changes to water quality downstream of construction discharges.	• Turbidity and pH. • TSS at 3 monthly intervals	Stream level triggered sampling at each site with stream level sampling point related to trigger event.	• Stream level calibrated to trigger event of 15mm/hr and 25 mm in a 24 hour period. • Frequency will be rain dependent throughout construction period.
Continuous Stream monitoring Upstream at EM1 & EM4 Downstream at CM1 & CM2	Continuous turbidity sampling to determine water quality downstream of the project earthworks prior to and during the earthworks activity.	• Turbidity	Continuous turbidity meter installed on site. Ability for an alert system that is effective 24 hours per day, 7 days per week.	• Continuous both pre and during earthworks activities
Manual Sampling Sediment retention ponds (SRPs) – a minimum of 50% of SRPs on site at any one time will be subject to this sampling. All SRPs discharging into the Mimi Wetland will be subject to this monitoring programme.	Assess the effectiveness of SRPs to inform SRP management, overall erosion control in the catchment, general performance and maintenance requirements. Will also determine effectiveness of flocculation programme.	• Turbidity for each trigger event. • pH weekly and for each trigger event. • TSS at 3 monthly intervals	Manual sampling at pond inflow and outflow on a selection of SRPs (50% on site as a minimum.).	• Frequency will be rain dependent throughout construction period. • pH on a weekly basis.
Sediment Deposition Sampling	Monitoring of sediment deposition as an ecological trigger.	• Sediment Deposition	In field sampling and measurements.	• Frequency will be rain dependent throughout construction period.

SD1 Mimi Wetland with location as shown in Figure 3.1.				• In response to exceedance of management thresholds at the upstream SRPs.
Ecological Monitoring Fish and Macroinvertebrate monitoring at sites shown on Figure 3.1.	Up to twice yearly (spring and summer) ecological monitoring during construction. Monitoring immediately downstream of Fill 12 and 13 during earthworks. Collection of baseline fish and macroinvertebrate data to allow comparison once earthworks starts.	• Fish surveys • Aquatic Macroinvertebrate surveys	In field sampling	• Twice yearly baseline collection of data pre earthworks. • Up to twice yearly during earthworks (frequency may be reduced). • Monitoring downstream of Fills 12 & 13 are only required during filling activity

4.1 Meteorological Monitoring

Rainfall will be monitored at a site climate station located as shown in Figure 3.1. Wind, air temperate and humidity are also recorded at the site climate station.

Rainfall is recorded at no less than 15 minute intervals and accessed "real-time" through a web portal: https://live.harvest.com/?cmd=home&sid=8047&group=Main

Rainfall trigger alerts are send via SMS and email when the "rolling" hourly or 24 hourly totals reach the initial rainfall trigger values.

4.2 Visual Inspections

Regular documented weekly inspections will be carried out by the Project team. This will include:

- Checking the controls for compliance and maintenance requirements
- System checks on flocculation units
- Weekly pH sampling at ponds where PAC is used

Following trigger rainfall, a visual inspection of all receiving waterways, SRPs and DEBs shall be carried out.

4.3 Manual Sampling

Manual water quality samples will be collected at the inflow and outflow of:

- the selected SRPs based on 50% of those utilised on site at any one time; and
- all SRPs that discharge directly into the Mimi Wetland.

Other sediment retention devices, such as decanting earth bunds, will be monitored in this same manner. The specific location of the sediment retention devices to be monitored shall be confirmed in the relevant SCWMPs.

At each monitoring location, a 1 L grab sample (approximately) shall be collected for testing (field and/or lab testing).

4.4 Stream Sampling

Static samplers are installed at WQ 1 to 5 monitoring locations. Static samples are a stationary device that collect a 1 L sample once the stream level reaches a pre-determined level that is representative of the stream channel depth (refer Figure 3.2). A submersible level logger continuously records stream level (relative to the stream bed) and allows the sampling level to be calibrated to rainfall records and for this project is calibrated to a rainfall of 25 mm in 24 hours.

Static samplers shall be emptied as soon as practical following a Trigger Event. The samples collected shall be emptied into a clean container for testing of field parameters or into laboratory supplied containers and shipped to a laboratory under chain of custody

documentation.

