Appendix Q

Erosion and Sediment Control Plan (ESCP)

Haughton Pipeline Stage 2 Project

Erosion and Sediment Control Plan

Townsville City Council

21 October 2022

→ **The Power of Commitment**

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1. Introduction

1.1 Project Overview

Townsville City Council (TCC) is undertaking the Haughton Pipeline Stage 2 (HPS2) Project which includes a new pump station and pipeline (herein referred to as the 'Project area'), connecting to the constructed Stage 1 and Stage 1.1 Haughton Pipeline Duplication Project (HPDP), to provide transfer of 364 ML/day of raw water from the Burdekin River to the Ross River Dam. The HPDP is a joint funding arrangement between the Queensland Government (the State) and TCC and includes:

– Stage 1 of the HPDP was completed in 2020 and comprises approximately 33 km of DN1800 pipeline constructed from the Haughton River to Toonpan Creek at the head of Ross River Dam
– Stage 1.1 of the HPDP was completed in 2021 and is an extension of the Stage 1 pipeline works from the Haughton River by 3 km, directed towards the Stage 2 pipeline alignment. The Stage 1.1 works end with an isolation valve pit and is the connection point for Stage 2
– Stage 2 comprises the construction of a new pump station adjacent to the Burdekin River (between the Tom Fenwick Pump Station and Clare Weir) and 28.5 km of DN1800 Glass Reinforced Polymer (GRP) pipeline from the pump station to Stage 1.1, to provide an integrated water transfer system.

Construction of the HPS2 Project will be split into two pipeline construction packages, with the pump station being a separate package of work.

Figure 1 provides an overview of the HPDP and HPS2 Project area.

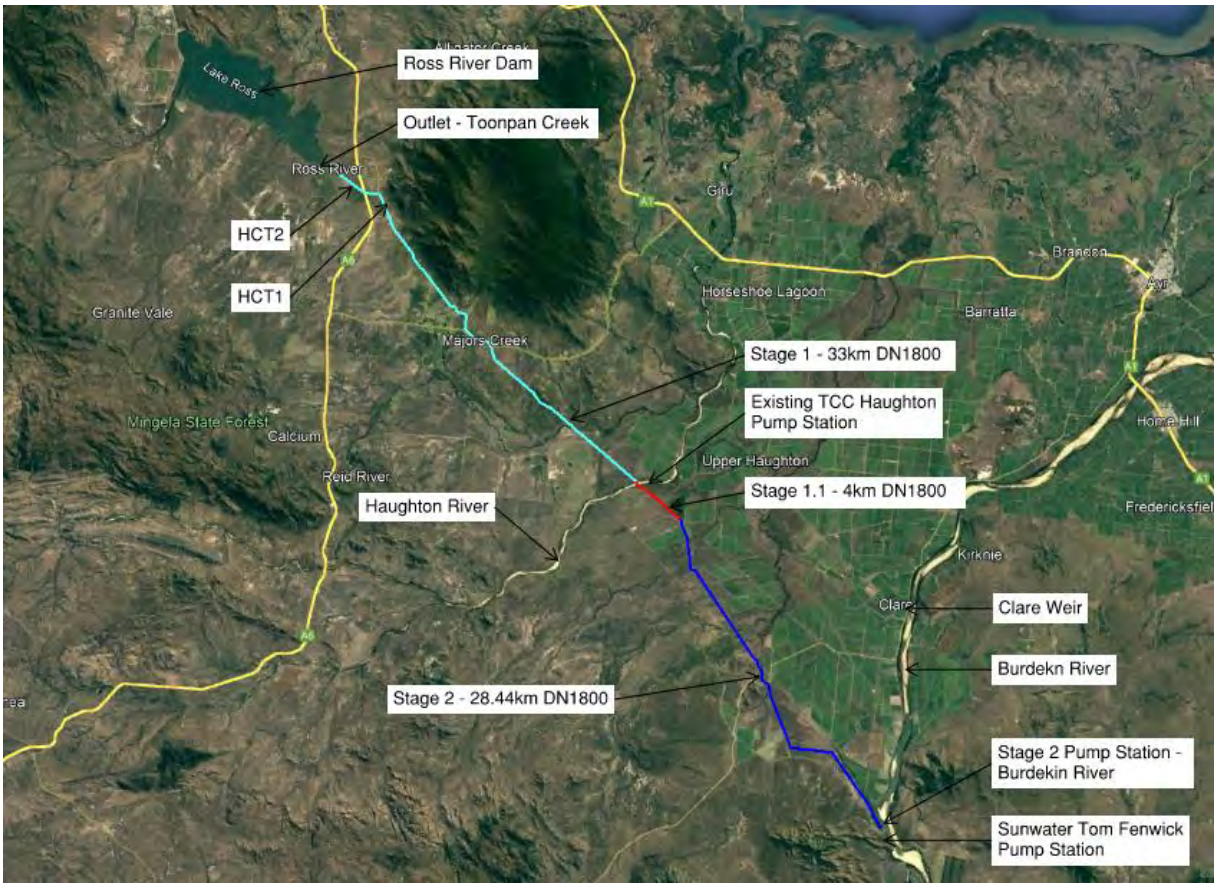


Figure 1 HPDP and HPS2 Project area

1.2 Purpose of this report

This Erosion and Sediment Control Plan (ESCP) has been prepared by a Certified Professional in Erosion and Sediment Control (CPESC) in accordance with Best Practice Erosion and Sediment Control (BPESC) guidelines for Australia (International Erosion Control Association (IECA)). The ESCP provides detailed information for the Construction Contractor to be able to develop their own site-specific erosion and sediment control plan (ESCP) in accordance with contract documentation for construction.

Contractors are required to submit a certified (written evidence from a CPESC) site specific ESCP for their relevant parcel of works prior to the commencement of works and within 20 business days after completion of works.

The purpose of this ESCP is to provide a set of overarching erosion and sediment control principals, concept layout plans and preliminary calculations as a guide for the Contractors. The control principles and management techniques outlined in this document are to be used as a guide by each Contractor during the project to minimise / eliminate the potential for sediment laden runoff to be discharged into the receiving environment for each site. In this regard, the purpose of this document is consistent with Section 5.2 of the IECA Best Practice Sediment and Erosion Manual (IECA Manual).

The IECA Manual states the following:

5.2 Erosion and Sediment Control Plans

High-risk sites may require preparation of a conceptual ESCP to assist in the appropriate planning of developments. These conceptual ESCPs are generally not as detailed as the final ESCPs because their very purpose requires them to be developed before key site layout and design information are finalised.

The purpose of preparing conceptual ESCPs is to:

- *Ensure appropriate soil data is collected and site constraints are identified*
- *Ensure consideration of erosion and sediment control requirements, site constraints and key environmental issues are introduced to the planning phase of the development*
- *Allow regulatory authorities to voice their key concerns before a development proposal progresses too far through the planning and site layout phase*
- *Demonstrate to the regulatory authority that there is a feasible means of constructing the project while still protecting key environmental values*

The content of required conceptual ESCPs can be highly variable depending on the available site and project data; however, all conceptual ESCPs need to satisfy at least the following outcomes:

- *Identify the need for the construction of Sediment Basins on the site*
- *Identify that adequate space has been made available for the construction and operation of major sediment traps and essential flow diversion systems*
- *Demonstrate to the regulatory authority that there is a feasible means of constructing the project while still protecting key environmental values*
- *Identify problem soil areas including, dispersive soils, acid sulphate soils, areas of potential mass movement*
- *Identify protected environmental features on the site such as protected vegetation*

This document does not prescribe or locate any permanent or temporary sediment and erosion control measures in detail but provides guidance with regards to the sediment control methodology which shall be required to satisfy the Contractors' responsibilities for the proposed works. Therefore, the Contractor is responsible for developing site and stage specific ESCPs, taking into consideration site knowledge and the staging of works. All ESCPs are to be developed in accordance with the best practice principles of the IECA Manual.

1.3 Relevant guidelines

This ESCP has been prepared in accordance with:

– The International Erosion Control Association (IECA) BPESC guidelines (IECA Manual) with reference to Catchments & Creeks Erosion and Sediment Control – A Field Guide for Construction Site Managers Ver 6 (2017).

1.4 Legislative requirements

A person or persons conducting land-disturbing development must conduct such development in accordance with the requirements of relevant environmental legislation (e.g. *Environmental Protection Act 1994*, and the associated *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*); and the *Planning Act 2016*. Relevant portions of these Acts are listed below.

1.4.1 Environmental Protection Act 1994

All persons have a legal duty under the *Environmental Protection Act 1994* (EP Act) (s319) to take all reasonable and practicable measures to minimise or prevent environmental harm. Such harm can be caused if sediment from construction sites enters (washes, blows, falls or otherwise) stormwater drains, roadside gutters or waterways. Stormwater run-off must be managed so that it is not released into waters, a roadside gutter, or stormwater drain in a state that results in the build-up of earth. Under s443 of the EP Act, a person must not cause or allow a contaminant to be placed in a position where it could reasonably be expected to cause serious or material environmental harm or environmental nuisance (e.g. placing a stockpile adjacent to a waterway).

In addition, people who are concerned with management in a corporation have an additional duty to ensure their corporation complies with the EP Act. This means supervisors need to take reasonable and practicable steps to ensure that the people under their control do not breach environmental laws.

People who become aware of environmental harm in association with their work (e.g. loss of sediment from their site into a watercourse or waterway) have a legal duty under the EP Act to notify the Department of Environment and Science (DES).

