TOITŪ TE WHENUA

LAND INFORMATION NEW ZEALAND

Fraser Thomas

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146 TE MAWHAI ROAD, TE AWAMUTU

FORMER TOKANUI PSYCHIATRIC HOSPITAL DEMOLITION AND REMEDIATION DISPOSAL SITE REPAIR AND UPGRADE WORKS EROSION AND SEDIMENT CONTROL PLAN

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FORMER TOKANUI HOSPITAL DEMOLITION AND REMEDIATION

DISPOSAL SITE REPAIR AND UPGRADE WORKS
EROSION AND SEDIMENT CONTROL PLAN

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FORMER TOKANUI HOSPITAL DEMOLITION AND REMEDIATION

DISPOSAL SITE REPAIR AND UPGRADE WORKS
EROSION AND SEDIMENT CONTROL PLAN

1.0 INTRODUCTION

This Erosion and Sediment Control Plan (ESCP) has been prepared in support of a resource consent application for planned repair and upgrade works to the closed landfill (existing disposal sites[1]) on the former Tokanui Psychiatric Hospital (FTPH) site (the Site), which are planned to take place over the next 2-4 years. Full details and description of the project and works are provided in the Existing Disposal Site Repair and Upgrade Works report, dated 15 November 2024 and should be read in conjunction with this ESCP.

This ESCP has been prepared in accordance with the Waikato Regional Council "Erosion and Sediment Control: Guidelines for Soil Disturbing Activities" (WRC ESCG), the associated Existing Disposal Site Repair and Upgrade Works report and best practice.

It does not cover demolition and remediation works on the former hospital site, which are the subject of a separate resource consent application and ESCP.

2.0 SITE LOCATION, DESCRIPTION AND DEED REQUIREMENTS

The Site is managed by LINZ on behalf of the Crown and held in the Treaty Settlements Landbank. Land held in the Landbank is Crown land which has been declared surplus can be used as cultural or commercial redress in Tiriti o Waitangi Settlement claims. The FTPH is a deferred selection property in the Ngāti Maniapoto Deed of Settlement (the Deed).

The former Tokanui Psychiatric Hospital is approximately 80ha in area, with 76 buildings, a wastewater treatment plant, swimming pool, eight substations, substantial roading and inground infrastructure and services. The site location and extent is shown in Figure 1.

While operational, the hospital also had its own landfill comprising two separate areas (referred to as the Disposal Site in this report), located off Farm Road (private road), directly east of the Wharekōrino Stream, located within the site boundary. These two areas are shown on Figure 2 – they comprise a northern fill area (D/E/F) and a southern fill area (H/A1/A2/B/C/G). The Disposal Site was closed in 2000 and is authorised by the Waikato Regional Council under the existing disposal consents numbered 102269.01.01, 102270.01.01 and 102271.01.01.

[1] As defined by 9.1.13 under Schedule 9: Tokanui Hospital Deferred Selection Process of the Ngāti Maniapoto Deed of Settlement Schedule: Property Redress

Figure 1: Site Location and Extent

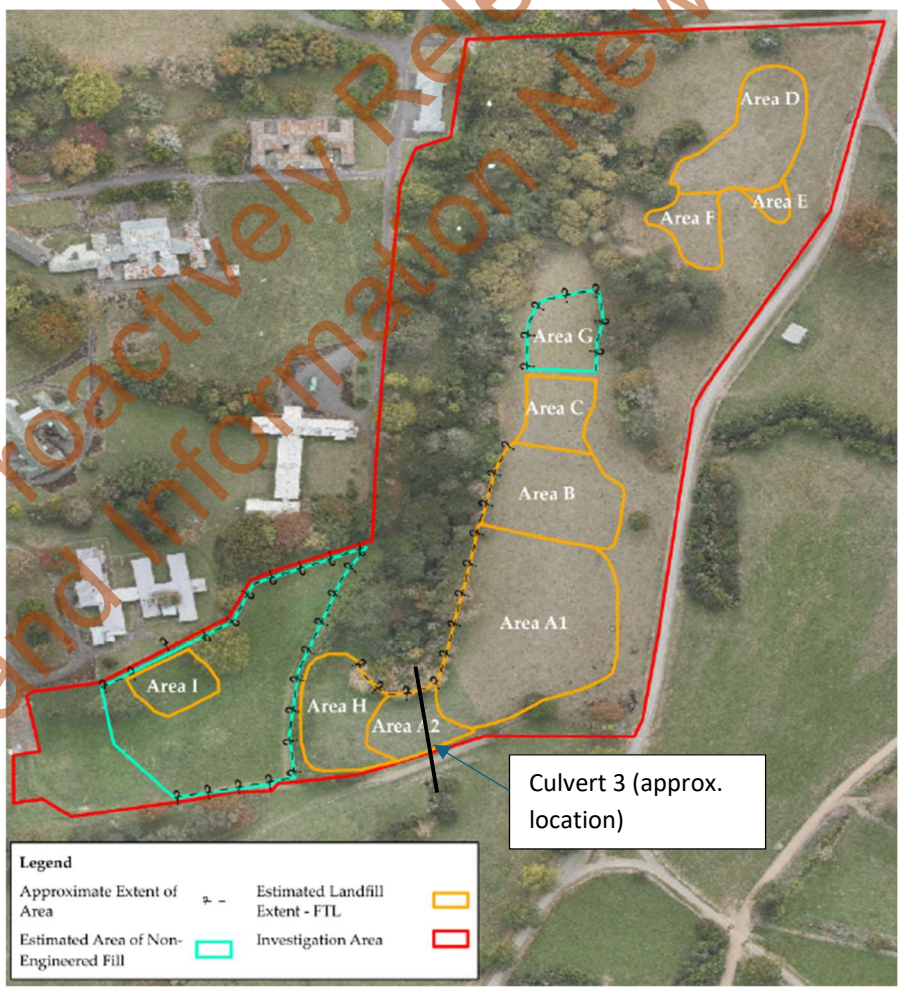

Figure 2: Site Location and Extent showing two landfill areas (Area I is not part of landfill)

Under the Deed, LINZ (on behalf of the Crown) is not required to carry out remedial works on the Disposal Site under the Deed, it is however required to maintain valid land use resource consents for the monitoring of the existing Disposal Site in perpetuity and is tasked with the ongoing management and monitoring of the existing Disposal Site on behalf of the Crown.

As part of this responsibility, LINZ has assessed various repair and upgrade options on the Disposal Site to ensure that human health, social and cultural values and the environment are protected from closed landfill hazards, to ensure responsible long-term taxpayer value for money, and to reduce the Crown's long-term liability. As part of this assessment, it was determined that Option 4 was the preferred option for implementation

As noted above, full information regarding the Crown's requirements under the Deed as well as the full analysis of options to inform a long-term management strategy is provided in the Existing Disposal Site Repair and Upgrade Works report (FTL, 2024).

3.0 PROPOSED EARTHWORKS AND LAND DISTURBANCE ACTIVITIES

3.1 EARTHWORKS DEFINITIONS

Waikato Regional Council refer to their Planning Standards definition of earthworks:

"the alteration or disturbance of land, including by moving, removing, placing, blading, cutting, contouring, filling or excavation of earth (or any matter constituting the land including soil, clay, sand and rock); but excludes gardening, cultivation, and disturbance of land for the installation of fence posts."

Waipa District Council defines earthworks as:

"the disturbance of the land surface by moving, removing, placing or replacing soil, spoil or earth, by excavation, cutting or filling operations (but does not include mineral extraction activities or tillage of land associated with the growing of crops where there is no significant change to landform)."

The **National Environmental Standard - Freshwater** (NES-FW) applies to all works within or within 10m of wetlands and defines land disturbance as:

"the alteration or disturbance of land (or any matter constituting the land including soil, clay, sand and rock) that does not permanently alter the profile, contour or height of the land."

3.2 OVERVIEW AND SEQUENCING

Based on the above definitions, earthworks and land disturbance works for the site have been divided into a number of stages, representing the preferred option (Option 4) identified from a separate high level assessment by Fraser Thomas Ltd (FTL) of repair and upgrade options for the existing Disposal Site (November 2024). These works are:

(a) Improved capping of the entire landfill.
(b) Removal of Culvert 2 and associated road embankment (covered under hospital demolition and remedial works report and consent application).

(c) Transfer of low- and moderate-contaminated soil[2] from hospital remedial works into Area E/F and isolated medical waste removal, with excavated material from this area being used as backfill in the demolition works.

(d) Shifting of fill/refuse material from the south-eastern corner of Area A1 that is located on AgResearch land (Section 3 SO 534156), outside of the subject site, into the A1 area within the subject site.

(e) Shifting of fill/refuse material from most of Area A2/H into Area A1/B and associated decommissioning (plugging) of Culvert 3 from these areas, plus stream reinstatement, with a new toe bund embankment on the eastern side to separate the reclaimed area from the residual A2 landfill area. Refer approximate Culvert 3 location in Figure 2.

(f) Maintain existing southern farm track crossing embankment and install new short section of culvert running under this, tying into reinstated stream. Raise track crossing slightly to assist with flood mitigation.

3.3 EARTHWORKS AND LAND DISTURBANCE AREA AND VOLUME SUMMARY

Earthworks and land disturbance areas and volumes are set out in Table 1.

Table 1: Earthworks Summary

Item	Area DEF	Area A1BC	Area A2H	Total
Area (m^2)	6,400	11,800	4,800	23,000
Cut Volumes (m^3):				
➢ Topsoil stripping to stockpile	750	2,380	130	3,360
➢ Cap stripping to stockpile	470	5,300	400	6,170
➢ Clay	5,900	-	4,800	10,700
➢ Unsuitables	50	100	50	200
➢ Refuse	800	**850**	3,400	5,150
➢ Total:	**7,970**	**8,630**	**8,780**	**25,580**
Fill Volume (m^3):				
➢ Refuse/Unsuitables	7,900	7,200		15,100
➢ Capping	4,150	7,300	450	11,900
➢ Topsoil	1,000	1,670	700	3,370
➢ Clay	-	1350	2,400	3,750
➢ Total:	**13,050**	**17,520**	**3,550**	**34,120**

Notes:

1. Volumes calculated using existing ground levels obtained from LiDAR, survey data and limited test pit investigations.
2. Stated fill volumes are solid measure, and do not include any bulking or compaction factors.
3. Total clay and cap cut = 16,870m^3 vs clay and cap fill = 15,650m^3; total topsoil cut = 3,360m^3 vs topsoil fill = 3,370m^3.