Figure 4.1 – Static sampler and level logger configuration at WQ4

4.5 Continuous Stream Monitoring

Continuous turbidity loggers will be installed within the Mimi and Mangapepeke Streams near the Project site boundary. Continuous stream levels loggers are already installed at WQ1-5 locations (refer section 4.3 above).

The continuous turbidity and stream level monitoring will enable:

- Understanding of changes in the stream under both antecedent (preceding dry) and rainfall conditions;
- Understanding of changes in stream quality from any construction related discharges which are likely to continue post-rainfall; and
- Changes in the stream to be recorded in a manner that is independent of grab sampling response time.

Continuous stream monitoring will be carried out at upstream locations during construction, to allow comparison of upstream and downstream data.

Continuous stream monitoring at downstream locations will commence prior to construction and inform the baseline data analysis (refer section 5). At least 3 months of continuous monitoring data will be collected to support this analysis.

When continuous monitoring is combined with information from routine environmental inspections and an understanding of the construction works areas, it will assist in identifying if changes to the stream are Project or Non-Project related, and trigger a process for ecological assessment if necessary.

4.6 Sediment Deposition Sampling

Sediment deposition at the Mimi Wetland shall be monitored in accordance with the monitoring procedure outlined within the Freshwater Ecology Management Plan in the ELMP. The location of this monitoring is as per Figure 4.1 below and will occur in response to an exceedance of relevant SRP Management Thresholds as per Section 5 of this CWDMP.

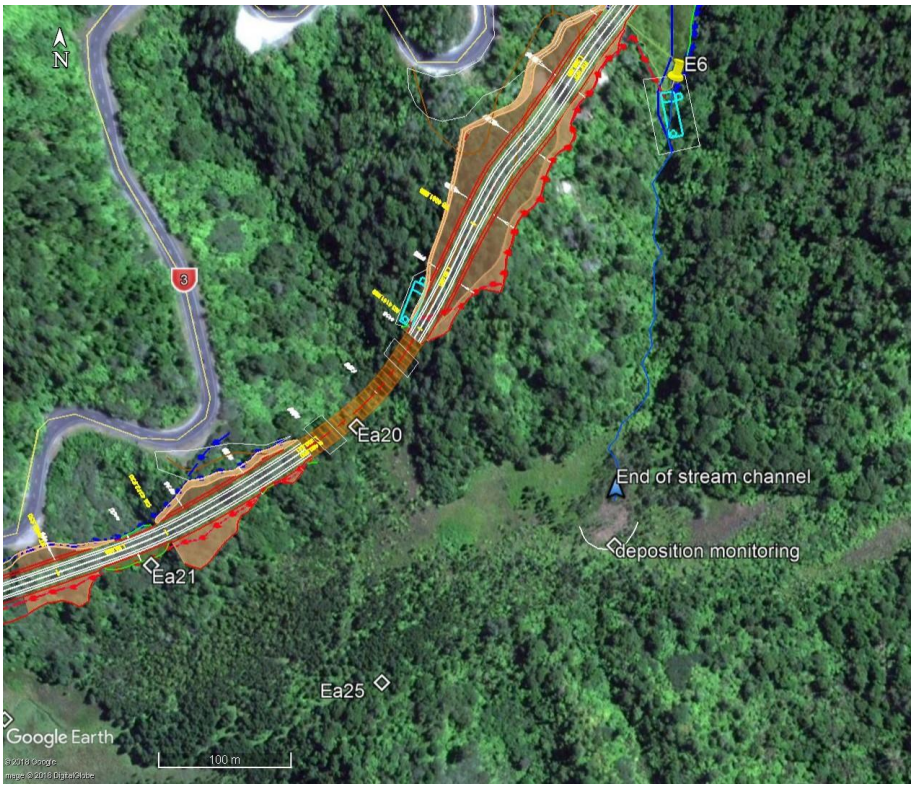

Figure 4.1 – Location of stream channel entering Mimi Wetland and location of sediment deposition monitoring in the event of SRP Management Threshold exceedance