1.4.2 Environmental Protection (Water and Wetland) Policy 2019

This policy sits under the EP Act. The *Environmental Protection (Water Wetland) Policy 2019* (EPP (Water)) provides environmental values and water quality objectives for Queensland waters. These are utilised when determining environmental harm and to inform other statutory and non-statutory decisions. Theses water quality objectives also assist in identifying whether environmental values are protected. These values and objectives will be utilised when determining risk of environmental harm from water releases or run-off, and appropriate erosion and sediment controls implemented.

1.4.3 Planning Act 2016

The *Planning Act 2016* (Planning Act) is the mechanism for assessing all developments within Queensland. The Planning Act establishes the process for sustainable planning and development assessment in an ecologically sustainable way. Under the Planning Act it is a serious offence to breach development conditions, i.e. those dealing with erosion and sediment control or stormwater quality.

1.5 Scope and Limitations

1.5.1 Scope

This plan applies to the design documentation prepared for the HPS2 Project. The scope is as follows:

– Preparation of a ESCP in accordance with the IECA 2008 guidelines
– Identification of erosion hazards and erosion risk assessment in accordance with the IECA 2008 guidelines
– Identification of soil and surface water control measures required to mitigate erosion within the areas of disturbance
– Locations of creek and waterway crossings to be planned for in the detailed erosion and sediment control plans for each construction package

1.5.2 Limitations

This report has been prepared by GHD for Townsville City Council and its Contractors and may only be used and relied on by Townsville City Council and its Contractors for the purpose agreed between GHD and Townsville City Council as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Townsville City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

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

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.6 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of geotechnical information provided by Douglas Partners Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.6 Assumptions

This report relies on soil information provided by Douglas Partners Pty Ltd being a true representation of the soils encountered during the geotechnical investigation.

– Report on Geotechnical Investigations, Haughton Pipeline Duplication Project Stage 2 Keith Venables Road to Tom Fenwick Pump Station, Upper Haughton, Project No.98721.00, Document No. R.001.Rev0, dated 28 January 2022

2. Project Description

2.1 Project location

The HPS2 Project area is located approximately 58 km south-east of Townsville and will connect to the completed Stage 1.1 pipeline. The pipe alignment (approximately 28.5 km in length) extends in a north westerly direction from the new pump station on the Burdekin River to the previously built Stage 1.1 pipeline (Figure 2 and Figure 3).

The pipeline will intersect a number of waterways, one Burdekin Shire Council (BSC) local government road, two TMR state-controlled roads, BSC road reserves and private properties.

The project resides within the BSC Local Government Area (LGA).

2.2 Design and construction details

The project will involve construction of the following:

– A new pump station and intake structure located adjacent to the Burdekin River (beside the existing SunWater Tom Fenwick pump station within the section of river known as the Clare Weir Storage)
– A buried DN1800 pressure pipeline (approximately 28.5 km in length) connecting to the completed Stage 1.1 pipeline
– Ancillary works for the pipeline construction including temporary access and haulage roads and five stockpile areas for materials and equipment
– Above ground facilities including pipeline air release valves, pipeline scour valves and pipeline isolation valves for operation and maintenance

Project construction works will typically involve the following:

– Clearing vegetation for the pipeline alignment construction corridor, river intake and pump station site
– Stockpiling topsoils to be used in the rehabilitation process
– Construction of temporary access and haulage roads to the pipeline construction corridor and a permanent 4m wide gravel access road along the pipeline corridor
– Construction of five temporary pipe delivery stockpile yards
– Delivery of pipe to designated temporary stockpile holding yards and stringing out along the pipeline construction corridor
– Use of excavators, trenching machines and conventional methods to create an open trench for the pipeline
– Assembly of pipe in the trench, bedding around the pipe with imported embedment materials, and backfilling the trench with stockpiled excavated materials and topsoil
– In-river construction works for construction of an edge of bank intake in the Burdekin River, access road, discharge pipeline and bank erosion and scour protection works
– Civil and building works at top of bank for construction of new pump station and supporting infrastructure
– High voltage (HV) substation and HV power line to supply the pump station from the nearby Powerlink power supply
– Rehabilitation of construction and non-operational areas

A typical section of the pipeline construction corridor is provided in Figure 4.