[2] Refer to the Site Specific Risk Assessment (HAIL Environmental Ltd, 2024) for defined soil guideline values.

4.0 ESCP OBJECTIVES

The main rationale and objectives for this ESCP are:

(a) To provide for appropriate erosion and sediment control measures during disposal site repair and upgrade works, that comply with best practice, regulatory requirements and technical reports for the hospital site.

(b) To minimise disturbance to areas where erosion may occur, including steep slopes and exposed land.

(c) To minimise the extent and duration of works on the site, including temporary stockpiles, and to ensure revegetation can occur in a staged manner, so as to reduce the risk of silt/sediment running off the site and entering the downstream receiving environment.

(d) To install perimeter controls such as diversion drains and silt fences to prevent sediment leaving the site.

(e) To provide sediment removal devices such as decanting earth bunds and sediment retention ponds to minimise the amount of sediment laden runoff leaving the site.

(f) To provide for temporary diversions during any stream works.

(g) To ensure exposed areas are stabilised as soon as practicable by lining, grassing or mulching to prevent erosion.

(h) To provide guidance in case of unforeseen events including poor weather.

(i) To ensure all control measures are inspected and repaired after storm events.

(j) To ensure that the site is stabilised prior to the removal of sediment control measures.

(k) To mitigate dust emissions from the site during earthworks so as not to adversely affect any nearby properties.

(l) To minimise potential environmental effects.

5.0 WORKS METHODOLOGY

5.1 OVERVIEW

This section summarises the proposed methodology for the existing Disposal Site repair and upgrade works, including all proposed erosion and sediment controls. These works are shown on the Fraser Thomas drawings provided as a separate volume, with relevant ESCP drawings referenced in this section and listed at the front of this report.

The final methodology and sequencing of these works may vary from that shown here, and will be determined on-site by the contractor and supervising engineer prior to commencement of works within each stage or substage. Approval for any significant changes will be sought from WRC, if and as required.

5.2 GENERAL

G.1 These works should be undertaken during the Waikato region earthworks season, with the landfill material transfer works and stream works ideally being undertaken during January-March, assuming a typical dry summer, so that rainfall, seasonal surface water flows and groundwater levels should be at their minimum.

G.2 Required erosion and sediment control measures will be installed and maintained during the works in accordance with best practice, utilising recommended measures set out in the latest version of the Waikato Regional Council publication, TR2009/02 "Erosion and Sediment Control: Guidelines for Soil Disturbing Activities" (2014 update), including updated fact sheets available on:

https://www.waikatoregion.govt.nz/services/publications/tr200902/, and the separate Landfill Erosion and Sediment Control Plan (ESCP).

G.3 All imported materials (e.g. capping material, topsoil) will be verified cleanfill, as defined in the consent conditions.

G.4 The following plans will be required to be submitted to Environment Waikato prior to works commencing in each stage:

(a) Erosion and Sediment Control Plan, including stream temporary diversion methodology;

(c) Asbestos Removal Control Plan (for asbestos materials within the landfill);

(d) Construction Management Plan (which the above items may be incorporated into). This shall include a component addressing potential and actual contamination issues, that may be encountered during the works, and any associated validation sampling requirements.

G.5 An Aftercare and Monitoring Plan will be required to be submitted to Env-Waikato for approval on completion of the works.

5.3 STAGE 1: AREA D, E, F WORKS (DEF)

These works are shown on drawings 33097/LF100-LF191. They will be done in two phases. The first phase involves works in Area EF as described in items DEF.1-7. The second phase involves the recapping of Area D, following steps DEF.8-9. This is reflected in the two phases of erosion and sediment controls shown on drawings 33097/LF190 and LF191.

5.3.1 Area EF

DEF.1 Install all erosion and sediment controls in accordance with the approved ESCP. This will involve silt fences, super silt fences and/or Decanting Earth Bunds (DEBs) on the downgradient side of the works area and clean water diversion channels on the upgradient side. See FTL Drawing 33097/LF190. These devices are considered more appropriate than sediment removal ponds (SRPs) for this site, as SRPs typically require a reasonable land area and their construction would involve excavation into the ground and potentially through landfilled material, while the proposed works will form excavation cavities that will contain any direct rainfall, thus reducing the risk of dirty runoff generation. Allow for pump in lowest area of excavation to pump dirty runoff to DEB. Where any runoff from within landfill works area comes into contact with refuse, testing of the runoff post-treatment, is required to check it can be discharged on-site to the natural environment. If not, then any such runoff will either need to be treated further on-site prior to discharge, or be tankered off-site for disposal as a trade waste.

DEF.2 Strip vegetation from works area prior to works. For this purpose, it would be useful to graze or mow the works areas pre-commencement.

DEF.3 Strip topsoil and cap from the works area and stockpile these materials outside of the works area for future reuse as cover material, if suitable, or placement into the landfill itself. Remove additional fill material from Area F to expose the former "offal pits" (cylindrical holes) used for the disposal of medical waste (mainly sharps). Excavate any medical waste found and dispose of off-site to a Class 1 landfill. Separate out any other pockets of refuse material from the works area and transfer to Area A1 (subject to suitable timing) or off-site to a Class 1 landfill.

DEF.4 Excavate suitable non-engineered fill material from the works area and transfer to the hospital via the Culvert 2 embankment road for use as backfill. Once sufficient material has been shifted from the works area to create space, contaminated soil can be transferred to the works area from the hospital and placed as compacted fill.

DEF.5 Compact, shape and trim the landfill surface to make it suitable for capping. Ensure that landfill batters adjacent to the stream are adequate to minimise scour/erosion which could damage the cap and expose underlying refuse in storm events.

DEF.6 Recap the landfill, with a GCL (geosynthetic clay liner) cap, underlain by a 150-300mm bedding/protection layer and overlain by a minimum 150mm thick protection layer, 300mm thick agricultural growth layer and 150mm thick topsoil, followed by regrassing. This gives a 600mm thick soil profile above the GCL liner, which is consistent with advice from Soil and LUC Consultant, Dr Scott Fraser that if a cap of no less than 60cm of good quality soil was reinstated this land could also be restored as Highly Productive Land.

DEF.7 Relocate groundwater monitoring bore, P7, to outside the landfill extent, and install at a greater depth than the existing monitoring bore.

5.3.2 Area D

DEF.8 Set up all erosion and sediment controls as per drawing 33097/LF191. Remove vegetation and topsoil, and then remove existing cap, except for leaving the bottom 200mm of cap in place to avoid exposing historic refuse and to provide a suitable ground surface for running trucks and small excavators across. Stockpile these materials outside of Area D for future reuse as cover material, if suitable, or for placement within the landfill.

DEF.9 Replace previous, lower quality, landfill cap materials on top of refuse to form a 150-300mm thick base layer, comprising compacted cohesive soils of permeability $1x10^{-7}$m/s with no sharps/abrasive material. This should connect into the cap over the perimeter bund. Construct new low permeability cap comprising a geosynthetic clay liner or similar, overlain by a 150mm thick protection layer. Replace previous landfill cap materials (if suitable) or imported materials on top of the protection layer to form a 300mm thick agricultural growth layer. Place minimum 150mm thick, verified clean topsoil on top of new landfill cap, reusing existing topsoil where appropriate, and then grassing.

5.3.3 Both Areas

DEF.10 Remove erosion/sediment controls once sufficient ground stabilisation (grass cover) achieved.

DEF-11 Reinstate any farm troughs and associated water supply lines, if disturbed or damaged by the works.

Notes:

1. No groundwater cutoff drain upgradient of the landfill is required for this area as groundwater has not been encountered in long term monitoring to the bottom of the piezometer (P7, 5.2m depth).
2. This work can be done in stages, keeping ahead of contaminated soil generation from the hospital demolition works.
3. Once the soil transfer process is completed, the Culvert 2 embankment can be removed.
4. Dirty water pump shown on drawing 33097/LF190 to drain disposal cell when it is below ground level, with water being pumped to DEB inlet.

5.4 STAGE 2: AREA A1/B/C WORKS (A1)

These works are shown on drawings 33097/LF200-LF291.

5.4.1 Area A1 (on AgResearch land; (Section 3 SO 534156))

A1.1 Begin works on AgResearch land area outside of the perimeter bund. Set up all erosion and sediment controls.

A1.2 Strip and temporary stockpile topsoil and landfill cap materials from this area.

A1.3 Remove all refuse from this area and a sufficient distance into the subject site for the new landfill toe bund.

A1.4 Construct a new landfill toe bund abutting the site boundary, including groundwater diversion trench under the toe bund.

A1.5 Backfill the AgResearch area with cleanfill (subsoils and minimum 150mm topsoil, followed by regrassing.

A1.6 Fill in the void created within the subject site to facilitate the toe bund construction with refuse material or suitable subsoils.

These works have to be undertaken before the perimeter toe bund referred to below can be completed. However, some of the steps outlined below for Raised Area A1B need to be undertaken first, so that refuse from the AgResearch land can be placed into the A1/B area avoiding double handling of it. Hence, there will be some overlap between works in these areas.

5.4.2 Raised Area A1/B

A1.7 Install all erosion and sediment controls in accordance with Waikato Regional Council Erosion and Sediment Control Guidelines and the landfill ESCP. Further details are provided below for Area A2/H, while silt fences, super silt fences and/or DEB should be placed around Area A1/B as shown on FTL Drawings 33097/LF290-291.

A1.8 Earthworks will be staged to minimise the open area. Begin with only the southern disposal area works.

A1.9 Construct perimeter bund, removing topsoil from beneath the bund and stockpiling/using to form clean water diversion drains. Perimeter bund to comprise of compacted clay or other suitable materials around Area A1/B in preparation for the placement of refuse

A1.10 Strip topsoil and cap from Area A1/B, except for leaving the bottom 200mm of cap in place to avoid exposing historic refuse and to provide a suitable ground surface for running trucks and small excavators across. Stockpile these materials outside of Area A1/B for future reuse as cover material, if suitable, or for placement within the landfill.

A1.11 Place transferred refuse/fill from Area A2/H into Area A1/B bunded cell. Contamination testing results for Areas A2 and H show some of the fill is contaminated with asbestos, with concentrations indicating these works will need to be done as Asbestos Related Works. Class B asbestos controls would be implemented in any localised areas, if necessary, based on site observations. Create minimum 1x1m windows through residual cap at 5m^2 spacings prior to placing additional refuse/fill on top.