4.7 Ecological Monitoring

Ecological monitoring of the immediate receiving environments (Mangapepeke and Mimi Streams) shall be monitored in accordance with the monitoring procedure outlined within the Freshwater Management Plan chapter of the ELMP. In summary:

- Fish and macroinvertebrate monitoring in summer and spring will be carried out prior to earthworks commencing in the catchment (baseline);
- Biannual fish and macroinvertebrate monitoring will be carried out once earthworks commence (construction period). Biannual monitoring includes sampling directly downstream of Fill 12 & 13, while filling activities are occurring. Following at least one year of baseline monitoring and one year of construction monitoring, monitoring frequency may reduce if the first year of monitoring finds only small changes in the fish or aquatic macroinvertebrate community.
- Annual reporting during construction, which includes an assessment of the overall magnitude of any effects associated with the Project on the streams.
- Identification of potential aquatic habitat mitigation measures that will be implemented in the event that adverse sediment effects are detected as occurring as a result of the site earthworks.

5 Baseline Water Quality Monitoring

Project baseline stream water quality sampling at sites WQ1 to 5 commenced in November 2017. The primary purpose of this baseline monitoring is to understand non-Project related water quality (with a focus on pH and sediment) in the immediate and wider freshwater environment. This baseline has been undertaken with reference to the trigger event of 25mm in 24 hours and has a relationship to high stream flow conditions in the Mangapepeke and Mimi Stream catchments.

Samples, using a stream level calibrated sampler, have been collected from nine rainfall events to date. The total rainfall for these events range from 25 – 170 mm within a 24 hour period, Samples were analysed for turbidity, pH and Total Suspended Solids (TSS) with the results outlined in Annexure 2.

In summary, where more than 25 mm total rainfall is recorded:

- The average pH at all sites (WQ1-WQ5) ranges from 6.8- 7.1.
- At the control sites:

- WQ1: TSS concentrations typically range between 100 – 1000 mg/L, generally increasing with total rainfall and higher peak intensity;
- WQ4: TSS concentrations typically stays above 1000 mg/L for most rainfall conditions; and
- Turbidity levels are above 100 NTU at both locations.

- At monitoring site WQ3 downstream of the Mimi Wetland, TSS concentrations typically range between 100 – 1000 mg/L, with concentrations typically being higher for higher rainfall. Turbidity levels typically are above 150 NTU, increasing with higher rainfall.
- At the downstream sites:
  - WQ5: TSS concentrations range from 138 – 8100 mg/L and turbidity levels are above 100 NTU;
  - WQ2: TSS concentrations range from 17 – 3200 mg/L. Similarly, a wide range of 30 –2800 NTU is observed for turbidity; and
  - The maximum concentrations at both these sites were measured following 81 mm total rainfall. TSS concentrations are notably higher at WQ5 compared to WQ2.

Further baseline sampling will continue prior to the commencement of the Project, which will provide the ability for comparative analysis over time.

In addition, continuous stream monitoring (refer section 4.4) will be undertaken prior to earthworks commencing at downstream locations, after reasonable mixing. This will provide a continuous record of baseline stream water quality at/near the boundary of the Project site and will allow for a direct comparative analysis to continuous sampling results collected during earthworks.

6 Management Thresholds and Process

Management thresholds allow early detection of potential on site issues but do not in themselves, indicate potential effects.

Management thresholds are determined for sediment and other construction water discharges including: concrete, oil/fuel and chemical flocculants, as outlined below. Exceedance of these thresholds shall instigate a second level of investigation as described below. These thresholds shall be referenced when Trigger Event monitoring occurs and any follow up monitoring that may be required.

First level of **Post Event** investigation (Trigger Event exceeded):

When a Trigger Event is exceeded, a site audit inspection of the various construction water management measures shall be undertaken by site monitoring staff as soon as practicable

(under safe conditions) following the trigger. The audit shall evaluate the performance of the project construction water management controls and identify any issues or opportunities that may exist, in conjunction with obtaining Stream Sampling and Manual Sampling water quality data.