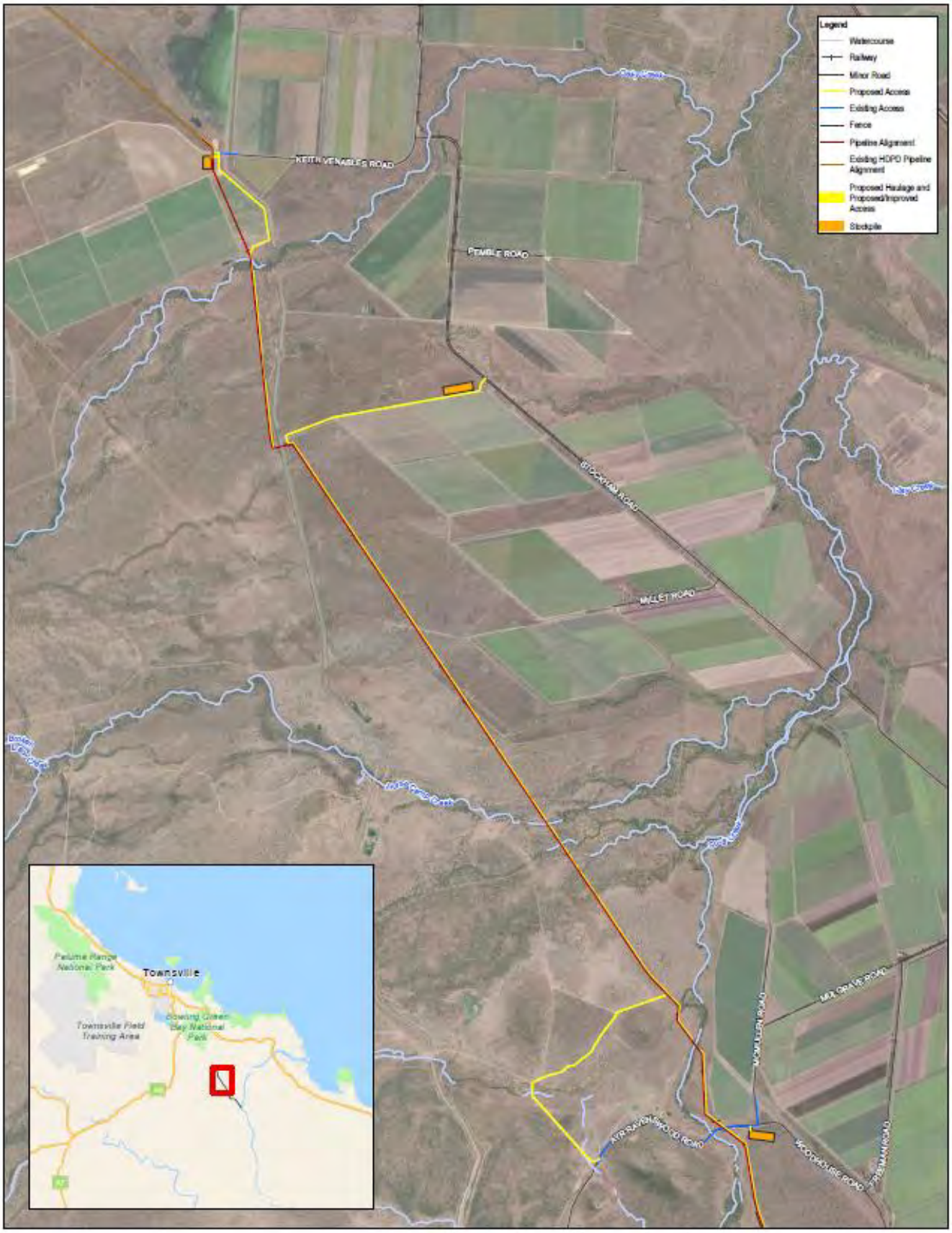


Figure 2 *HPS2 Project area (Sheet 1)*

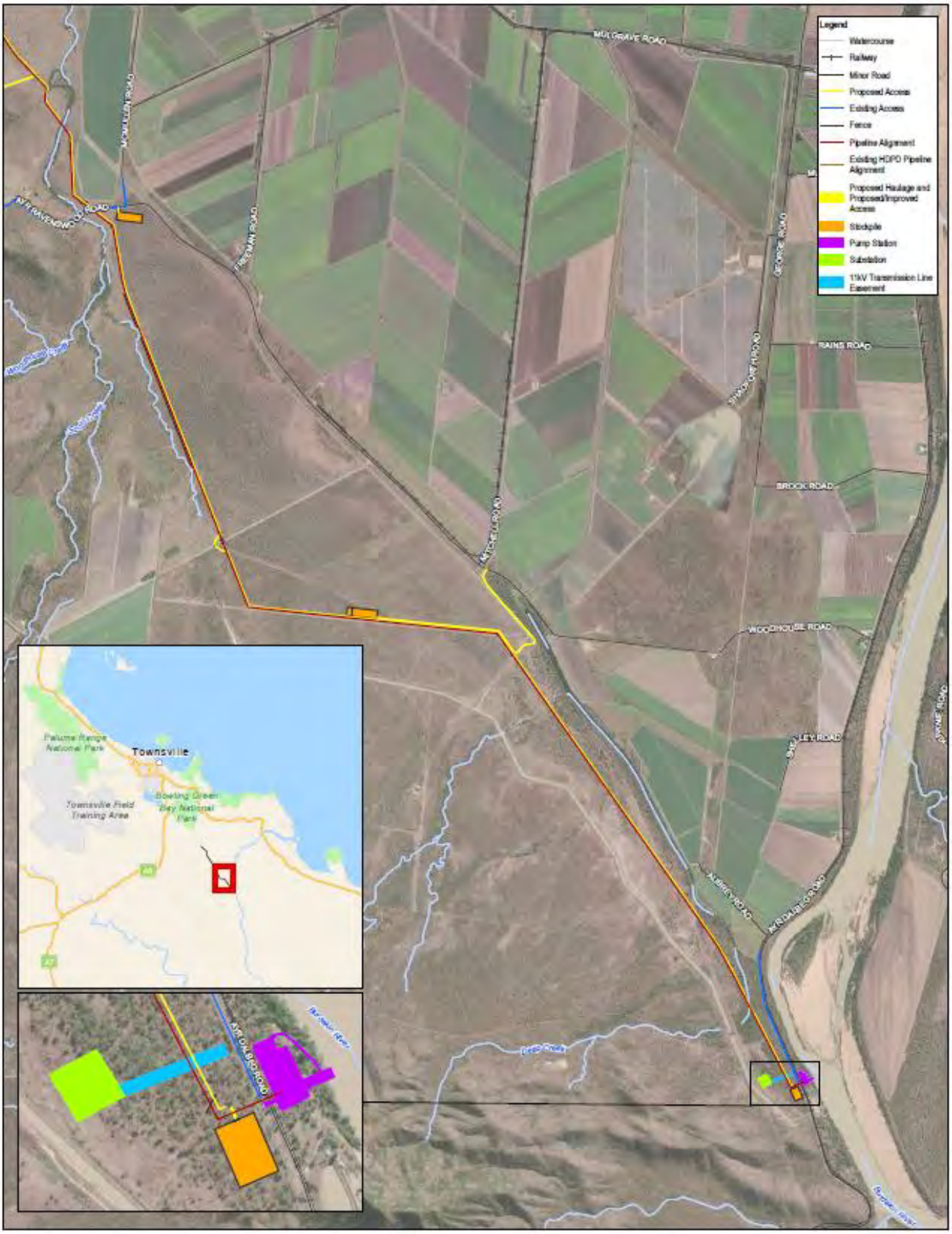


Figure 3 *HPS2 project area (Sheet 2)*

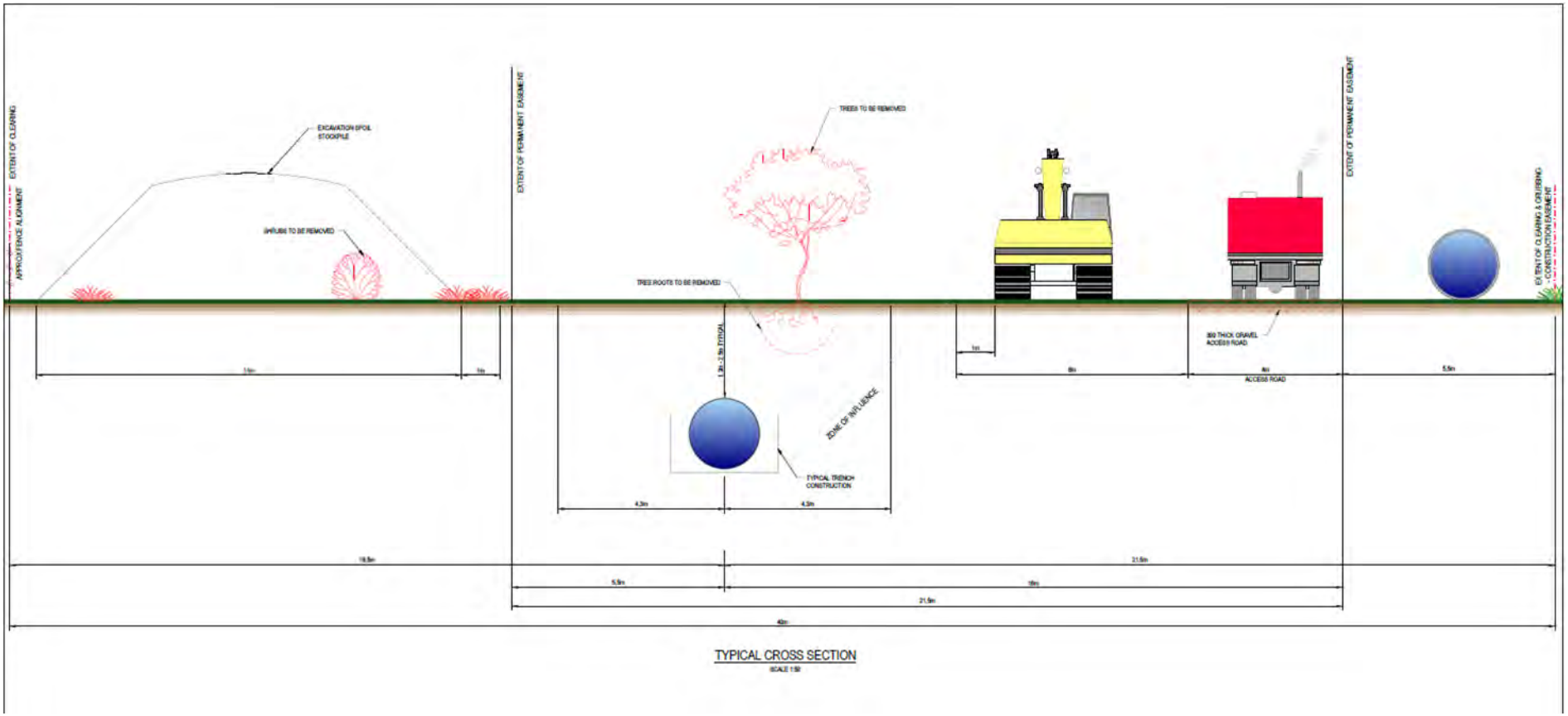


Figure 4 *Pipeline 40m wide construction corridor (outside vegetation management watercourses and riparian zones where reduces to 20m)*

3. Site Assessment

A desktop assessment of available databases regarding the site was undertaken in order to develop an understanding of the site environmental values.

3.1 Rainfall

Rainfall data was obtained from weather station 033287 (Millaroo Alert) as the closest to the southeast end of the pipeline, and 033280 (Powerline TM) as the closest station to the northwest end of the pipeline. Historic rainfall data indicates that the area is likely to receive higher rainfall during December to March, with the driest months being August, September and October.

Historic rainfall data for Millaroo Alert Station and Powerline TM stations are provided in Table 1 and Table 2, respectively.

Table 1 Millaroo rainfall data (BOM, 2021)

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean (mm)	181.4	175.2	96.9	32.5	25.6	21.0	17.5	7.2	7.6	14.6	29.5	88.2
Highest (mm)	381	502	350	86	213	156	93	57	62	47	185	423

Table 2 Powerline TM rainfall data (BOM, 2021)

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean (mm)	252.3	192.7	113.6	54.7	28.5	18.2	30.9	12.4	9.3	14.6	31.4	75.6
Highest (mm)	583	780	492	258	212	76	166	107	104	64	297	551

3.2 Topography

The alignment is relatively flat to slightly undulating, ranging from 27 mAHD to 46 mAHD with a steep incline (approx. 3-3.5%) at the intake from the Burdekin River. The approximate average slope of the Stage 2 alignment is 0.5%.

3.3 Soils

A summary of the dominant soils throughout the alignment, as identified by the site test pits and deep bore holes geotechnical investigations conducted by Douglas Partners Pty Ltd (2021), can be found in Table 3,

Table 4 and Table 5. The location of boreholes utilised to conduct these investigations are provided in Appendix A.

As outlined in the BPESC Erosion Hazard Assessment Forms (Appendix B), the ‘worst case’ soil classification was used, therefore yielding the highest assessment score (Section 4.3).

Table 3 Soil types – Shallow Bores

Borehole Location	"Worst Case" Classification	Description of "Worst Case" Strata
BHS 1	CH	Silty Clay
BHS 2	ML/CL	Clayey Silt/Silty Clay
BHS 3	CL	Silty Clay
BHS 4	ML/CL	Sandy Silt/Silty Clay/Sandy Gravelly Clay
BHS 5	ML/CL	Clayey Silt/Silty Clay/Sandy Clay
BHS 6	CL	Silty Clay
BHS 7	SC/CH	Clayey Sand/Sandy Clay
BHS 8	ML/CL	Sandy Silt/Sandy Clay
BHS 9	ML/CL	Clayey Silt/Silty Clay/Sandy Clay
BHS 10	ML/CL	Clayey Silt/Silty Clay
BHS 11	ML/CL	Clayey Silt/Silty Clay
BHS 12	ML	Sandy Clayey Silt
BHS 13	SM	Silty Sand
BHS 14	CL	Sandy Clay
BHS 22	CH	Silty Clay
BHS 23	CL	Sandy Clay
BHS 24	CL	Sandy Clay
BHS 25	ML	Sandy Silt
BHS 26	ML/CL	Sandy Silt/Sandy Clay
BHS 27	ML/CL	Sandy Silt/Sandy Clay
BHS 28	ML/CL	Clayey Silt/Silty Clay
BHS 29	CL	Sandy Clay
BHS 30	CL	Sandy Clay
BHS 31	CL	Sandy Clay
BHS 32	SC	Clayey Sand
BHS 33	CL	Sandy Clay
BHS 34	SC	Clayey Sand
BHS 35	SC	Clayey Sand
BHS 36	SC	Clayey Sand