A1.12 Place transferred fill material from Area H into Area A1 on top of the A2 material. If necessary, drier material from Area H may be mixed with any deeper, likely moist material from step A1.5.

A1.13 Replace previous, lower quality, landfill cap materials on top of refuse to form a 150-300mm thick base layer, comprising compacted cohesive soils of permeability 1x10^{-7}m/s with no sharps/abrasive material. This should extend over the top of the perimeter bund. Construct new low permeability cap comprising a geosynthetic clay liner or similar, overlain by a 150mm thick protection layer. Replace previous landfill cap materials (if suitable) or imported materials on top of the protection layer to form a 300mm thick agricultural growth layer. Place minimum 150mm thick, verified clean topsoil on top of new landfill cap, reusing existing topsoil where appropriate.

A1.14 Stabilise the southern disposal area with hay mulch and seed.

5.4.3 Area A1/B/C (outside perimeter bund)

A1.15 Begin works on area outside of the perimeter bund. Set up all erosion and sediment controls.

A1.16 In stages, remove vegetation and topsoil, and then remove existing cap, except for leaving the bottom 200-300mm of cap in place to avoid exposing historic refuse and to provide a suitable ground surface for running trucks and small excavators across.

Stockpile these materials outside of Area A1 for future reuse as cover material, if suitable, or for placement within the landfill.

A1.17 Replace previous, lower quality, landfill cap materials on top of refuse to form a 150-300mm thick base layer, comprising compacted cohesive soils of permeability $1x10^{-7}$m/s with no sharps/abrasive material. This should connect into the cap over the perimeter bund. Construct new low permeability cap comprising a geosynthetic clay liner or similar, overlain by a 150mm thick protection layer. Replace previous landfill cap materials (if suitable) or imported materials on top of the protection layer to form a 300mm thick agricultural growth layer. Place minimum 150mm thick, verified clean topsoil on top of new landfill cap, reusing existing topsoil where appropriate.

A1.18 Relocate groundwater monitoring bore, P2, to outside the landfill extent.

A1.19 Reinstate any farm troughs and associated water supply lines, if disturbed or damaged by the works.

A1.20 Complete construction of a groundwater cutoff drain upgradient of the landfill adjacent to Farm Rd and extend along sides of landfill to a suitable discharge point for gravity discharge to stream.

5.4.4 Area A2/H works (A2)

These works are shown on drawings 33097/LF300-LF390. The below methodology includes proposed stream temporary diversion measures during the works.

A2.1 Install silt fences, portable silt/sediment removal device or DEB(s) outside of works area and clean water diversion drains, as shown on drawing 33097/LF390. Allow for pump in lowest area of excavation to pump dirty runoff to portable silt/sediment removal device/DEB(s). Where any runoff from within landfill works area comes into contact with refuse, testing of the runoff post-treatment, is required to check it can be discharged on-site to the natural environment. If not, then any such runoff will either need to be treated further on-site prior to discharge, or be tankered off-site for disposal as a trade waste. Use the existing farm crossing as a clean water diversion bund upstream of the works, and maintain Culvert 3 live for as long as possible during the works. Allow for clean water diversion pump to be available for diversion of stream water if necessary.

A2.2 Groundwater piezometers are planned to be installed in this area to check groundwater depths within Area A2/H as part of detailed design. If necessary, based on the groundwater depth findings, install a number of dewatering wells or wellpoints or temporary pump for dewatering to lower the groundwater table within the works area.

A2.3 Mark out the approximate alignment of Culvert 3 pre-works (assumed straight line between inlet and outlet). Trafficking over this culvert should be minimised during the works, with refuse being shifted from Area A2/H to A1/B by truck via the existing farm crossing. The best available information indicates that the top of Culvert 3 is just over 2m below existing ground level.

A2.4 Strip existing topsoil and landfill cap from the works area and stockpile separately outside the works area. Refuse layers will then be removed and transferred to Area A1 by truck. Fill material (that is not refuse) will either be transferred to Area A1 or used for other purposes (e.g. cap) depending on its contamination status.

A2.5 Once the refuse has been transferred, construct a compacted toe bund embankment along the western side of the residual A2 Area. Stockpiled landfill material will be placed in the void between the toe bund and refuse as necessary. A low permeability cap will then be placed over the material followed by topsoil. Capping details will be as for Area A1.

A2.6 Cut in the new stream channel (approximately 75m long with base width of 3m with side slopes of 1V:3H, with some meanders), retopsoiling the channel and line with biodegradable coir matting to stabilise it, followed by planting with natives in accordance with the landscaping plan and placement of some rocks and logs. Place clean, stockpiled capping material or clean fill material from Area H to fill any depressions within Area A2 and then retopsoiling, using clean topsoil.

A2.7 For the new outfall to the stream, strip vegetation and trees. Install a temporary dam comprising steel shields or similar around the outfall works area and pump out water from inside the dam. Continue the stream channel to connect into the existing stream. Line with biodegradable coir matting to stabilise it, followed by planting as above.

A2.8 For installation of the new shorter Culvert 3 (1350 dia x 44 m long), install this in a downstream to upstream direction starting at the top of the new channel. A temporary dam will be installed as for A2.7 on the western side of the existing Culvert 3 inlet, to isolate the area where the new culvert inlet will be installed, from water in the existing stream which will continue to flow through the existing culvert. Water will then be pumped out from inside the dam. Once the new culvert is "live", the temporary dams at each end of the stream diversion will be relocated to block off the inlet and outlet to the existing culvert. This culvert (1350mm dia x approximately 60m long) will then be filled with flowable concrete fill or similar (~86m^3), with both ends of this culvert being sealed. Water within this culvert will be pumped out if necessary, or alternatively expelled naturally during the filling process.

Note: Maximum dirty water catchment area is 0.47ha. Works should be able to be progressively stabilised so that if DEBS are used, a single DEB (max 0.3ha catchment) can be used for all works. Otherwise, two DEBs may be needed to provide for entire works area.

6.0 EROSION AND SEDIMENT CONTROL MEASURES

Erosion and sediment control requirements are set out in this section. All sediment control works are to be operational prior to any other works commencing on site and shall remain in place until development works are complete and measures are in place to minimise erosion.

All erosion and sediment controls shall comply with the WRC document 'Erosion & Sediment Control Guidelines for Soil Disturbing Activities' dated January 2009, technical report number No.2009/02, updated in 2014, with current information on specific items found online (https://waikatoregion.govt.nz/services/publications/tr200902/).

6.1 SUMMARY

Principal erosion and sediment control measures to be used on the site are summarised below.

Table 2: Primary Erosion and Sediment Control Measures Summary

Item	Provided	Comments
Construction Entrance	If required	Majority of vehicle movements will be within the existing disposal site area, with some vehicle movements across the Culvert 2 embankment into the former hospital area. For vehicles bringing any imported materials (e.g. capping materials or topsoil), a construction entrance will be provided.
Filter Socks	Possibly	Possibly around stockpiles.
Silt Fences	Yes	Primary means of sediment control. Works area is generally relatively flat and silt fences will be installed on downgradient side of works areas. Refer locations on attached ESCP drawings.
Super Silt Fences	Yes	Super silt fences proposed around part of Area A2/H works area.
Clean diversion drains/bunds	Yes	At relevant locations around the site to divert clean runoff around works areas. Refer locations on attached ESCP drawings.
Dirty diversion drains/bunds	Yes	Required to collect and convey dirty runoff to DEBs/SRPs. Refer locations on attached ESCP drawings.
Decanting earth bunds (DEBs)	Yes	DEBs proposed for Area DEF works (2), ABC (1) and potentially for Area A2/H (1-2), each sized for maximum allowable 0.3ha catchment.
Sediment retention ponds (SRPs)	No	Not proposed – limited area for SRPs, given none can be placed on landfilled areas as would involve excavation through refuse.
Portable sediment removal devices	Possibly	Possible lamellar clarifier or similar portable sediment removal devices, for dirty water pumped from Area A2/H works.
Dirty water pumps	Yes	Dirty water pumps proposed for pumping dirty runoff from base of excavation to DEB sediment removal devices, in locations where gravity flow is not possible. Locations shown on ESCP drawings.
Stream diversions	Yes	Required for Culvert 3 removal and stream daylighting works.

6.2 OVERVIEW

All sediment laden runoff from the site will be routed through sediment retention structures. These structures are to be designed, constructed and maintained in accordance with best practice and generally as set out in this report. The proposed erosion and sediment controls include the following:

(a) Temporary and long term control works for the separation at source of dirty and clean stormwater.

(b) DEBs as the primary means of erosion/sediment control for the three works areas. For Area A2/H, a portable sediment removal device may be used instead, due to the catchment area (0.47ha) exceeding the maximum 0.3ha limit for DEBs, if it is not possible to progressively stabilise the works to keep within the 0.3ha limit or due to space limitations for installing a DEB.

(c) Silt fences and super silt fences as the primary means of erosion/sediment control, where DEBs or SRPs are not feasible.

(d) Clean and dirty water diversion drains.

(e) Temporary stream diversions.

6.3 PROPOSED SEQUENCING

The works will be broken up into a number of different works areas. The expected sequence of earthworks and associated activities in each work area is summarised below:

- Install all silt/sediment control structures required for earthworks/land disturbance, including silt fences, decanting earth bunds, sediment retention ponds, diversion drains/bunds and construction entrance for machinery access to site, as appropriate, in each works area. Obtain approval from Engineer prior to commencing works.
- Undertake landfill repair and upgrade works.
- Undertake backfilling, placing and compacting subsoils, followed by retopsoiling. Where services cross over areas to be reinstated as gravel farm tracks, backfill with hardfill.
- Mulch, hydroseed or grass all batters and exposed soil surfaces, as appropriate. This will be done progressively as different areas are completed.
- Decommission silt control devices once exposed surfaces are fully stabilised.

Further details on specific items from the above list are given in the following sections as required

6.4 VEGETATION REMOVAL

Vegetation tends to improve erosion and sediment control by binding of the soil by the root systems of trees and other vegetation, which provides mechanical reinforcement and resists erosion by surface water, and by the reduction of surface water by the evapotranspiration process. Vegetation strips may also enhance the natural sediment filtering process.