Second level of **Post Event** investigation (Management Threshold exceeded):

Following an exceedance of a Management Threshold (as specified in 5.1 below) a second level of investigation shall be undertaken, which includes:

- The site monitoring staff re-notifying the E&SC supervisor and the Project Environmental Manager.
- The E&SC supervisor inspecting the specific site area where the threshold has exceeded, identifying specific continuous improvement opportunities (if any) and documenting it as per the reporting process set out below (refer section 6). This step will include:
    - Inspect the earthworks site, all water management including erosion and sediment controls and associated management procedures to identify any problems or activities likely to have contributed to the threshold exceedance;
    - Collect further water quality samples from device discharges as necessary; and
    - Remedy any identified problems and implement any further controls on activities that are likely to contribute to ongoing management threshold exceedances.
- In the event of an exceedance of the Management Threshold for sediment (as a result of the Sediment Deposition Sampling) within the Mimi swamp forest, the ecological response and monitoring actions set out in the Freshwater Management Plan (Chapter 8) of the ELMP shall be undertaken.

6.1 Management Thresholds

6.1.1 Sediment Management

The following Management Thresholds shall be applied:

- For Manual Sampling, less than 80% reduction in turbidity between the pond inflow and outflow.
- For Continuous stream monitoring, a 2030% increase in downstream turbidity compared to the upstream :

Commented [RD2]: I believe this was previously 20%. I'm not sure why this has been changed to 30%?

- CM1 (construction) x 1.3 > EM1 (construction)
- ~~CM2~~ Ea26 (construction) x 1.3 > EM4 (construction)

The trigger increase percentage may be reviewed following at least 3 months of baseline monitoring. Changes to the trigger increase (if any) shall be provided to TRC for certification at least 1 month prior to relevant construction works commencing.

Continuous data will be transmitted to an online portal which has the ability to automatically produce email notification to alert the Project team of an exceedance of a trigger at continuous monitoring locations. An exceedance alert shall trigger:

  - Verification of the exceedance, based on data review only;
  - Notification to TRC of exceedance, once verified within 24 hours of the exceedance; and
  - Visual inspection within two working days, pending safe access.
- For Stream Sampling, a difference of more than 20% in turbidity or pH from the control at the following locations (wider receiving environment trigger):
  - WQ2 (north discharge) x 1.2 > WQ1 (north control)
  - WQ5 (south discharge) x 1.2 > WQ4 (south control)
- For Sediment Deposition monitoring at the Mimi swamp forest, greater than 6 mm at any point within the area demarcated by the line shown in Figure 4.1.

6.2 Concrete management

Concrete or grout particles in water can result in sediment and high pH. Concrete and grout wash or waste water shall be contained for treatment and testing on-site prior to discharge into the freshwater environment. The following management thresholds shall apply:

- Water visually appears to be tinted grey; and/or
- pH of more than 8 at the treatment device outflow.

6.3 Oil/Fuel management

All practicable measures shall be carried out to avoid oil/fuel spills into the freshwater environment, (i.e. appropriate containment, bunding of storage areas, limiting storage volumes). The following management thresholds shall apply:

- Notable leaks/spills outside of the containment/bunded area; and/or
- Oil sheens in the downstream freshwater environment.

6.4 Flocculant management

Where flocculant containing PAC is used, it is proposed to adopt visual observation and pH parameters to monitor all SRP's and DEBs where this chemical treatment is used. The following management thresholds shall apply:

- Water visually appears to be tinted blue-green; and/or
- pH of less than 5.5 at the SRP outflow.

Chemical use and dose rates shall be reassessed if data shows that the current chemical flocculation/coagulation is breeching management thresholds.

It is noted that some of the flocculants available have no effect on pH levels and if such chemicals are used on this Project then there will be no requirement to monitor discharge pH levels. Where other chemical flocculants are used, specific monitoring parameters (if any) shall be set out in the relevant SCWMPs.

6.5 Review of management thresholds

Management thresholds may be revised by the Environmental Manager where appropriate as further information (such as baseline water quality, rainfall and on site experience) becomes available.