Table 4 Soil types – Deep Bores

Borehole Location	"Worst Case" Classification	Description of "Worst Case" Strata
BHD 101	ML/CL	Clayey Silt/Sandy Clay
BHD 102	ML/CL	Clayey Silt/Sandy Clay
BHD 103	ML	Clayey Silt
BHD 104	ML/CL	Clayey Silt/Silty Clay/ Sandy Clay
BHD 105	ML/CL	Clayey Silt/Sandy Clay
BHD 106	ML/CL	Clayey Silt/Sandy Clay
BHD 107	ML/CL	Clayey Silt/Sandy Clay
BHD 108	ML/CL	Clayey Silt/Sandy Clay
BHD 109	ML/CL	Clayey Silt/Silty Clay/ Sandy Clay
BHD 110	ML/CL	Clayey Silt/Silty Clay
BHD 111	ML/CL	Clayey Silt/Silty Clay/ Sandy Clay
BHD 112	ML/CL	Clayey Silt/Silty Clay
BHD 113	ML	Clayey Silt
BHD 114	CL	Sandy Clay
BHD 115	ML	Clayey Silt
BHD 116	ML/CL	Clayey Silt/ Sandy Clay
BHD 117	ML/CL	Clayey Silt/Silty Clay/ Sandy Silty Clay
BHD 121	ML/CL	Clayey Silt/Sandy Clay/Sandy Gravelly Clay
BHD 126	ML	Clayey Silt
BHD 127	CH	Silty Clay
BHD 128	ML	Clayey Silt
BHD 129	ML	Clayey Silt
BHD 130	ML/CL	Clayey Silt/ Sandy Clay
BHD 131	ML/CL	Clayey Silt/ Silty Clay
BHD 132	ML/CL	Clayey Silt/ Silty Clay/ Sandy Clay
BHD 133	ML/CL	Silty Clay/ Sandy Clay
BHD 134	ML/CL	Silty Clay/ Sandy Clay
BHD 135	ML	Clayey Silt
BHD 136	ML/CL	Clayey Silt/ Sandy Clay
BHD 137	SC	Clayey Sand
BHD 138	ML	Sandy Silt
BHD 139	CL	Silty Clay

Table 5 Test pit with Emerson Class

Location	Depth (m)	Primary Description	Emerson Class No
TP1	3.6-3.8	Sandy CLAY	3 - Moderate
TP2	2.3-2.5	Silty CLAY	2 – Moderate to High
TP3	2.2-2.4	Silty CLAY	1 – Very high
TP4	2.4-2.6	Sandy CLAY	3 – Moderate
TP5	0.8-1.0	Clayey GRAVE	3 – Moderate
TP6	3.3-3.5	gravelly SANDLY	1 – Very high
TP7	1.8-2.0	Sandy CLAY	2 – Moderate to High
TP8	3.2-3.4	Sandy CLAY	2 – Moderate to High
TP9	2.2-2.4	Sandy CLAY	1 – Very high
TP10	1.5-1.7	Sandy CLAY	2 – Moderate to High
TP11	3.4-3.6	Sandy CLAY	3 – Moderate
TP12	2.6-2.8	Sandy CLAY	3 – Moderate
TP13	3.2-3.4	Sandy CLAY	2 – Moderate to High
TP14	3.0-3.2	Silty CLAY	1 – Very high
TP15	3.2-3.4	Silty CLAY	1 – Very high
TP16	3.8-4.0	Gravelly SAND	2 – Moderate to High

A desktop assessment of the project site has identified both low and extremely low probability of occurrence for Acid Sulphate Soils (Figure 5).

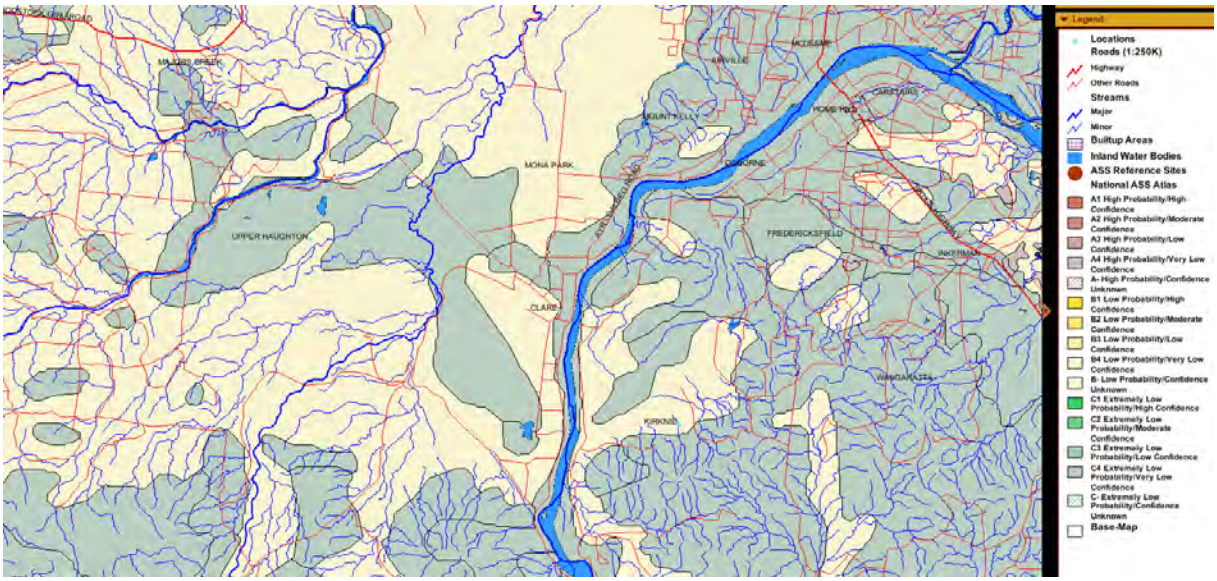


Figure 5 Acid Sulfate Soils

3.4 Regional Ecosystems

Quaternary surveys were completed along the length of the pipeline alignment and Regional Ecosystems (REs) verified within the nominated disturbance areas. Based on the field verified data, there are 15 REs present within the HPS2 Project area as described in Table 6 and shown in Appendix C.

Table 6 Regional ecosystem descriptions

Regional Ecosystem	VM Act Status	Description
11.3.4	Of Concern	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains
11.3.4a	Of Concern	*Corymbia tessellaris* woodland. On alluvial sandridges to elevated levees and level terraces adjacent to larger stream channels which are irregularly flooded or possibly relict.
11.3.7	Least Concern	*Corymbia* spp. open woodland on alluvial plains
11.3.9	Least Concern	*Eucalyptus platyphylla, Corymbia* spp. woodland on alluvial plains
11.3.10	Least Concern	*Eucalyptus brownii* woodland on alluvial plains
11.3.12	Least Concern	*Melaleuca viridiflora, M. argentea +/- M. dealbata* woodland on alluvial plains
11.3.13	Of Concern	*Grevillea striata* open woodland on coastal alluvial plains
11.3.25	Least Concern	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines
11.3.25b	Least Concern	*Melaleuca leucadendra* and/or *M. fluviatilis, Nauclea orientalis* open forest
11.3.25f	Least Concern	Main river channels. Open water or exposed stream beds and bars. Usually devoid of emergent vegetation although scattered trees and shrubs such as *Melaleuca viminalis* or *Melaleuca* spp. May be present and aquatic species may be abundant particularly in water holes and lagoons. Occurs in river channels. Riverine
11.3.30	Least Concern	*Eucalyptus crebra, Corymbia dallachiana* woodland on alluvial plains
11.3.31	Of Concern	*Ophiuros exaltatus, Dichanthium* spp. grassland on alluvial plains
11.3.35	Least Concern	*Eucalyptus platyphylla, Corymbia clarksoniana* woodland on alluvial plains
11.3.35a	Least Concern	*Corymbia tessellaris, C. clarksoniana* and E*ucalyptus platyphylla* woodland
11.12.1	Least Concern	*Eucalyptus crebra* woodland on igneous rocks

3.1 Waterways

Watercourses and drainage lines associated with remnant vegetation within the construction corridor are detailed in Table 7.

Works constituting waterway barrier works within Qld mapped waterways for waterway barriers works are subject to the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018).

Table 7 Watercourse chainages, stream order and corresponding RE's

Pipeline Chainage (m)	Latitude	Longitude	Stream order	Qld WWBW classifications	Corresponding RE
1578.992886	-19.740135	147.084186	4	Purple - Major	11.3.25b
2803.019057	-19.751129	147.08547	1	Orange - Moderate	11.3.7
8379.5925	-19.792166	147.111868	1	Orange - Moderate	11.3.35
9096.037065	-19.797542	147.11568	1	Not classified	11.3.35
9476.656766	-19.800398	147.117706	4	Purple - Major	11.3.25b
9766.980128	-19.802576	147.119251	5	Purple - Major	11.3.25b
10025.57953	-19.804517	147.120627	1	Not classified	11.3.4a
10140.96884	-19.805382	147.121241	1	Orange - Moderate	11.3.7
12217.86974	-19.820566	147.132489	1	Orange - Moderate	Non-rem
12672.56564	-19.824019	147.134456	5	Purple - High	11.3.25b
23328.34677	-19.888934	147.191586	1	Orange - Major	11.3.35
23328.34677	-19.888934	147.191586	1	Red - High	11.3.35
24138.55718	-19.894915	147.196049	1	Orange - Major	Non-rem
27185.56834	-19.917895	147.212004	3	Red - High	11.3.25b

3.2 Wetlands

The proposed HPS2 alignment is located downstream from a number of MSES wetlands (i.e. wetlands of high ecological significance) (Figure 6). No MSES wetlands are intersected by the alignment or located immediately downstream.