Vegetation removal for the landfill repair and upgrade works primarily involves grass (pasture) removal from the works areas and removal of some trees from around the existing Culvert 3 inlet/outlet and along the route of the new culvert and reinstated stream (Area A2/H).

Indicative vegetation removal requirements are shown on drawing 33097/LF311.

Existing vegetation removal required around the existing Culvert 3 inlet/outlet are provisional and will depend on the contractor's methodology for getting access to these areas to seal the existing culvert, particularly how they will isolate the works area from the normal stream flows. Any riparian vegetation that has to be removed to facilitate this or is accidentally damaged during the works will be reinstated on works completion.

The northern most area is shown as a provisional vegetation removal area. Vegetation removal from this area would only be required if the stream channel is further to the east of the location indicated by Lidar data.

Vegetation removal within the disturbance areas will be delayed as much as practicable prior to commencement of land disturbance works in each works area to minimise the time unstabilised ground is exposed. These areas will be stabilised as soon as practicable once demolition works are complete in each area.

6.5 RECAPPING EXISTING LANDFILL AREAS

Recapping of existing landfill areas will involve topsoil stripping,

These works will be undertaken in short duration work packages, undertaking topsoil stripping, cap upgrading, retopsoiling and grassing, prior to starting the next package. This methodology will significantly reduce the time disturbed ground is exposed and allow permanent stabilisation measures to be taken as soon as practicable.

Topsoil and any excavated capping material will be stockpiled close to the works area and provided with erosion and sediment controls.

6.6 DEWATERING

Certain repair/upgrade works (e.g. groundwater intercept trench) will create trenches below the surrounding ground. Any direct rainfall into these cavities, or shallow groundwater ingress, will be allowed to soak into the underlying ground, or if this may impede or delay the works, a portable pump will be used to pump out water collected in the cavity, with this being pumped into a "turkey's nest" or similar device and then allowed to disperse across adjacent grassed areas. In any locations where this is not possible, the water would be pumped in to a portable sediment removal device, or collected by sucker truck and taken to the on-site SRP for treatment or pumped out into an intermediate bulk container (IBC) for transfer to the on-site SRP or for disposal off-site. This measure does not apply to any areas where rainfall is likely to come into contact with refuse.

Figure 3: Top - Turkey's nest made from filter socks; Bottom left: dewatering bag and pipe sock; Bottom right: mobile "turkey's nest.

Groundwater may also be encountered during refuse transfer, particularly from the deeper excavations in Area A2/H. Dewatering would then likely be required to facilitate the refuse transfer works. This groundwater may be contaminated from contact with refuse. The field testing approach set out in section 6.7 below will be followed in this situation.

6.7 LEACHATE MANAGEMENT

During the refuse transfer works, there will be times when old refuse is exposed temporarily. The contractor will be required to minimise areas of exposed refuse, with temporary cover being provided at the end of each working day, comprising 100-150mm thick soil barrier, polythene sheeting or alternative approved method. Temporary cover will also be provided over the refuse, where practicable, during significant rainfall.

The refuse materials that will be exposed have been in place for over 25 years and groundwater monitoring data indicates low level contamination of groundwater passing through the landfill. Hence, the potential for leachate contamination of surface runoff from contact with refuse is considered to be relatively low.

Localised soil bunds will be placed around exposed refuse areas to trap any gross solids or debris that may get washed off. Any runoff trapped behind these barriers will be tested using a multi-meter or similar for pH and conductivity, with this information being used as a quick field indicator of potential leachate contamination.

If any runoff overtops these bunds (from a significant storm event) or when other runoff from within the works area comes into contact with refuse and is conveyed to DEBs or portable sediment removal devices for treatment, testing of the treated water discharge would be required to check it can be discharged on-site to the natural environment. Again, it is proposed to use pH and conductivity field measurements as indicators of leachate contamination.

Some initial field trials, involving comparing field pH/conductivity measurements against corresponding laboratory testing for pH, conductivity, heavy metals, boron and ammoniacal-nitrogen are recommended to determine appropriate conductivity trigger levels above which any runoff should be handled as leachate.

During the works, if the field testing indicates the runoff exceeds the leachate trigger levels, then it will either need to be treated further on-site prior to discharge, or be tankered off-site for disposal as a trade waste.

6.8 PERIMETER CONTROLS

Prior to earthworks activities commencing, appropriate perimeter and diversion drain controls (clean and dirty) will be installed for sediment control. Principal perimeter controls include silt fences and diversion drains/bunds, while filter socks may also be used.

The locations of these various devices, as described in the following, are shown on the Fraser Thomas 33097 drawings. These locations are provisional and exact requirements and locations may be changed on-site by the Engineer or Contractor during construction, subject to discussion and agreement with the WRC Monitoring Officer.

6.9 FILTER SOCKS

Filter socks are tubular stormwater and sediment control devices, consisting of a mesh tube filled with filter material (e.g. compost, sawdust, straw). Where works are detached from the main works areas and diversion drains are not required, filter socks can be used to bund the works area and treat the associated dirty runoff. The main advantage of these devices is their portability and flexibility allowing constant adjustment as works progress.

Filter socks may be installed:

- Where small gradients exist and the works area is small.
- As a containment structure where it is not possible to drain to the sediment removal devices (e.g. works in a gully).
- As check dams to slow flow in the diversion drains.

They can also be substituted for silt fences in some locations on-site.

6.10 SILT FENCES

Silt fences are a temporary barrier of woven geotextile fabric used to intercept runoff, reduce velocity, and impound sediment runoff from small areas (<0.3ha) of disturbed soil. On gradients steeper than 2%, returns will be placed in accordance with the WRC ESCG. Silt fences (or diversion bunds) will be used across the site for smaller works areas and where DEBs are not feasible.

6.11 SUPER SILT FENCES

Super Silt fences are a temporary barrier of woven geotextile fabric used to intercept runoff, reduce velocity, and impound sediment runoff. Super silt fences are an upgraded version of silt fences. The use of a chain link fence and two layers of geotextile enable them to be used on catchments greater than 0.5ha, subject to contributing catchment slope and length constraints. On gradients steeper than 2%, returns need to be placed in accordance with the WRC ESCG.

Super silt fences will be used in specific areas, where silt fence use criteria are not met, and where DEBs are not feasible.

6.12 DIVERSION DRAINS / BUNDS

Temporary diversion drains/bunds have been divided into clean and dirty water drains.

Clean water diversion drains will be installed at relevant locations around the site to direct clean runoff to avoid it entering active works areas and/or mixing with dirty runoff.

Dirty water collection drains/bunds will be used to collect dirty runoff from works areas where appropriate and convey it to downstream sediment retention ponds or decanting earth bunds.

The drains will be designed with capacity to accommodate a 5 year storm event, with additional freeboard to accommodate a 100 year event. All drains over 2% gradient will be lined or otherwise stabilised to prevent localised scour and erosion.

Due to the relatively flat nature of the site and nature of the works, most clean/dirty water drains have small catchments. Required drain dimensions are shown below.

Table 3: Dirty Water Drain Dimensions

Drain Type	Width (m)		Depth (m)
	Base	Top	
All drains	0.5	2.0	0.25

Notes:

1. Internal side slopes 1V:3H and external side slopes no steeper than 1V:2H.
2. All drains with gradients >2% or velocities >1.5m/s need lining with geotextile.

6.13 DIRTY WATER PUMPS

Portable dirty water pumps will be used to collect dirty runoff from shallow cavities (generally open areas) created during landfill repair/upgrade works with the dirty water pumped from the base of excavations to portable sediment removal devices or DEBs, in locations where gravity flow is not possible. Locations where pumps are likely to be required are shown on the ESCP drawings.

6.14 DECANTING EARTH BUNDS

Decanting earth bunds (DEBs) are designed to settle out sediment entrained in runoff during construction activities before it can leave the site, or enter the stormwater system. DEBs are appropriate for exposed catchments of up to 0.3ha. They are sized using WRC ESCG for a minimum volume of 2% of the contributing catchment, on sites with slopes <10% and less than 200m in length. This gives a DEB size of 60m^3 for the maximum allowable catchment area.

6.15 SEDIMENT RETENTION PONDS

Sediment retention ponds (SRPs) are designed to settle out sediment entrained in runoff during construction activities before it can leave the site or enter the stormwater system.

No SRPs are proposed for use for these works for the reasons described in Table 2.

6.16 FLOCCULATION

During the initial stage of works, dirty runoff generated from the works area will contain dissolved and particulate particles deriving from the natural soils on-site. If new capping and/or topsoil material is brought in, the characteristics of the dirty runoff will change, being increasingly controlled by the nature of the materials being placed on-site. In this case the nature of the dirty runoff entering any DEBs will depend on the type and extent of the exposed soil types for dirty runoff and the extent and ground cover of stabilized/restored or yet to be disturbed areas.

For these reasons, flocculation bench testing using PAC (polyaluminium chloride) or other suitable flocculants will be undertaken of the natural soils on-site to determine if chemical flocculation is needed during the early stages of the works and the required dosing rate. Ongoing monitoring will then determine if any changes are required to the flocculant dosing regime.

If bench testing confirms that flocculation is needed, a Chemical Treatment Management Plan (CTMP) will then be prepared, based on batch or rainfall activated flocculation dosing, with the

CTMP provided to WRC for approval. The requirements within this plan must be met prior to commencing activities in this area.

The pH and clarity of the pond discharge will be monitored for compliance with the WRC ESCG and remedial works undertaken in accordance with the CTMP, as required.

6.17 PORTABLE SEDIMENT REMOVAL DEVICES

Various suppliers provide mobile lamella clarifiers, where sediment is pumped into a tank and then passes over a baffle, with water being forced up through coalescing media where solids are settled out. Typically, these solids are then passed through dewatering bags (1T in size) to further reduce the water content to make them suitable for reuse and/or transport off-site. This system has a smaller footprint than DEBs or SRPs and may need to be used in areas where a DEB can not be installed. Some systems also provide for automated flocculant dosing and real-time Total Suspended Solids (TSS) monitoring.

Figure 4: Example of Mobile Sediment Removal Device

6.18 TOPSOIL AND BACKFILL STOCKPILE AREAS

Topsoil and backfill materials will be stockpiled at suitable locations. These stockpiles will either be grassed, hydroseeded, mulched or covered with geotextiles to prevent erosion and transport of loose soil, and be provided with appropriate perimeter controls (silt fence, small bunds (minimum 300mm high) or filter socks).