7 Incident Response

Incident response shall be undertaken in accordance with the process outlined in Section 5.16 of the Project CEMP. In relation to construction water management, an incident is defined as:

- Discharges from non-stabilised areas that are not treated by erosion and sediment control measures as required by the CWMP / SCWMPs;
- Failure of any erosion and sediment control measures;
- Discharge of a hazardous substances, including cement, to a water body;
- Failure of any temporary stream diversion and
- Any other incident, which either directly or indirectly causes, or is likely to cause, adverse ecological effects in any waterbodies, that is not authorised by a resource consent.

Incidents will primarily be identified by site observations by Project staff and as a result of specific environmental and erosion and sediment control inspections undertaken by the Environmental team. An incident may also be identified as a result of the monitoring undertaken for the Project or through complaints or stakeholder feedback.

7.1 Corrective Actions

As soon as practicable after an incident, the Environmental Manager and the Construction Manager shall:

- Determine the immediate actions to be taken to re-establish control measures where these have failed or have not been implemented in accordance with the relevant management plan as soon as possible.
- The corrective actions shall be implemented as soon as practicable, taking into account health and safety issues.
- As appropriate, liaise with TRC to establish what remediation or rehabilitation is required and whether this is practicable to implement.
- Carry out any remedial action to the satisfaction of TRC (as appropriate).

In addition to the above requirements an incident report will include the following details:

- Description and location of incident;
- Description of the weather conditions before the incident;
- Description of work being carried out at the time of the incident and how the incident occurred;
- Corrective actions taken to rectify the situation and mitigation measures to be taken to minimise the adverse effects on the environment;
- Causes of the incident; and
- Environmental controls in place at the time of the incident.

Additional monitoring may be required as a result of the incident and changes may be required to the CWMP or approved and future SCWMPs.

8 Monitoring reporting

8.1 Continuous turbidity data reporting

A Project website will be established to report continuous monitoring data once construction has commenced. Publicly accessible information will comprise:

- Continuous turbidity data (refreshed hourly) for:
  - EM1 and EM4 (upstream sites);
  - CM1 and Ea26~~CM2~~ (downstream sites)
- A graphical (or otherwise approved) comparison of upstream versus downstream data;
- Site rainfall data~~.~~

8.2 Trigger rainfall reporting

A trigger rainfall report shall be prepared to summarise:

a) Visual inspections of all receiving waterways, SRPs and DEB's;

b) Manual inlet and outlet monitoring data from SRPs;

c) Stream grab sampling monitoring data at WQ1 to WQ5; and

d) Sediment deposition measurements at Mimi wetland.

The monitoring data collected shall be reported on the Project website within one week of the results becoming available.

8.3 Investigation reporting

All investigations to construction water management controls and methodologies shall comprise:

- A full audit of all erosion and sediment controls relevant to the location; and
- For Management Threshold exceedances, an audit report provided to the Environmental Manager within 2 days, which shall include:
  - Monitoring and sampling results from both Stream Sampling, continuous sampling and Manual Sampling;
  - Cause and duration of any exceedance (based on visual observations and/or further monitoring and sampling) with reference to the Management Thresholds;
  - Actions to minimise further construction related discharges, carried out to the satisfaction of the Environmental Manager, and in accordance with the ELMP where required; and
  - An assessment by the Project Freshwater Ecologist to assess the extent of any effect on the Mimi Wetland (for exceedance of Management Thresholds at SD1

only) or any ecological effects determined through the ecological (fish and invertebrates) monitoring.

All Trigger Events will be reported to TRC, as soon as practicable with any associated Management Threshold exceedances, actions and response to that Trigger Event documented.

Implementation of further construction water management controls and continuous improvement may need to occur in order to minimise sediment yields and construction water discharges from the works and minimise any potential effects on the downstream environment. This will be confirmed by the Project Erosion and Sediment Control specialist and may include further temporary stabilisation of disturbed surfaces, installation of additional sampling or measurement devices and changing methodologies.

8.4 Annual Summary Report

At the end of each earthworks season, a Construction Water Discharges Summary Report shall be prepared which summarises the outcomes of the water quality monitoring undertaken in accordance with this plan over the previous 12 month period. The Summary Report shall include details of all trigger events recorded, follow up investigations and details of any ecological monitoring/mitigation undertaken in response to sediment discharge effects. The Summary Report shall be submitted to TRC and DoC within 1 month of completion.