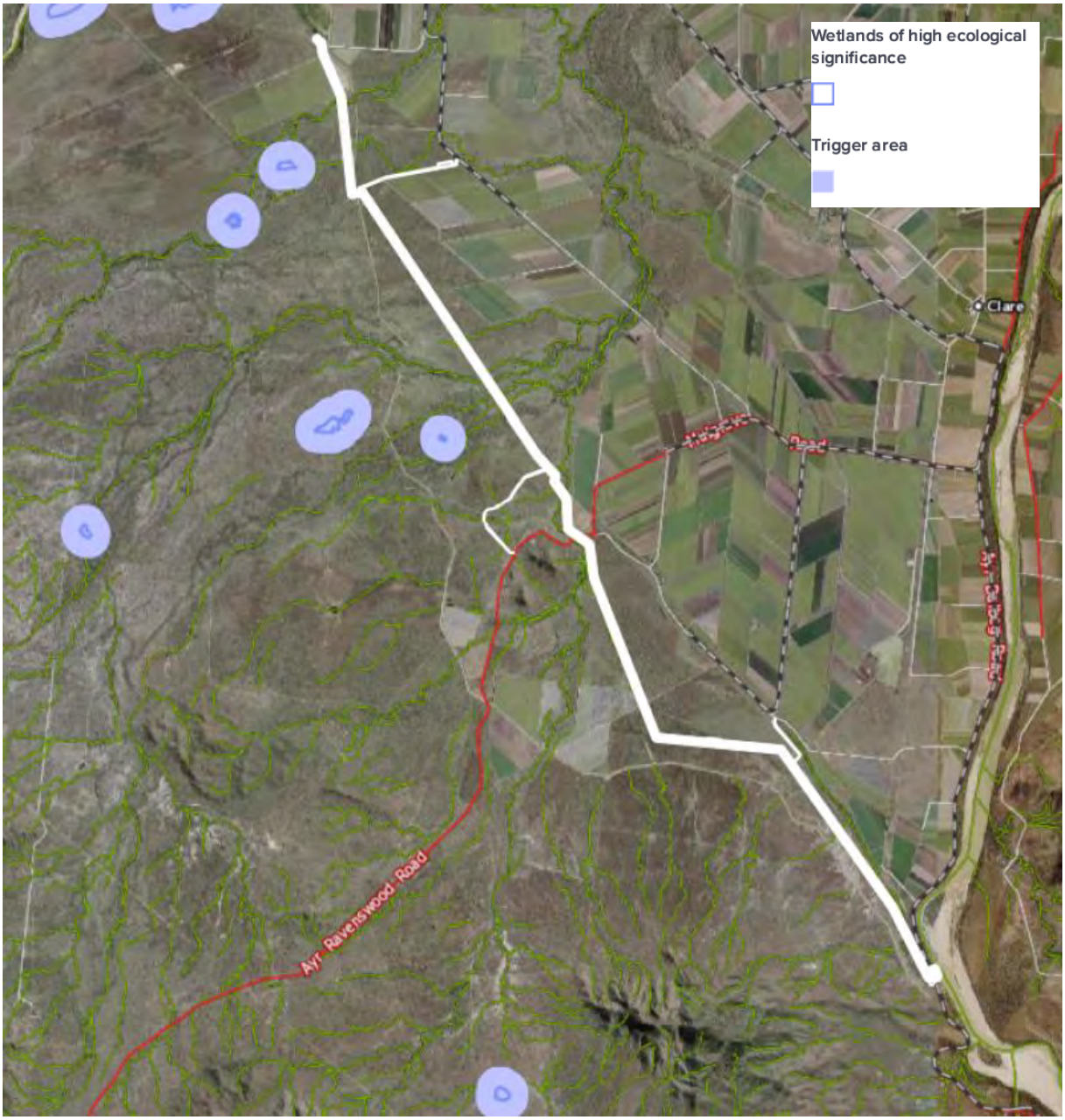


Figure 6 *MSES wetland features*

Source: QLD Globe, accessed 04/11/2021

4. Erosion Hazard Assessment

4.1 Overview

In accordance with Section 5.2 of the BPESC Guidelines, an erosion hazard assessment has been undertaken to provide an indication of the erosion risk for the site and identify areas where erosion and sediment control measures may need to be implemented.

4.2 Land disturbance activities

As described in Section 2.2, the works generally include the construction, testing and handover of approximately 28.5 km of DN1800 pipe and associated facilities, including an intake pump station and substation.

To summarise, the main elements of the work are:

– Earthworks and trenching
– Pipeline installation
– Construction of temporary pipe delivery stockpile yards and access and haulage roads
– Temporary waterway barrier works for approximately 14 waterway crossings
– Under boring (trenchless construction) of Ayr-Dalberg Road and Scotts Creek crossings
– River intake and pump station construction (Figure 7)
– Substation and power supply works (Figure 8)
– Construction of permanent access roads for the pump station and substation sites

Construction will be split into two pipeline construction Packages, with the pump station being a separate package of work.

The construction footprint of the pipeline will be 40m wide (reduced down to 20m wide a riparian zones and watercourse/waterway crossings) with access to the construction corridor via private properties as well as locally and state-controlled roads.

The pipeline will be laid in a continuous trench up to 5-6m deep with a surface width of 10m and a base width of 2.8m (see typical trench detail in Figure 9). The bottom of the pipeline will sit on bedding sand free from organic matter and compacted to a density of at least 70% (Zone A).

The bedding sand surrounding the pipeline (Zone B1) will also be free from organic matter and compacted to a density of at least 60% for normal construction and 70% under roadways.

The pipeline is to be overlain by trench spoil free from stones larger than 100mm and any construction waste (Zone C).

The trench fill is to be overlain with uncompacted topsoil (Zone D).

In areas with poor foundation or high-water table levels, Zone A will be underlain with 20mm nominal graded aggregate (Zone E), and Zone B1 will be replaced with imported granular material free from organic matter (Zone B2).

Figure 7 *Intake and pump station general arrangement*

Figure 8 *Substation and high voltage power supply*

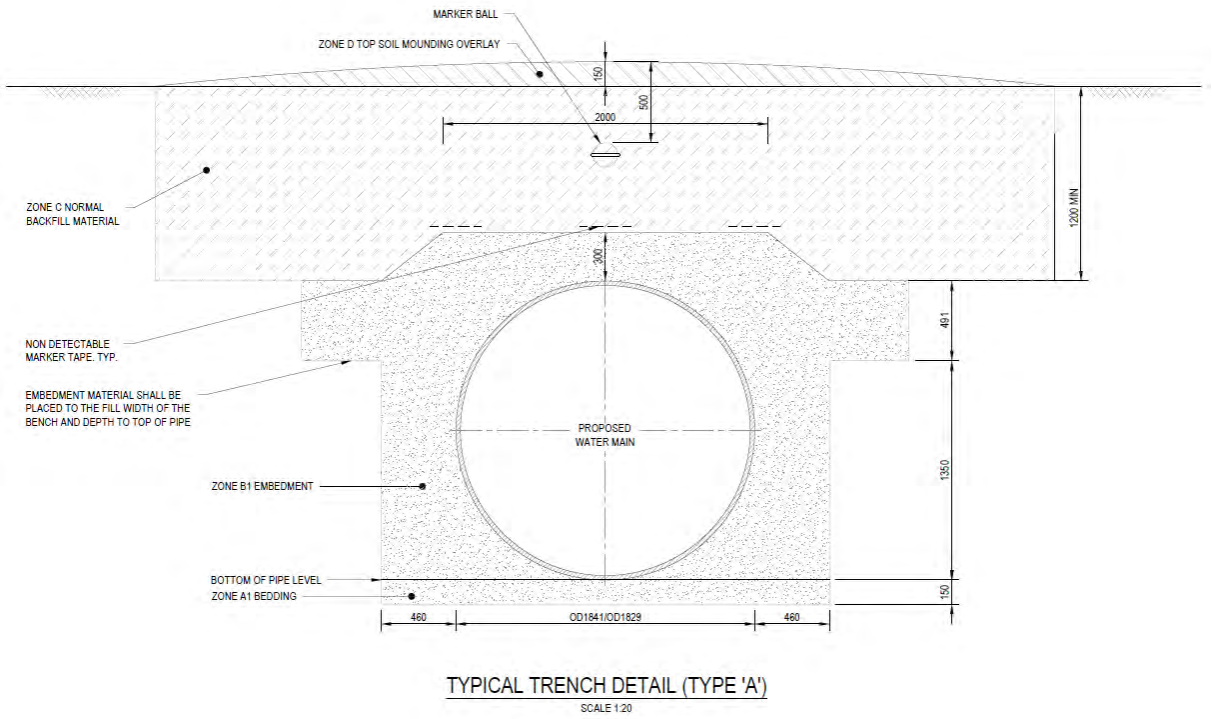


Figure 9 Typical pipe trench detail

4.3 Rainfall and erosion risk

Where construction activities are anticipated to result in exposure of bare earth, increased erosion and sediment control measures will be implemented to reduce potential runoff to sensitive areas. Table 8 and Table 9 show rainfall data for the site with an erosion risk rating that has been determined according to the criteria listed in Table 33 of IECA 2008 (refer to Table 10).

Table 8 Rocky Sugar Mill rainfall data (BoM 2021)

	January	February	March	April	May	June	July	August	September	October	November	December
Mean (mm)	18 1.4	175.2	96.9	32.5	25.6	21.0	17.5	7.2	7.6	14.6	29.5	88.2
Erosion risk rating	E	E	H	H	H	M	M	L	L	M	H	H

Key: E=Extreme, H = High, M = Moderate, L = Low, VL = Very Low

Table 9 Rocky Sugar Mill rainfall data (BoM 2021)

	January	February	March	April	May	June	July	August	September	October	November	December
Mean (mm)	252.3	192.7	113.6	54.7	28.5	18.2	30.9	12.4	9.3	14.6	31.4	75.6
Erosion risk rating	E	E	E	H	H	M	H	M	L	M	H	H

Key: H = High, M = Moderate, L = Low, VL = Very Low

Table 10 Erosion risk rating based on average monthly rainfall (IECA 2008)

Erosion risk rating [1]	Expected 24-hour rainfall	Average monthly rainfall
Very Low	0 to 2 mm	0 to 30 mm
Low	2+ to 10 mm	30+ to 45 mm
Moderate	10+ to 25 mm	45+ to 100 mm
High	25+ to 100 mm	100+ to 225 mm
Extreme	> 100 mm	> 225 mm

[1] Erosion risk rating based on worst case of expected rainfall within any 24-hour period or average monthly rainfall.