6.19 STABILISATION OF COMPLETED WORKS AREAS

As each work area is completed, they will be backfilled appropriately (subsoils/topsoil or hardfill) and re-vegetated through either grassing, mulching or hydroseeding. Any excess backfill materials and topsoil will remain stockpiled and maintained in a stabilised condition for future use.

6.20 DUST CONTROL MEASURES

Dust management during the Disposal Site repair/upgrade works will generally comply with the procedures set out in *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016).

Dust control aims to prevent or reduce the movement of dust from disturbed soil surfaces that may create nuisance, health hazards, traffic safety problems and/or off-site damage and discharge to the environment.

Standard dust control measures will be used to control dust at the site and soil disturbance measures will be suspended if dry and windy conditions prevail, or alternatively the disturbance area shall be watered and maintained in a slightly moist state to minimise dust generation.

Dust will be controlled at the works site using appropriate measures from the following toolbox:

- Minimising the extent of the exposed area at any one time.
- Limiting traffic to specified construction access roads and minimising travel distances by optimising site layout.
- Controlling vehicle speeds.
- Maintaining road surfaces.
- Minimising tracking of dirt on vehicle wheels onto paved surfaces.
- Minimising drop heights when loading and unloading vehicles.
- Limiting stockpile heights.
- Providing shelter from the wind for stockpiles.
- Consolidating and sealing off loose surface material.
- Progressive placement of hardfill (sub-basecourse) for hardstand areas and mulching and grass establishment, as works are completed in grassed/vegetated areas.
- Use of water carts to dampen exposed areas.
- Use of soil binders to form a cohesive membrane or protective crust that reduces windblown dust generation (contingency measure).
- Use of textiles as temporary covers on stockpiles or partially completed batter slopes, or as permanent cover (e.g. vegetation promotion blanket) on completed areas (contingency measure).

6.21 VEHICLE SILT/SEDIMENT TRACKING MITIGATION

If vehicles transporting materials on/off site can be restricted to paved areas, then their wheels are less likely to require cleaning prior to leaving the site.

For any vehicles trafficking unsealed areas, they are likely to pick up silt/sediment on their wheels, which could subsequently be deposited on internal roading within the site and/or the public road network. For such vehicles, they will be required to pass through a stabilised construction entrance, prior to leaving the site. This comprises a stabilised accessway, complying with updated TR2009/02 requirements; i.e. it will maintain a minimum of 50-75mm washed gravel depth of 150mm over a minimum 10m length and minimum 4m width on a geotextile layer. This will minimise the deposition of sediment onto adjacent properties.

If site experience finds that the construction entrance does not satisfactorily prevent off-site tracking of silt/sediment on vehicle wheels, the contractor would provide a wheel washing facility, most likely comprising a water blaster, with washwater directed to an appropriate silt/sediment trap, prior to discharge off-site.

6.22 MULCHING, TEMPORARY AND PERMANENT SEEDING

The primary objective of erosion and sediment control is to minimise the time ground is exposed prior to permanent stabilisation. If delays occur during the works or an intermediate form of stabilisation is required (e.g. on stockpiles), mulching or hydroseeding may be utilised. Permanent stabilisation can be achieved via the application of topsoil (150mm minimum thickness), followed by seeding or planting. Disturbed areas will be considered stabilised once a minimum 80% vegetative cover has been established. Grass seed will be sown at an appropriate rate as set out in the WRC ESCGs (90kg/ha for perennial rye grass; 30kg/ha for brown top; 30kg/ha for red/white clover mix). Mulch will be applied at a minimum rate of 6000kg/ha.

Combined mulching and seeding will not only stabilise the works area instantly (from the mulch) but will also typically decrease the time required to achieve 80% vegetative cover.

6.23 WEATHER MONITORING

Monitoring and predicting rainfall is essential to the performance of erosion and sediment control and civil works in general. Forecast rainfall will be monitored and high risk work will be undertaken during extended periods of fine weather, as much as practicable. When rainfall is predicted, all efforts will be made to ensure that the necessary measures are in place prior to rainfall and further inspections are made during rainfall and after to ensure that erosion and sediment control measures are functioning as intended.

7.0 MAINTENANCE

7.1 GENERAL

The sediment control measures will be regularly monitored during earthworks/land disturbance operations and after any significant rain event.

A visual inspection of the earthworks erosion/sediment control system will be carried out as soon as practicable and no later than 15 hours after a heavy rainfall event, in which 20mm of rain or greater is recorded on the site rainfall gauge within the preceding 24 hour period or 15mm or greater within one hour. The status of the system, including any problems or unusual occurrences, will be recorded. Remedial works will be carried out as soon as conditions are safe for workers and machinery.

Maintenance of all structures including silt fences, sediment retention ponds, diversion drains and/or bunds will be carried out on a regular basis. Exposed surfaces will be stabilised with grass by hydroseeding or by geotextile fabric or mulching, and reinstated as soon as practicable after works.

Maintenance will be the responsibility of the Contractor and will be carried out daily-weekly and subsequent to any storm event that produces runoff. The maintenance inspection will include, but not be limited to, the following:

- Inspection of silt fences, including:
  - Check waratahs, returns and back stays are secure in ground.
  - Check geotextiles extend into ground and there are no gaps under the fence.
  - Check geotextiles for tears and replace immediately.
  - Check joins in geotextile and replace where necessary.
  - Remove silt when sediment accumulation reaches 50% of the fabric height.
  - Make any necessary repairs when bulges occur.

- Inspection of any filter socks including:
  - Removing sediment once sediment reaches approximately 50% of the fabric height and repairing/replacing the filter sock if damaged (e.g. bulging).
  - Inspection after each rainfall event.
  - Checking the integrity of the filter sock and media.
  - Check for excessive ponding, indicating that the filter media has become clogged.

- Inspection of earthworks area including:
  - Checking for exposed areas and either isolate with a diversion drain, silt fence and re-seed, mulch the exposed area.
  - Checking for erosion on batter slopes and stabilising, as necessary.

- An inspection of the topsoil stockpiling areas, including:
  - Inspecting the silt fences/bunds, cleaning, repairing and checking that geotextiles are covering stockpiles and properly secured.

- Inspection of any decanting earth bunds and sediment retention ponds, including:
  - Checking embankments, spillways, level spreader and any exposed areas. Any areas with seepage/leaks will be sealed.
  - Checking the sediment depth (at 6 monthly intervals) and removing sediment once it reaches 20% of the device volume. To assist in gauging sediment loads, the 20% volume height will be clearly marked on the decant riser. During device cleaning, the outlet valve will be shut and water containing sediments will be pumped to an area where it can be treated before being discharged from the site. Any such area will be in a location where the sediment cannot be eroded and re-enter the stormwater system.
  - Checking the operation of the decant arrangement.
  - Checking any debris arrestors/screens and clearing them.

- Inspection and maintenance of any portable sediment removal devices, in accordance with supplier's recommendations.

- Inspection of temporary diversion bunds and channels, including:
  - Checking for exposed areas and re-hydroseeding;

- Checking for obstructions, damage and erosion and reinstating drains/bunds where necessary. Parts of the channel experiencing regular erosion will be treated with either turf slabs, tensar mat, reno mattress or rock riprap.

- Inspection and maintenance of any temporary roading/tracking.

- Inspection of the downstream receiving environment, to check for sediment buildup/deposition.

7.2 MITIGATION AND CONTINGENCY MEASURES

Multiple measures have been included in the design of sediment control measures for the demolition works to prevent excess sediment loads entering the receiving environment. These measures include:

- Undertaking enabling works (topsoil stripping, minor earthworks/soil disturbance, etc.) over as short a period as possible, ideally during an extended period of fine weather.
- Undertaking recapping works in short packages to minimise the cavity area open at any one time.
- Installation of appropriately sized SRPs to settle out and decant sediments prior to discharge of flows to the stormwater system.
- Installing clean runoff diversion bunds/drains to minimise the loading on the sediment retention ponds.
- Installation of filter socks or silt fences downslope of all earthwork/land disturbance areas and around temporary stockpiles to contain silt/sediments on-site. Perimeter measures will remain in place until restoration of the associated works area is complete.
- Stabilising exposed surfaces as soon as practicable upon completion of earthworks with mulch, hydroseed or topsoil and grass to reduce erosion.

Provided these mitigation measures are in place and correctly maintained the risk of sediment runoff from the proposed works is considered to be less than minor.

7.3 PROPOSED MONITORING

The SRPs associated with site development earthworks will be monitored as set out in this ESCP and in accordance with any additional requirements in the CTMP (should one be required).

7.4 DECOMMISSIONING

Sediment control works in specific works areas may only be decommissioned once it has been determined that all surface soils have been suitably stabilised through consultation and inspection by the contractor and LINZ. Decommissioning will be undertaken by light weight equipment or manually where possible and include the following:

- Respread any excess stockpiled topsoil and decommission the topsoil stockpiling area.
- Backfill any temporary collection drains and/or remove any diversion bunds and turf or mulch/grass seed as appropriate.
- Removing relevant silt fences, accumulated silt/sediment and reinstating the ground surface in those areas by turfing, mulching and/or grassing as appropriate.

- Remove bunds and decant structure and remove the DEBs, as appropriate. Sediments from the pond will be spread out on a pre-selected area to be dried, topsoiled and grassed, or disposed of to an appropriate disposal facility. The pond area will be reinstated by grassing.
- Remove any temporary sediment control devices on stormwater inlets.

7.5 ASBUILTS

As-built certification for the proposed sediment retention devices and associated dirty water and clean water diversion drains will be provided to WRC on completion.