9 Review

A review of the CWDMP will occur to assess the effectiveness of the monitoring programme to advice site management and detect changes in ecological trends. The timing of the review will be 3 monthly from works commencement for the first 12 month period followed by annual reviews for each subsequent 12 month period, carried out to the satisfaction of the Environmental Manager.

The review will consider:

- If additional sampling / measuring points are appropriate;
- If the use of continuous or automatic samplers to monitor water quality at further sites is necessary to achieve the monitoring outcomes and objectives; and
- If further, or an amended, ecological monitoring programme is required.

Additional data from the above methods will be determined necessary if the existing monitoring programme cannot:

- Satisfactorily detect changes in ecological trends as a result of the Project, as determined by the Project Freshwater Ecologist; and/or

Satisfactorily identify and isolate Project areas when Second Level Investigations are required, as determined by the Project Erosion and Sediment Control specialist with resultant identification of continuous improvement opportunities.

ANNEXURE 1 – MONITORING PROCESS DIAGRAM

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FEEDBACK LOOP

FEEDBACK LOOP

Trigger Event – Greater than 15mm/hr or 25mm total rain in 24 hours

Stream Sampling (WQ1 to WQ5)

To provide catchment wide water quality knowledge:
1) pH and turbidity event samples (baseline & during construction)

2) Visual inspection during and/or post event (during construction)

Manual Monitoring (grab samples, deposition measurements)

pH and turbidity grab samples At 50% SRPs, which shall include all SRPS upstream of Mimi Wetland

Sediment deposition monitoring at Mimi swamp forest

First level investigation

Site audit inspection to evaluate performance of the project construction water management controls and identify any issues or opportunities

Check Management Thresholds as per Section 6.1 of CWDMP

If Management Thresholds not exceeded

No further site action

Report Trigger Event results to TRC

Event Reporting to TRC

Report Trigger Event results to TRC

If Management Thresholds are Exceeded

Notify E&SC supervisor and the Environmental Manager

Inspection and further monitoring as directed by the E&SC supervisor

If sediment deposition trigger is exceeded

Project ecologists to assess the extent of any effect on the Mimi swamp forest

Undertake an assessment of the overall magnitude of any effects associated with the Project on the Mimi swamp forest and recommendations for further monitoring or remedial actions.

Event Reporting to TRC

Report exceedance of Management Threshold exceedances, along with proposed actions, further monitoring and/or remedial actions

Review of Monitoring Programme

3 monthly from works commencement for the first 12 month period followed by annual reviews for each subsequent 12 months

Routine monitoring

Quantitative: Continuous Turbidity monitoring near WQ2 & WQ5

Continuous turbidity (baseline & during construction)

Note: Continuous turbidity records will be manually downloaded for analysis following a trigger event.

Qualitative: Weekly site monitoring during construction

Visual inspections of erosion and sediment control measures

System checks on flocculation units

Weekly pH sampling at ponds where PAC is used

Quarterly monitoring during construction

Sampling carried out during a Trigger Event:

TSS grab samples at 50% of SRPs (during event

TSS grab samples at WQ1-WQ5

Maintenance actions register/list

Register maintained by the E&SC supervisor noting maintenance actions, priority order and completion date.

Develop TSS –turbidity relationships

Baseline relationship

During construction

Ecological monitoring

Baseline monitoring in Mimi and Mangapepeke Catchments

Fish survey and Macroinvertebrate monitoring in summer and spring (6 locations)

Sediment deposition event monitoring (1 location)

At base of fills 12 & 13 during filling activity (note 1)

Fish survey and Macroinvertebrate monitoring 2 locations)

Sediment deposition event monitoring (1 location)

Mimi and Mangapepeke Catchments (note 1)

Fish survey and Macroinvertebrate monitoring in summer and spring (4 locations)

Annual report

Summary of water quality and ecological monitoring results

Assessment of the overall magnitude of any effects associated with the Project on the streams

Recommended actions for site management amendments (if any)

Note 1: *Frequency may be reduced to once a year after 1 year of construction monitoring, based on results.*