The works within waterways and low lying areas shall be completed outside the wet season. Where works are required during the wet season, they must not occur during heavy rainfall events to minimise the potential risk of soil erosion.

The construction Contractor shall ensure implementation of erosion and sediment controls and shall monitor rainfall forecast for the upcoming week. Rainfall exceeding 10 mm significantly increases erosion risk. Therefore, the Construction Contractor will be required to inspect that there are no unprotected exposed surfaces, and that all sediment controls are functioning and have the required capacity prior to predicted (greater than 50% chance) rainfall events of greater than or equal to 10 mm.

A Severe Weather Management Plan shall be developed by the Contractor to address the potential for flash flooding.

4.4 Preliminary erosion hazard assessment

An erosion hazard assessment form from the BPESC Guidelines was completed for each of the Haughton Pipeline construction packages. The forms are attached in Appendix B.

The erosion hazard assessment for each construction package of works is as follows:

– Construction Package 1 – 19
– Construction Package 2 – 19
– Pump Station Inlet Structure (Riparian Zone) – 24; and
– Pump Station site – 22.

This ESCP has been submitted to referral agencies as part of an Operational Works Development Application and the relevant approvals obtained as part of the planning phase due to the following erosion hazard assessment determinants:

– Disturbance to natural watercourses and waterways.
– Construction duration of more than 6 months; and
– Total hazard assessment score exceeding 17

5. Soil loss equation (RUSLE)

This section uses the IECA Best Practice Erosion and Sediment Control Guidelines (2008) to measure the soil erosion hazard and soil erosion risk to determine the appropriate controls to be implemented. The soil erosion hazard and soil erosion risk demonstrate:

– How much soil is at risk of being eroded (rainfall calculations)
– How much soil is lost over certain catchments (soil erodibility calculations).

The calculations for each catchment shall be attached with site-specific ESCP to be developed by the Construction Contractor.

In order to calculate the soil erosion hazard and the soil erosion risk, the Revised Universal Soil Loss Equation (RUSLE) from *IECA 2008, Appendix E, page E.3* was used using the following formula:

$$A = K \times R \times LS \times P \times C$$

Where:

– A: is the predicted soil loss per hectare per year
– K: is the soil erodibility factor
– R: is the rainfall erosivity factor
– LS: is the slope length/gradient factor (varies for each catchment)
– P: is the erosion control practice factor (1.3)
– C: is the ground cover and management factor (default value of 1 adopted) or 0.1 for sections of road having asphalt/bitumen stripped but base course layers remain.

The Soil Loss from each catchment can be set a nominal Control Type (1-3) from Table 14.

5.1 Soil erodibility factor (K Factor)

The K-Factor is a measure of the resistivity to erode of soil to the energy of rain. It is a parameter that effects the total soil loss as it increases. Generally, the particle distribution is the main factor in the measurement, therefore can be carried out in a laboratory.

Soil testing was undertaken as part of the soil assessment for this project but it did not specifically include testing for a K-facto value. As some Emerson testing was carried out to adjust for dispersive soils, K-factors should be increased by 20% for all Emersion Aggregate Class 1 and 2 soils (Landcom, 2004). The adoption of a conservative K factor of 0.040 +20% to equal 0.048 was estimated by using the default value in *Table E4 of IECA (2008).*

It is noted that the values adopted for this assessment have been used for planning purposes only. The Construction Contractor shall undertake assessment of the soil types and extents when considering the proposed works methodology and construction staging.

5.2 Rainfall erosivity (R Factor)

R-factor is a measurement of the energy associated with rainfall events, i.e. The erosive energy of the median rainfall for the area. The R-factor can be found in *IECA Best Practice Erosion and Sediment Control Guidelines (2008) , Picton, NSW. Table E1-E2. Pg E5*, or calculated using the methodology for estimating R factors from rainfall intensity *IECA, 2008, Best Practice Erosion and Sediment Control. International Erosion Control Association (Australasia), Picton, NSW. Appendix E, page E.3*.

The first method provides a R-factor (for Townsville) of → 9790

The second method calculates the R factor. The relevant formula is:

R = 164.74(1.1177)S S x 0.6444

Where:

R = Rainfall erosivity (MJ.mm/ha.h.yr)

S = 2 year ARI (equivalent to the 0.5EY) 6 hour rainfall event (13.6mm/hr for the site) sourced from BOM IFD for -19.7949 (S), 147.1632 (E).

Based on this data, rainfall erosivity (R factor) of 4022 (MJ.mm/ha.t.yr) was calculated for the project area. The most conservative R-factor value should be used to determine worst case scenario. The project will use the R-factor value of 9790.

5.3 Slope length and slope gradient (LS Factor)

This factor is a combination of the length (L) and steepness (S) of a slope. The way the formula uses this number is to assume that the whole catchment has this ratio. For safety generally the highest LS factor for the catchment is used. This gives the worst possible case of soil loss.

Within the project this will be calculated per local catchment.

5.4 Erosion practice and cover (P and C – Factors)

The P-factor refers to Erosion Control Practice. This allows the user of the formula to adjust the total soil loss as a factor based on practices the erosion control with regards to the compactness of the ground. The industry standard for construction is default at 1.3, defined as ‘Compacted and smooth’ IECA 2008, Table E11.

The C-Factor is a function of cover over the soil. It represents methods for controlling erosion other than altering the soil. As standard practise there is no cover while areas are under construction.

5.5 Calculated soil loss and ESC design

Calculated soil loss (RUSLE) and the associated erosion risk was used to determine the minimum sediment control standard required for implementation during the construction phase of the project. The sediment control standards for the project area according to IECA (2008) are presented in Table 13 and Table 14. Type 1 means the catchment requires a sediment basin to treat the runoff, Type 2 catchments require a Rock Filter Dam or similar and Type 3 require a silt fence or similar. These design criteria are detailed in Table 14.

An example soil loss exercise was carried out in Table 11 based on a 500m section of corridor on a slope of 3%, 5%, 10% and 15%. This represents a very low, low, medium and high risk as per Table P4 -Erosion risk parameters and suggested ratings from Appendix P – Pipeline constructions. It should be noted that the soil loss estimate is not considered representative of actual annual soil loss for the project area and should be used rather as indicator of potential erosion risk and a link between risk and controls. If at any time circumstances affecting the above factors should change, a reassessment should be conducted immediately.

Table 11 Example soil loss for 500m length of corridor

Catchment #	1-1	1-2	1-3	1-4
Catchment size (m2)	20000	20000	20000	20000
Slope Length (m)	40	40	40	40
Slope Gradient (%)	3%	5%	10%	15%
LS-factor	0.47	0.80	1.75	2.79
Soil Loss (t/ha/yr)	9.06	15.41	33.72	53.75
Soil Loss (t/yr)	18.11	30.83	67.43	107.50
Type of control required	Type 3	Type 3	Type 3	Type 3

The Construction Contractor shall calculate a soil loss estimate for each catchment and determine the required sediment control technique listed in the site-specific ESCP.

5.5.1 Design requirements

5.5.1.1 Drainage controls

The project timeframe will determine the design criteria shown in Table 12. The design for temporary drainage structures shall be calculated to have capacity based on the correlating event (IECA, 2008a). Specific design requirements for other structures shall be as per Table 12. These are the current standards from these documents which have been developed.

Table 12 Design requirements for drainage and sediment structures

Structure	Lifetime		
	0 – 12 Months	1 – 2 Years	+2 Years
Drainage controls Diversion drains Channels Batter chutes	39.3 % AEP (2 year ARI)	18.13% AEP (5 year ARI)	~10% AEP (10 year ARI)
Temporary Culvert Crossing	Minimum 1 in 1 year ARI hydraulic capacity wherever reasonable and practicable		

(Department of Main Roads and Transport, 2018) (IECA, 2008a)

Note: Design capacities do not included freeboard.

5.5.1.2 Erosion and sediment control standard

Unless otherwise stated in the contract for the works, Table 13 and Table 14 from IECA (2008) should be accepted for Erosion and Sediment control standards. The table based on monthly rainfall was used so an easy comparison could be made with the weather data shown in the future sections.

Table 13 Erosion risk rating

Erosion risk rating	Average monthly rainfall depth (mm)
Very Low	0 to 30
Low	30+ to 45
Moderate	45+ to 100
High	100+ to 225
Very High	>225

(IECA, 2008d)

Further to the erosion rating the following sediment control standards should be used to assess each catchments required control.

Table 14 Sediment control standard

Area Limit (m^2)[1]	Soil loss Rate Limit (t/ha/yr)[2]			Soil Loss Rate Limit (t/ha/month)[3]		
	Type 1	**Type 2**	**Type 3**	**Type 1**	**Type 2**	**Type 3**
250	N/A	N/A	[4]	N/A	N/A	[4]
1000	N/A	N/A	All Cases	N/A	N/A	All Cases
2500	N/A	> 75	75	N/A	> 6.25	6.25
> 2500	> 150	150	75	> 12.5	12.5	6.25
>10,000	>75	N/A	75	>6.25	N/A	6.25

Notes: [1] Area is defined by the catchment area draining to a given site discharge. Sub-dividing a given drainage catchment shall not reduce its 'effective area' if runoff from these sub-areas ultimately discharges from the site at the same general location. The 'area' does not include any 'clean' water catchment that bypasses the sediment trap. The catchment area shall be defined by the 'worst case' scenario, i.e. the largest effective area that exists at any instance during the soil disturbance.