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Drawings

(refer separate volume)

Appendix A

Erosion and Sediment Control Calculations

Fraser Thomas Overland Stormwater Runoff - Rational Method			
Job no:	33097	Date:	7/11/2024
Client:	Land Information New Zealand	Revision:	1
Job Name:	Tokanui Disposal Site	Designer:	FV
		Reviewer:	SF
Purpose:	20 year ARI Drains		

As per New Zealand Building Code E1/VM1, 2.0

Catchment runoff

Q = (C · i · A) / 360

Catchment coefficient based on NZBC clause E1

Stormwater intensity is taken from the HIRDS database output

RCP	Historical	Climate scenario - IPCC Representative Concentration Pathway (RCP)
ARI	5	yearly
Time of concentration method	User input	As per New Zealand Building Code E1/VM1, 2.3.2 b) or user input
User Time of concentration	10	minutes
Period	N/A	years

Catchment size	Surface type	Area, A_i ha	Run-off Coeff, Table 1 Ci	Slope correction Table 2 %	Run-off Coeff, Ci	T_c (min)	Intensity (mm/hr)	Flow Q (m^3/s)
1000-2000m^2	Grass	0.200	0.67	0-5%	0.72	10	77.70	0.031
		0.200						**0.031**
2000-5000m^2	Grass	0.300	0.67	0-5%	0.72	10	77.70	0.043
		0.300						**0.043**
2000-5000m2	Grass	0.430	0.67	0-5%	0.72	10	77.70	0.062
		0.430						**0.062**

Fraser Thomas Overland Stormwater Runoff - Rational Method			
Job no:	33097	Date:	7/11/2024
Client:	Land Information New Zealand	Revision:	1
Job Name:	Tokanui Disposal Site	Designer:	FV
		Reviewer:	SF
Purpose:	100yr drains		

As per New Zealand Building Code E1/VM1, 2.0

Catchment runoff

Q = (C · i · A) / 360

Catchment coefficient based on NZBC clause E1

Stormwater intensity is taken from the HIRDS database output

RCP	Historical	Climate scenario - IPCC Representative Concentration Pathway (RCP)
ARI	100	yearly
Time of concentration method	User input	As per New Zealand Building Code E1/VM1, 2.3.2 b) or user input
User Time of concentration	10	minutes
Period	N/A	years

Catchment area	Surface type	Area, A_i ha	Run-off Coeff, Table 1 Ci	Slope correction Table 2 %	Run-off Coeff, Ci	T_c (min)	Intensity (mm/hr)	Flow Q (m^3/s)
1000-2000m^2	Grass	0.200	0.67	0-5%	0.72	10	149.00	0.059
		0.200						**0.059**
2000-5000m^2	Grass	0.300	0.67	0-5%	0.72	10	149.00	0.083
		0.300						**0.083**
2000-5000m2	Grass	0.430	0.67	0-5%	0.72	10	149.00	0.119
		0.430						**0.119**

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Nov 8 2024

LF Works 1% Swale Sizing

Trapezoidal

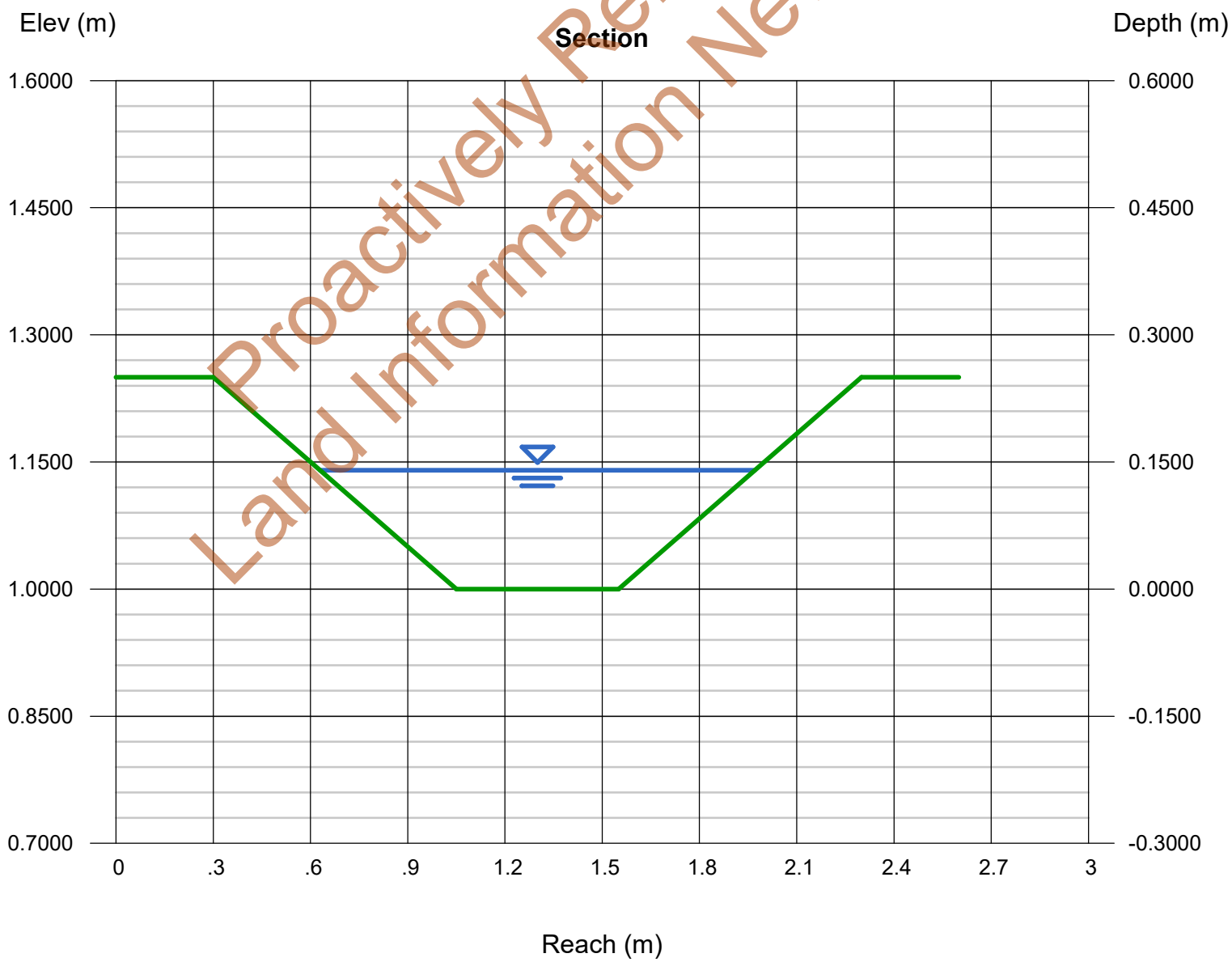
Bottom Width (m)	= 0.5000
Side Slopes (z:1)	= 3.0000, 3.0000
Total Depth (m)	= 0.2500
Invert Elev (m)	= 1.0000
Slope (%)	= 1.0000
N-Value	= 0.030

Calculations

Compute by:	Known Q
Known Q (cms)	= 0.0860

Highlighted

Depth (m)	= 0.1402
Q (cms)	= 0.086
Area (sqm)	= 0.1291
Velocity (m/s)	= 0.6663
Wetted Perim (m)	= 1.3868
Crit Depth, Yc (m)	= 0.1158
Top Width (m)	= 1.3412
EGL (m)	= 0.1629



Client	LINZ	**3000M2 DEB**	By	TB	Date	6/11/2024
Job	33097		Checked	SF	Date	6/11/2024

Job location: Waikato

Storage Volume Requirement

Catchment area:	0.3	ha	Maximum catchment area =	0.3	ha
Catchment slope:	5	%			
Catchment length:	100	m			
Volume requirement:	2%	of catchment area			
Storage volume:	60	m^3			

Pond Parameters

Depth	0.9	m from invert to primary spillway
Length to width ratio	3	
Internal batter slopes 1:	2	
Entry batter slope 1:	3	
Pond invert level	10	m RL
Baffles required:	No	

Location	Depth	Level	Width	Length	Area	Volume	Required
Base	0	10	2.40	13.5	32	0	
Dead storage	0.4	10.4	4.00	15.5	62	19	18
Primary spillway	0.9	10.9	6.00	18.0	108	61	60
Emergency spillway	1	11	6.40	18.5	118	72	
Top of pond	1.25	11.25	7.40	19.8	146	105	

Check:

Max decant operating range no more than 1.5m:						OK
Live storage = 70% of storage volume						OK
Dead storage = 30% of storage volume						OK
Dead storage depth must be between	0.3	m	and	0.4		OK
Base width	>=	1	m			OK

Decants

Number of decants:	1		
Decant rate:	3	L/s per ha	
Required decant flow:	0.9	L/s	
Design decant flow:	0.9	L/s	Total holes 40

Decants	RL	Holes
Decant 1	10.4	40
Decant 2	NA	NA
Decant 3	NA	NA
Decant 4	NA	NA

Discharge Pipe

Spillway diameter	100	mm	
Pipe gradient	1%		(Pipe to be at 1-2% grade)
Pipe capacity	5	L/s	
Pipe sufficient:	Yes		

Emergency spillway

Catchment C value	0.8		
Rainfall rate	125	mm/hr	1% AEP storm event
Q_p	0.08	m^3/s	

Emergency (1% AEP) spillway dimensions

Bottom width:	2	m
Side slope = 1V:	3	H
Spillway depth	0.25	m
Top width	3.5	m
Spillway capacity	0.55	m^3/s
Spillway sufficient:	Yes	

Appendix B

WRC ESCG Fact Sheets

Earthworks series – erosion and sediment control factsheet

Stabilised construction entrance

DEFINITION

A stabilised pad of aggregate on a filter cloth base located at any point where traffic will be entering or leaving a construction site.

PURPOSE

To prevent site access points from becoming sediment sources and to help minimise dust generation and disturbance of areas adjacent to the road frontage by giving a defined entry/exit point.

APPLICATION

Use a stabilised construction entrance at all points of construction site ingress and egress, with a construction plan limiting traffic to these entrances only. They are particularly useful on small construction sites but can be used for all projects.

DESIGN

- Clear the entrance and exit area of all vegetation, roots and other unsuitable material and properly grade it.
- Provide drainage to carry run off from the stabilised construction entrance to a sediment control measure.
- Place aggregate to the specifications below and smooth it.

Stabilised construction entrance

AGGREGATE SPECIFICATIONS	
Aggregate size	50-75mm washed
Thickness	150mm minimum
Length	10m minimum
Width	4m minimum

Maintenance

Maintain the stabilised construction entrance in a condition to prevent sediment from leaving the construction site.
After each rainfall inspect any structure used to trap sediment from the stabilised construction entrance and clean out as necessary.
When wheel washing is also required, ensure this is done on an area stabilised with aggregate which drains to an approved sediment retention facility.

Earthworks series – erosion and sediment control factsheet

Catch pit protection

Always implement appropriate best management site practices and primary environmental controls to prevent problems from first occurring, and minimise the amount of contaminants you have to manage and the potential risks of discharges from your site.