CWDMP ELMP

Accidental Spills or Incidents and Management Response in Section 7 of the CWDMP

ANNEXURE 2 – BASELINE STREAM SAMPLING RESULTS

Table A2-9.1: WQ1 Summary

ID	Sampling details				North Control - low sampler				North Control - high sampler			
	Event date	Total rainfall (mm)	Peak intensity (mm/hr)	Comments	pH_l	TSS (g/m3)_l	Turbidity (NTU)_l	Settleable solids (mL/L)_l	pH_h	TSS (g/m3)_h	Turbidity (NTU)_h	Settleable solids (mL/L)_h
				Max	**7.00**	**25000.00**	**21000.00**	**56.00**	**7.30**	**16300.00**	**9200.00**	**70.00**
				Mean	**6.94**	**6637.60**	**5133.00**	**26.33**	**6.80**	**3622.83**	**2013.67**	**28.20**
1	8/11/2017	25	11	sampler not installed								
2	5/01/2018	81	25	Possible slow leak noted during collection (low only)	7.00	7300.00	4100.00	20.00	6.40	16300.00	9200.00	56.00
3	18/01/2018	50	8		7.00	162.00	101.00	<1	6.70	177.00	97.00	<1
4	12/02/2018	23	6	only low collected	7.00	66.00	34.00	<2				
5	8/03/2018	170	38		6.90	25000.00	21000.00	56.00	6.90	1260.00	640.00	70.00
6	9/04/2018	25	3	only high collected					6.80	990.00	208.00	3.60
7	12/04/2018	47	15	only high tested					6.70	2400.00	1800.00	9.00
8	16/04/2018	53	23	only high tested					7.30	610.00	137.00	2.40
9	6/05/2018	26	11	only low collected	6.80	660.00	430.00	3.00				

Table A2-9.2: WQ2 Summary

ID	Sampling details				North discharge - low sampler				North discharge - high sampler			
	Event date	Total rainfall (mm)	Peak intensity (mm/hr)	Comments	pH_l	TSS (g/m3)_l	Turbidity (NTU)_l	Settleable solids (mL/L)_l	pH_h	TSS (g/m3)_h	Turbidity (NTU)_h	Settleable solids (mL/L)_h
				Max	**7.40**	**1180.00**	**1500.00**	**9.80**	**7.20**	**3200.00**	**2800.00**	**9.00**
				Mean	**7.12**	**308.33**	**315.85**	**8.00**	**6.85**	**720.13**	**629.88**	**5.03**
1	8/11/2017	25	11	Test round - rainfall measured at TRC station	6.90	1180.00	1500.00	6.20	6.90	980.00	1050.00	5.00
2	5/01/2018	81	25	Possible low sampler represents a previous event. Possible slow leak on high sampler noted during collection	7.10	94.00	53.00	<3	7.10	3200.00	2800.00	9.00
3	18/01/2018	50	8	Both samplers not full	7.00	17.00	18.10	<5	6.80	43.00	34.00	<1.7
4	12/02/2018	23	6	Only high tested					7.20	63.00	46.00	<3
5	8/03/2018	170	38		7.10	360.00	230.00	9.80	6.90	119.00	93.00	<1.2
6	9/04/2018	25	3		7.40	125.00	51.00	<1.5	6.60	76.00	46.00	<1.3
7	12/04/2018	47	15	only high tested					6.80	970.00	740.00	<1.3
8	16/04/2018	53	23	only low collected	7.20	74.00	43.00	<1				
9	6/05/2018	26	11	only high tested					6.50	310.00	230.00	1.10