[2] Soil loss defines the maximum allowable soil loss rate (based on RUSLE analysis) from a given catchment area. A slope length of 80 m should be adopted within the RUSLE analysis unless permanent drainage or landscape features reduce this length.

[3] RUSLE analysis on a monthly basis shall only apply in circumstances where the timing of the soil disturbance is/shall be regulated by enforceable development approval conditions. When conducting monthly RUSLE calculations, use the worst-case monthly R-Factor during the nominated period of disturbance.

[4] Refer to the relevant regulatory authority for assessment procedures. The default standard is a Type 3 sediment trap.

[5] Exceptions to the use of sediment basins shall apply in circumstances where it can be demonstrated that the construction and/or operation of a sediment basin is not practical, such as in many forms of linear construction where the available work space or Right of Way does not provide sufficient land area. In these instances, the focus must be erosion control using techniques to achieve an equivalent outcome. The 'intent' shall always be to take all reasonable and practicable measures to prevent or minimise potential environmental harm.

(IECA, 2008c)

All the above design requirements are required to guide the implementation of this ESCP.

5.5.2 Performance requirements

Performance requirements shall be used to give an indication if the applied controls are meeting standards set out in the contract and/or relevant legislation. The main indicator this section shall cover is the monitoring of directly impacted waterways and water at the point of discharge off site. This will be an evidence based approach to ensure any downstream impacts to listed threatened species and communities is mitigated.

The locations and parameters of monitoring shall be catered to the scope and sensitivity of the project and shall include considerations such as:

– Existing habitat (before during and after storm events)
– External sources of pollution (sediment or otherwise)
– Local issues regarding water quality
– Potential conservation significant species
– Receiving waters
– Erosion risk of the project area
– Type of pollutant most likely to be released from project area
– Downstream (off-site) controls (grasslands and basins)
– Concerns of local landholders/community.

The Healthy Waters Management Plan is a planning mechanism to improve the quality of Queensland water. It aims to meet the requirements set out in *the Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP(W)P), which is subordinate legislation under the EP Act. The EPP(W)P includes environmental values (EV) and water quality objectives (WQO) for waters within Queensland.

During the construction phase of the Project, off-site surface water releases must comply with the design objectives outlined in Table 8.2.1 of the Queensland Water Quality Guidelines (QWQG) 2009, which details currently used stormwater quality design objectives for development in Queensland, as

well as the compliance criteria outlined in Section 8.2.2 of the MRTS51 Environmental Management Technical Specification. The design objectives established to protect EVs during construction are shown in Table 15.

Table 15 Summary of discharge design objectives

Description	QWQG 2009 design objectives[1,9]
Intent	To protect water EVs by minimizing hydrologic disturbance and the loads of contaminants in runoff.
Pollutant/Issue	Stormwater design objectives[2]
Coarse Sediment	Retain coarse sediment on site.
Fine Sediment (Total Suspended Solids – TSS)	Take all reasonable and practicable measures to collect all runoff from disturbed areas and drain to a sediment basin – up to the design storm event.[3] Site discharge during sediment basin dewatering complies with a TSS concentration less than 50 mg/L up to the design event – flocculation as required. In storms greater than the design event take all other reasonable and practicable measures to minimise erosion and sediment export.
Turbidity	Released waters from the approved discharge point(s) have turbidity[4] (NTU) less than 10% above receiving waters turbidity – measured immediately upstream of the site.
Nutrients (N and P)	Manage through sediment control.
pH	Acceptable site discharge pH range 6.5 to 8.5[5]
Litter or other Waste	Prevent litter/waste entering the site or the stormwater system or internal watercourses that discharge from the site – minimise on-site production, contain on-site and regularly clear bins[6].
Hydrocarbons and other contaminants[7]	Prevent from entering the stormwater system or internal watercourses that discharge from the site – control storage, limit application and contain contaminants at source. Waste containing contaminants must be disposed of at authorised facilities. Store oil and fuel in accordance with Australia Standard AS1940 – no visible oil or grease sheen on released waters.
Wash down water	Prevent from entering the stormwater system or internal watercourses that discharge from the site.
Cations and anions	As required under an approved Acid Sulfate Soil Management Plan, including aluminium, iron and sulfate.
Stormwater drainage/flow management	Take all reasonable and practicable measures[8] to minimise changes to the natural waterway hydraulics and hydrology from: - Peak flow for the 1-year and 100-year ARI event (respectively for aquatic habitat and flood protection) - Runoff frequency and volumes entering receiving waters Uncontrolled release of contaminated stormwater.
Dissolved Oxygen	N/A

Table notes:

1. For small scale construction sites (defined as disturbance area less than 2500 m^2) and independent of a larger common development, the implementation of best practice environmental management should be in accordance with the Queensland Development Code, local government planning scheme requirements (including any deemed to comply provisions) and Draft urban stormwater – Queensland BPEM guidelines Appendix 1 'Model Provisions for Best Practice Erosion and Sediment Control'.
2. Compliance release limits for rainfall events less than the design storm event – (based on the design rainfall event of 80%ile five day rainfall depth for developments involving land disturbed less than six months, and 85%ile for longer disturbance).

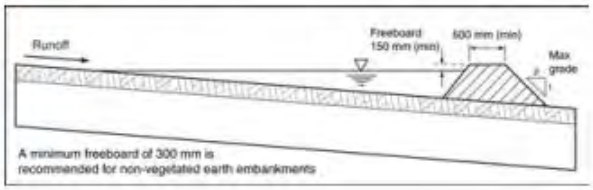
3. For sites with disturbance greater than one hectare, drain such area to a sediment basin where practicable. See Table 6.3 of Urban Stormwater – Queensland BPEM guidelines and IECA 2008 for details.
4. A site-specific relationship should be developed between turbidity and suspended solids, prior to the commencement of construction on large and medium scale construction sites. Background refers to receiving waters immediately upstream of site waters release points.
5. Note the range may be further limited to prevent mobilisation of specific elements.
6. Avoid wind blown litter; remove gross pollutants.
7. See the prescribed contaminant list in the *Environmental Protection Regulation 1999.*
8. Including making best use of constructed sediment basins to attenuate the discharge of stormwater from the site.
9. Source: Draft urban stormwater – Queensland best practice environmental management guidelines, 2009.

5.5.3 Evidence of best practice success/implementation

Flow diversion bank

Flow diversion banks

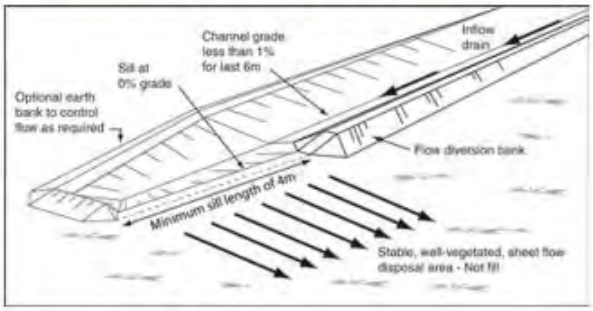
- Flow diversion banks are typically used for the diversion of flows when in-situ subsoils are dispersive or otherwise highly erodible.
- They may be formed from the stripped topsoil as an alternative to stockpiling.



Level spreader used to release road runoff into the adjacent farmland

Level spreaders (LS)

- Level spreaders are used at the end of *Flow Diversion Banks* and *Catch Drains* to discharge minor flows down stable, grassed slopes, or into bushland.
- They can also be used to discharge road runoff into grassland or bushland.



Sandbag check dam

Sandbag check dams (SBC)

- Sandbag check dams are typically used in drains less than 500 mm deep, with a gradient less than 10%.
- These check dams are typically small (in height) and therefore less likely to divert water out of the drain compared to rock check dams.
- Sandbag check dams can also be used as a temporary (supplementary) sediment trap.

Check dam sediment trap

Check dam sediment traps (CDT)

- A supplementary sediment trap.
- Check dams can be used as minor sediment traps to supplement the site's primary sediment control system.
- Typically used in table drains during the revegetation phase.
- Check dams may be constructed from rock, sand bags, or compost-filled socks.
- Compost-filled socks can adsorb some dissolved and fine particulate matter.

Rock filter dam - geotextile filter

Rock filter dam - geotextile filter (RFD)

- A Type 2 sediment trap
- Rock filter dams are used in locations where it is impractical to construct a formal *Sediment Basin*.
- The critical design parameter is the surface area of the settling pond, which must be maximised.
- The incorporation of filter cloth is the preferred construction technique if the removal of fine-grained sediment is critical.

Excavated sediment trap

Excavated sediment trap (EST)

- A Type 2 or 3 sediment trap
- Excavated sediment traps are often combined with *Rock Filter Dams.*
- **Caution;** placing an excavated pit immediately up-slope of an 'aggregate filter' may reduce the filtration performance of the rock filter dam.
- Placing an excavated pit immediately up-slope of an 'geotextile filter' will help to reduce blockage of the filter, and thus should extend the effective operation life of the sediment trap.

Rock check dam

Rock check dams (RCD)

- Rock check dams should **only** be used in drains at least 500 mm deep, with a gradient less than 10%.
- They should only be used in locations where it is known that they will be removed once a suitable grass cover has been established within the drain.
- Can also act as minor sediment traps.
- Rock check dams can be used as a permanent velocity-control device and/or sediment trap in non-vegetated, earth-lined drains (check with road authority).