To prevent run off of muddy/silty water into gutters and drains, use one or more of the following measures:

1. Bunding: The drain is surrounded by a sediment sock/tube or sand bags, which traps sediment but still allows water to flow through to prevent flooding.
2. Catch pit (sump protection): Install a specially designed bag inside the drain sump to catch any dirty/silty run off but allow water to flow through. The methodology for ensuring no gap between the fabric and the road surface is always an issue. The best approach is to put light gravel on top to weigh down the fabric.
3. Covering: This must be well secured to prevent any water seeping through. If the drain grate can be lifted, place a barrier sheet/plastic under it and hold in place by the grate. Only use this method when there is no risk of causing flooding elsewhere.

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Silt fence

DEFINITION

A temporary barrier of woven geotextile fabric used to intercept run off, reduce its velocity and impound sediment laden run off from small areas of disturbed soil.

PURPOSE

To detain flows from run off so that deposition of transported sediment can occur through settlement.

Silt fences can only be used to intercept sheet flow. Do not use silt fences as velocity checks in channels or place them where they will intercept concentrated flow.

APPLICATION

- On low gradient sites or for confined areas where the contributing catchment is small, such as short steep batter fills and around watercourses.
- To delineate the limit of disturbance on an earthworks site such as riparian areas or bush reserves.
- To store run off behind the silt fence without damaging the fence or the submerged area behind the fence.
- Do not install silt fences across watercourses or in areas of concentrated flows.

DESIGN

- Ensure silt fence height is a minimum of 400mm above ground level.
- Place supporting posts/waratahs for silt fences no more than 2m apart unless additional support is provided by tensioned wire (2.5mm HT) along the top of the silt fence. Where a strong woven fabric is used in conjunction with a wire support, the distance between posts can be extended up to 4m. Double the silt fence fabric over and fasten to the wire and posts with wire ties or cloth fastening clips at 150mm spacing. Ensure supporting posts/waratahs are embedded a minimum of 400mm into the ground.
- Always install silt fences along the contour. Where this is not possible or where there are long sections of silt fence, install short silt fence returns, projecting upslope from the silt fence to minimise concentrations of flows. Silt fence returns are a minimum of 2m in length, can incorporate a tie back and are generally constructed by continuing the silt fence around the return and doubling back to eliminate joins.
- Join lengths of silt fence by doubling over fabric ends around a wooden post or batten or by stapling the fabric ends to a batten and butting the two battens together as shown in figure 1 (overleaf).
- Maximum slope lengths, spacing of returns and angles for silt fences are shown in table 1 (overleaf).
- Install silt fence wings at either end of the silt fence projecting upslope to a sufficient height to prevent outflanking.

- Where impounded flow may overtop the silt fence, crossing natural depressions or low points, make provision for a riprap splash pad or other outlet protection device.
- Do not use silt fences in catchments of more than 0.25ha.
- Where water may pond behind the silt fence, provide extra support with tie backs from the silt fence to a central stable point on the upward side. Extra support can also be provided by stringing wire between support stakes and connecting the filter fabric to this wire.

CONSTRUCTION SPECIFICATIONS

- Use silt fence material appropriate to the site conditions and in accordance with the manufacturer's specifications.
- Excavate a trench a minimum of 100mm wide and 200mm deep along the proposed line of the silt fence. Install the support posts on the downslope edge of the trench and silt fence fabric on the upslope side of the support posts to the full depth of the trench. Backfill the trench with compacted soil.
- Use supporting posts of tanalised timber a minimum of 50mm square, or steel waratahs at least 1.5m in length.
- Reinforce the top of the silt fence fabric with a wire support made of galvanised wire of a minimum diameter of 2.5mm. Tension the wire using permanent wire strainers attached to angled waratahs at the end of the silt fence.
- Where ends of silt fence fabric come together, ensure they are overlapped, folded and stapled to prevent sediment bypass.

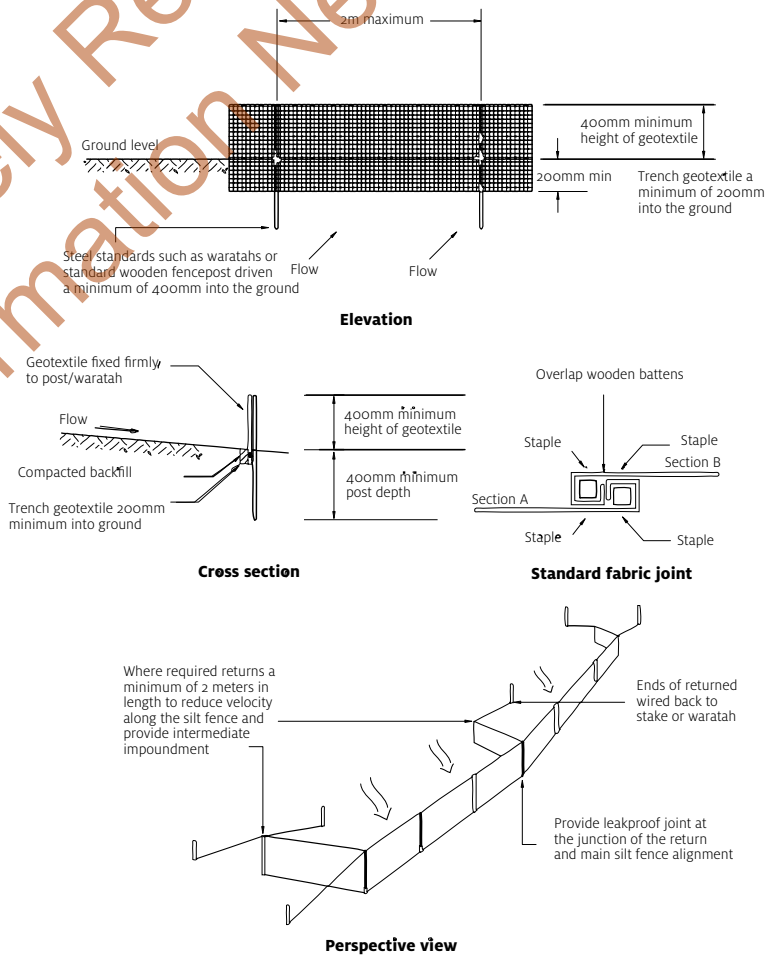
MAINTENANCE

- Inspect silt fences at least once a week and after each rainfall. Make any necessary repairs when bulges occur or when sediment accumulation reaches 50 per cent of the fabric height.
- Any areas of collapse, decomposition or ineffectiveness need to be immediately replaced.
- Remove sediment deposits as necessary to continue to allow for adequate sediment storage and reduce pressure on the silt fence. Ensure that the sediment is removed to a secure area.
- Do not remove silt fence materials and sediment deposition until the catchment area has been appropriately stabilised. Stabilise the area of the removed silt fence.

Table 1

Silt fence design criteria			
Slope steepness (%)	Slope length (m) (Maximum)	Spacing of returns (m)	Silt fence length (m) (Maximum)
Flatter than 2%	Unlimited	N/A	Unlimited
2-10%	40	60	300
10-20%	30	50	230
20-33%	20	40	150
33-50%	15	30	75
> 50%	6	20	40

Figure 1



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Earthworks series – erosion and sediment control factsheet

Silt sock/filter log

DEFINITION

A temporary barrier of woven geotextile fabric with mulch/bark filling used to intercept run off, reduce its velocity and impound sediment laden run off from small areas of disturbed soil.

PURPOSE

To detain flows from run off so that deposition of transported sediment can occur through settlement. Are a suitable alternative to silt fences in small/limited spaces.

Can be used to contain and filter discharges from pumped water or concrete wash water (turkeys nest).

Can be used for clean water diversions in small areas and to assist with catch pit protection.

Do not place silt socks in channels or use them where they will intercept concentrated flows.

APPLICATION

- On low gradient sites or for confined areas where the contributing catchment is small, such as short steep batter fills, around watercourses and small building sites.
- Around stockpiles, berms and silt edges where run off is imminent.
- In kerbs and channels, and around catch pits to divert water and retain sediment.
- Can be effective check dams.
- As a turkeys nest to treat pumped dirty water and concrete wash water.
- Can be doubled and secured down to increase capacity.

DESIGN

- Place directly onto the ground.
- Can be secured in place with twine and stakes to keep firmly in place to prevent water undercutting the sock and causing erosion at the edge of the site.
- Always install silt socks along the contour.
- Join lengths of silt sock by overlapping and securing the ends and securing with pegs and twine.

CONSTRUCTION SPECIFICATIONS

- Use product appropriate to the site conditions and in accordance with the manufacturer's specifications.
- Can be secured with pegs and twine to reduce movement and possible erosion.

MAINTENANCE

- Inspect silt socks at least once a week and after each rainfall. Make any necessary repairs or when sediment accumulation reaches 50 per cent of the sock height.
- Any areas of underscoring, decomposition or ineffectiveness need to be immediately replaced.
- Remove sediment deposits as necessary to continue to allow for adequate sediment storage and reduce pressure on the silt sock. Ensure that the sediment is removed to a secure area.
- Do not remove silt socks until the catchment area has been appropriately stabilised.

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Decanting earth bund

DEFINITION

A temporary berm or ridge of compacted earth constructed to create impoundment areas where ponding of run off can occur, and suspended material can settle before run off is discharged.

PURPOSE

Used to intercept sediment-laden run off and reduce the amount of sediment leaving the site by detaining sediment-laden run off.

APPLICATION

Decanting earth bunds can be constructed across disturbed areas and around construction sites and subdivisions. Keep them in place until the disturbed areas are permanently stabilised or adequately replaced by other means.

Decanting earth bunds can assist the settling of sediment laden run off, and are particularly useful for controlling run off after topsoiling and grassing before vegetation becomes established. Where works are occurring within the berm area, compact the topsoil over the berm area as bunds adjacent and parallel to the berm. This will act as an impoundment area and controlled outfall while also keeping overland flow away from the construction area.