Table A2-9.3: WQ3 Summary

ID	Sampling details				South wetland - low sampler				South wetland - high sampler			
	Event date	Total rainfall (mm)	Peak intensity (mm/hr)	Comments	pH_l	TSS (g/m3)_l	Turbidity (NTU)_l	Settleable solids (mL/L)_l	pH_h	TSS (g/m3)_h	Turbidity (NTU)_h	Settleable solids (mL/L)_h
				Max	**7.10**	**10100.00**	**4200.00**	**26.00**	**7.20**	**10900.00**	**4900.00**	**28.00**
				Mean	**6.88**	**2305.20**	**959.20**	**14.10**	**6.83**	**2386.43**	**1334.43**	**8.94**
1	8/11/2017	25	11	sampler not installed								
2	5/01/2018	81	25		6.90	750.00	370.00	2.20	6.70	10900.00	4900.00	28.0
3	18/01/2018	50	8	Intakes blocked by vegetation	6.90	330.00	155.00	<2	6.70	610.00	330.00	2.0
4	12/02/2018	23	6	only low collected	7.10	66.00	32.00	<3				
5	8/03/2018	170	38		6.70	10100.00	4200.00	26.00	6.70	2800.00	2300.00	8.7
6	9/04/2018	25	3		6.80	280.00	39.00	<1.5	6.80	280.00	165.00	<5
7	12/04/2018	47	15	only high tested					6.90	1660.00	1440.00	4.0
8	16/04/2018	53	23	only high tested					7.20	145.00	54.00	<1.7
9	6/05/2018	26	11	only high tested					6.80	310.00	152.00	2.0

Table A2-9.4: WQ4 Summary

ID	Sampling details				South Control- low sampler				South Control- high sampler			
	Event date	Total rainfall (mm)	Peak intensity (mm/hr)	Comments	pH_l	TSS (g/m3)_l	Turbidity (NTU)_l	Settleable solids (mL/L)_l	pH_h	TSS (g/m3)_h	Turbidity (NTU)_h	Settleable solids (mL/L)_h
				Max	**7.30**	**10400.00**	**4800.00**	**31.00**	**7.60**	**39000.00**	**18500.00**	**100.00**
				Mean	**6.88**	**3455.00**	**2321.67**	**16.92**	**6.96**	**7497.00**	**4139.29**	**26.43**
1	8/11/2017	25	11	Test round - 25mm rainfall measured at TRC station	6.60	2100	3300	24	6.70	3400	5000	25.0
2	5/01/2018	81	25	Both intakes blocked on both samplers while filling	7.30	2000	1070	<5	7.60	119	75	<7
3	18/01/2018	50	8		6.70	2300	1100	6	6.80	3300	2300	12.0
4	12/02/2018	23	6	Only low collected	7.10	1830	3100	16				
5	8/03/2018	170	38		6.70	10400	4800	31	6.80	39000	18500	100.0
6	9/04/2018	25	3		6.90	2100	560	8	7.00	1600	360	6.0
7	12/04/2018	47	15	no sample - leaked								
8	16/04/2018	53	23	only high tested					7.10	4500	2500	14.0
9	6/05/2018	26	11	only high tested					6.70	560	240	1.6

Table A2-9.5: WQ5 Summary

ID	Sampling details				WQ5 South discharge - low sampler				WQ5 South discharge - high sampler			
	Event date	Total rainfall (mm)	Peak intensity (mm/hr)	Comments	pH_l	TSS (g/m3)_l	Turbidity (NTU)_l	Settleable solids (mL/L)_l	pH_h	TSS (g/m3)_h	Turbidity (NTU)_h	Settleable solids (mL/L)_h
				Max	**7.20**	**1160.00**	**500.00**	**3.00**	**7.20**	**8100.00**	**7600.00**	**42.00**
				Mean	**6.98**	**524.00**	**209.25**	**2.50**	**6.93**	**4242.50**	**3188.25**	**21.60**
1	8/11/2017	25	11	sampler not installed								
2	5/01/2018	81	25		7.00	1160	500	3	6.60	8100	4200	20.0
3	18/01/2018	50	8		7.00	220	94	<1	6.70	4800	3400	15.0
4	12/02/2018	23	6		7.20	86	51	<3	7.20	102	53	<1
5	8/03/2018	170	38	low not collected					7.10	7100	6900	32.0
6	9/04/2018	25	3		6.70	630	192	2	6.80	138	53	<1
7	12/04/2018	47	15	only high tested					6.90	7500	7600	42.0
8	16/04/2018	53	23	only high tested					7.10	3200	1540	12.0
9	6/05/2018	26	11	only high tested					7.00	3000	1760	8.6