DESIGN

- Decanting earth bunds need a constructed outlet structure and spillway, (see follow sections of this guide). The depth should be measured from the base of the decanting earth bund to the top of the primary spillway.
- Construct the decanting earth bunds such that the maximum contributing catchment does not exceed 0.3ha
- Lay the discharge pipe at a 1-2 per cent gradient, compact fill appropriately and incorporate an anti-seep collar.
  - Ensure all anti-seep collars and their connections are watertight.
- Use a flexible thick rubber coupling to provide a connection between the decant arm and the primary spillway or discharge pipe. Fasten the flexible coupling using strap clamps and glue and /or screws to prevent it coming off.
- Ensure the section of pipe leading through the decanting earth bunds and continuing downslope below the decanting earth bunds is non-perforated.
- On earthwork sites with slopes less than 10 per cent and less than 200m in length, construct the decanting earth bund with a minimum volume of 2 per cent of the contributing catchment ($20m^3$ for each 1000 square metres of contributing catchment).
- On sites with slopes greater than 10 per cent and/or 200m in length, construct decanting earth bunds with a minimum volume of 3 per cent of the contributing catchment ($30m^3$ capacity for each 1000 square metres of contributing catchment).

- Where possible, install the discharge pipes through the embankment as the embankment is being constructed.
- Fully stabilise the external batter face by vegetative or other means immediately after construction.
- Ensure all external bare areas associated with the decanting earth bund are stabilised in a manner consistant with the guidelines, such as mulch, cloth or vegetation.

DESIGN – EMERGENCY SPILLWAY

Stabilise the emergency spillway by lining it with a strong woven low permeability geotextile overlaid with a soft non-woven needle punched geotextile. Ensure the geotextile is pinned at 0.5m centres over the full area of the emergency spillway.

If there is sand, pumice or other erodible material under the spillways geotextile lining, install a waterproof layer underneath the geotextile, and an alternative method to pinning the geotextile is as follows:

- Bury the edges of the geotextile as per Figure 1.
- Connect a No 8 gauge wire between two waratah standards on either side of the spillway invert, tighten to hold the geotextile down as shown in Figure 1.
- If there is sand, pumice or other erodible material in the decanting earth bund embankment then an antiseep collar must be installed during the construction of the embankment.
- Ensure that all decanting earth bund embankments are compacted appropriately, particularly around the outlet pipe.
- Where possible, construct emergency spillways in well vegetated, undisturbed ground (not fill) and discharge over long grass. The emergency spillway must be located behind the decant system as far away as possible from the inlet.
- If the emergency spillway is constructed on exposed soil, provide complete erosion protection by means such as grouted riprap, asphalt, erosion matting/ geotextile or concrete.
- Construct the emergency spillway with a minimum of 100-150mm freeboard height above the primary spillway invert.
- The minimum emergency spillway dimensions are 2 metres wide with 250mm freeboard

Figure 1:

Connect to waratah on both sides, tighten wire

Waratahs	
No 8 gauge wire	

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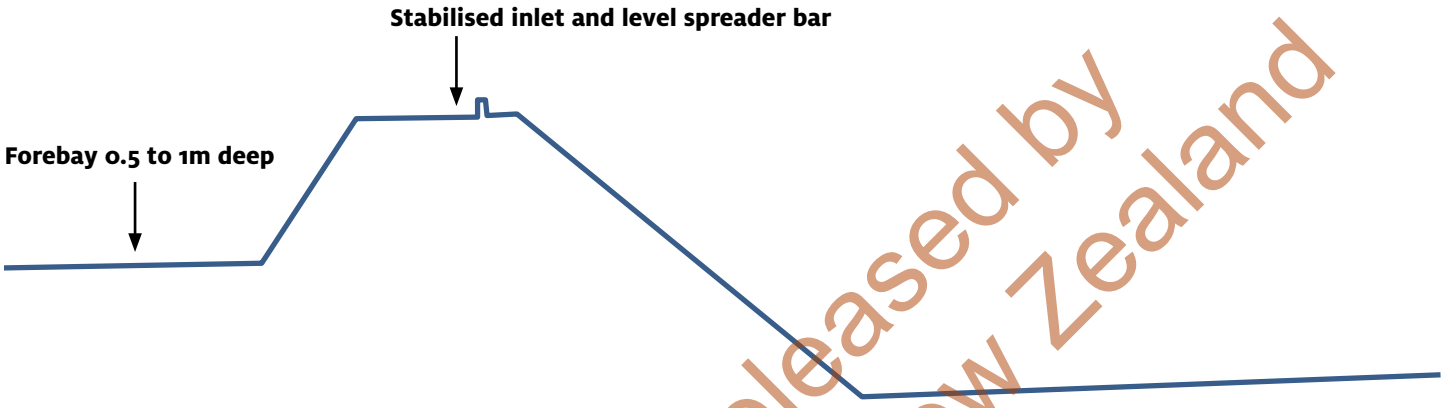
DESIGN – OPTIONAL FOREBAY

Benefits include the ability to clean deposition from the front of the control structure without damaging the 'clean' discharge side of the control.

- Construct a forebay with a volume equal to 10 percent of the pond design volume.
- The forebay is to extend the full width of the main pond and is to be 0.5 to 1 m deep.
- Inlets into the forebay are to be stabilised.
- Access to the forebay is to be maintained at all times to allow easy and frequent removal of accumulated sediments by an excavator.
- Sediment should also be removed after every large storm event and or when 20% of the pond volume is accumulated sediment.

Figure 2:



DESIGN – T-BAR DECANT

T-bar decants must be able to operate through the full live storage depth of the sediment retention pond.

- Position the decant inlet to provide 50 per cent live storage volume with a minimum distance of 5m of flat ground from the inlet. Otherwise raise the inlet so the dead storage level extends out at least this far.
- The decant rate is to be equal to 3 litres per second per hectare. Set the decant rate by drilling the correct amount of 10mm holes in the decant. For a 1,000 square metre contributing catchment 13 X 10mm holes will provide 0.3 litres per second. For a 1,500 square metre contributing catchment 20 x 10mm holes will provide 0.45 litres per second.
- The DEB must be set up so that all inflows enter as far as possible away from the decant.
- Ensure that a primary spillway (upstand riser) is constructed as part of the T-Bar decant, as detailed in figure 3.
- Ensure that the T-bar decant float is securely fastened with steel strapping directly on top of the decant arm and weight it to keep the decant arm submerged just below the surface through all stages of the decant cycle. This will also minimise the potential for blockage of the decant slots by floating debris.
- Position the T-bar decant at the correct height by supporting the decant arm between waratahs as detailed in figure 3.

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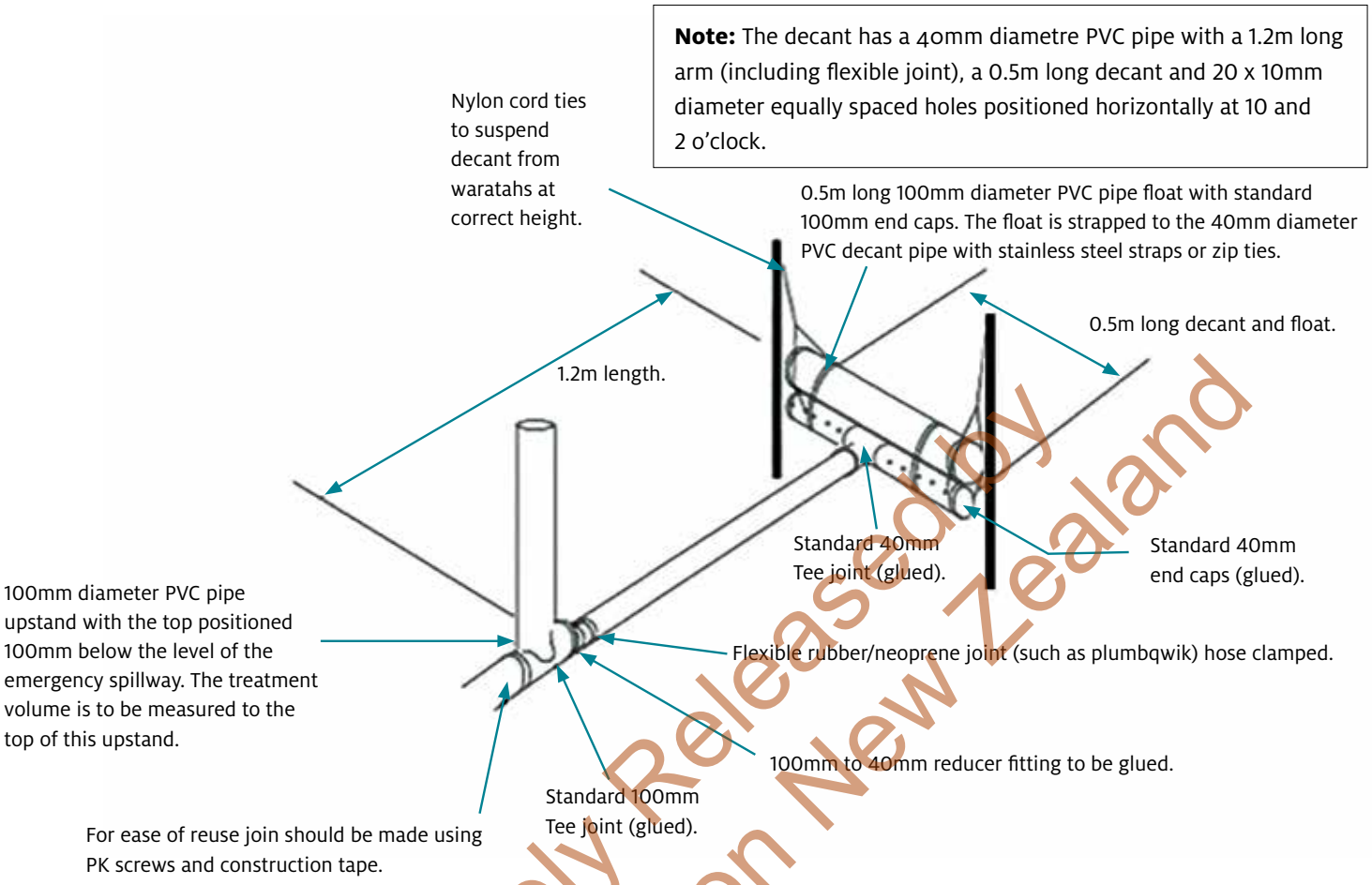
Figure 3: 40mm decant with upstand for decanting earth bund.



MAINTENANCE

Inspect and maintain decanting earth bunds regularly and after each rainfall event to check for accumulated sediment which may cause overtopping. Check any discharge points for signs of scouring and install further armouring or other stabilisation if scouring is evident.