Mulch berm

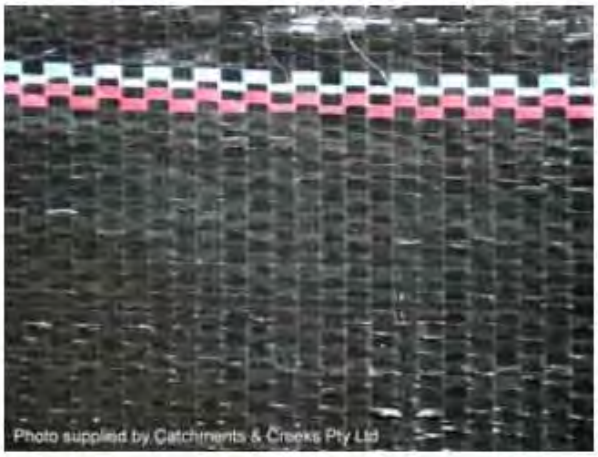
Compost berms (CB)

- A Type 2 sediment trap.
- Sheet flow conditions only.
- Suitable for all soil types.
- Compost berms may either be free standing or contained within a sock (*Filter Sock*).
- Can perform better than a traditional sediment fence, but only while the berm remains undamaged (e.g. by construction traffic or shifting material).

Mulch berm

Mulch berms (MB)

- A Type 2 sediment trap.
- Mulch berms are suitable for all soil types.
- The mulch must be produced through the use of tube grinders or the like, but **not** by chipping. The mulch needs to be very fibrous with the woody splinters allowing good interlocking. The mulch should not appear as clean cut (i.e. chipped by blades).
- Mulch and compost berms can act as both a drainage control system, and a sediment control system.



Woven sediment fence fabric

Woven sediment fence

- A Type 3 sediment trap.
- Sheet flow conditions only.
- Woven fabrics (left) are generally suitable for all soil types, but sediment capture is limited to the coarser sediment fraction.
- The traditional woven fabrics are generally preferred on long-term construction sites that are likely to experience several storm events.

Temporary pipe culvert

Temporary culvert crossings (TCC)

- Temporary culvert crossings are typically used on wide stream crossings.
- They are best used when fish passage is not critical; however, suitable fish passage can be achieved through appropriate design.
- Recycled steel pipes (left) are most commonly used.

Ford crossing or alluvial stream

Temporary ford crossings (TFC)

- Ford crossings are used on 'dry' creek and river crossings when stream flows are not expected. The regular crossing of 'wet' creek beds (left) by construction vehicles should be avoided.
- These crossings are typically used in shallow, intermittent streams that are expected to have negligible base flow during the construction period.
- *Cellular Confinement Systems* can be used to stabilise dry, sandy bed crossings.

Isolation barrier

Isolation of disturbances from stream flow

- Wherever practical, priority should be given to the use of instream flow diversion systems that successfully isolate all soil disturbances from stream flow.
- Isolation barriers can be formed from sediment fence fabric (flow depth < 0.8 m), floating silt curtains (depth > 0.8 m), large water-filled rubber dams, and sheet piling.
- Photo (left) shows a non-woven composite sediment fence (adjacent bank) forming a coarse sediment trap, with a woven fabric (adjacent stream channel) forming a quiescent, fine sediment, settling pond.

Bank rehabilitation

Erosion control measures

- All disturbed surfaces, bed, banks and overbank areas, must be appropriately rehabilitated as soon as practical.
- Temporary erosion control measures include the use of rock (along the toe of the bank), 100% biodegradable erosion control blankets, and native vegetation.
- Alternatively, *Jute Logs* may be incorporated into the toe of the bank to protect newly stabilised banks from minor flows.

Filter tube

Filter tubes (FT)

- Commercial filter tubes are suitable for the treatment of low to medium flow rates.
- The filter tubes collect only coarse-grained sediments, within minimal control of turbidity.
- It is important to ensure that there are suitable means of collecting and removing the filter tubes once full of sediment.
- Placing the filter bag up-slope of a substantial grass filter bed (*Buffer Zone*) can improve the collection of fine sediments and turbidity control.

Rock pad

Rock pads

- Suitable for all soil types.
- The critical design parameter is the total void spacing between the rocks.
- Minimum 10 m length for single dwelling building sites, and 15 m for construction sites.
- Generally perform better than *Vibration Grids* during wet weather.
- Drainage controls (e.g. cross bank) may need to be incorporated into the rock pad to direct sediment-laden runoff to an appropriate sediment trap.

Vibration grid

Vibration grids

- Vibration grids are best suited to sandy soils.
- Can also be used in clayey soil regions to control sediment movement from heavy construction traffic during dry weather.
- A rock pad must extend from the vibration grid to the sealed road surface.

Site signage

Environmental and safety controls

- It is important to ensure trucks and other construction equipment leaving the site do not transport sediment or rocks onto public roads.
- Rock of a size 75 to 100 mm can become wedged between dual tyres and transported off the site.
- Where appropriate, place signs to remind drivers to check their loads, tie ropes, and covers.

Hydromulching

Hydromulching

- Hydromulching can be used for grass establishment and the protection of newly seeded areas.
- Best used on slopes <10% and slopes with a vertical fall of less than 3 m.
- Hydro-mulched surfaces generally have higher watering requirements than surface treated with straw mulch.
- Tackifiers incorporated into the mix are normally water soluble and thus easily disturbed by heavy rainfall and concentrated overland flows.

Temporary grass cover

Temporary seeding (TS)

- In certain situations, a rapid and complete cover of 'annual grasses' can act as an effective, well-anchored mulch on embankments, batters and table drains.
- Even if the grass is allowed to die-off immediately after establishment (left), the surface can still provide effective erosion control, thus avoiding the need for ongoing watering.
- Can be a useful technique in rural and semi-arid areas.

Bush mulch

Bush, bark and woodchip mulch (BM)

- Bush mulch is typically used on garden beds, and for the temporary protection of exposed soils prior to the completion of earthworks or other construction activities.
- **Caution**; some wood-based (woodchip) mulches can reduce nitrogen levels within the soil.

Jute blanket

Biodegradable blankets

- Organic-based blankets have low shear strength, and thus a low allowable flow velocity.
- Critical performance parameters include their ability to control raindrop impact and sheet erosion of the underlying soil.
- The key to successful revegetation in association with these blankets is:
  - good soil condition
  - good surface preparation, and
  - intimate contact between the blanket and the soil (i.e. no 'tenting')

Jute mesh

Open mesh-type blankets

- A 'mesh' is an open weave blanket made from rope-like strands such a hessian (jute) or coir rope.
- Typical design life in dry environments of 12 to 24 months.
- Jute blankets have a service life similar to that of a hessian bag placed on the ground (i.e. approximately 3 months).
- Coir blankets (made from coconut fibres) have a service life similar to that of a common domestic doormat placed directly on the ground.

Application of soil binders

Soil binders (SBS)

- Soil binders are typically used for dust control of unsealed roads and mining operations.
- Selection of product depends on the potential environmental impacts, trafficability and longevity.
- The application and success of soil binders vary from region to region.
- Usually best to trial various measures and learn from experience.

Water truck

Water trucks

- Water trucks can be used for dust control of unsealed roads and access tracks.
- Dust levels can also be controled by minimising site traffic and the movement of site traffic outside designated areas.
- The addition of wetting agents and polymer binders (*Soil Binders*) to the water can decrease both the water usage and the required application frequency.

Gravel-stabilised car park

Gravelling (GRAVEL)

- Typical uses of gravelling include:
  - protection of non-vegetated soils from raindrop impact erosion
  - stabilisation of site office area, temporary car parks, and access roads
- Where appropriate (e.g. long-term construction sites) gravelling can also be used to minimise soil compaction and the generation of excessive mud around car parks and the site compound.

Recently stabilised area

Revegetation (R)

- The best way to control soil erosion is to promptly revegetate all disturbed areas.
- This technique includes turfing and temporary seeding.
- At least 70% ground cover (combined plant and mulch) is considered necessary to provide a satisfactory level of erosion control.

6. Erosion and sediment controls

6.1 General

The Contractor is responsible for implementing all erosion and sediment control measures and these must be implemented in accordance with best practice principles. A range of control measures are available for use across the project site, and those recommended in this section are based on the IECA '*Best Practice Erosion and Sediment Control*' documents (2008), and more specifically Appendix P: Land-based Pipeline Construction of the IECA,2008 document. The selection and implementation of appropriate ESC measures is dependent on several factors including the anticipated disturbance duration, slope, soil characteristics and availability of materials etc.

The following are the suggested erosion and sediment control measures for the HPS2 Project. Standard drawings have been sourced from BPESC guidelines and referred to in Appendix D of this report. Reference is made to Appendix P: Land-based Pipeline Construction of the BPESC guidelines which provides additional guidance and alternative treatment options during construction.

Where practicable, the soil erosion hazard on the site shall be kept as low as possible. The staging of works, and therefore the amount and duration of the soil disturbance will be minimised to limit the exposure of the site to erosion hazards.

All erosion and sediment controls will be designed by a suitably qualified engineer and installed within the project boundary. All erosion, sediment and drainage control measures must remain in place until all construction works are completed and surfaces are stabilised and rehabilitated.

6.2 Environmental Management Plan (EMP) framework

The construction Contractor shall be required to prepare additional, site specific environmental management documentation, inclusive of procedures, protocols and Environmental and Safe Work Method Statements compliant with these requirements. The construction Contractor is responsible for implementing all erosion and sediment control measures, and these must be implemented in accordance with best practice principles. The erosion, sediment and drainage control measures set out in this section are applicable across the entire Project site.

Erosion, sediment and drainage control measures that are required only for the construction phase of the Project will remain in place until the applicable construction works are completed and surfaces are stabilised and rehabilitated. The timeframe for such controls will vary as the Project construction phase is expected to take around 22 months, with a staged approach across the entire alignment.

Some erosion, sediment and drainage control measures are an integral part of the pipeline infrastructure and will remain in place permanently, namely those associated with permanent infrastructure.

6.3 Approvals and training

All necessary environmental approvals shall be obtained prior to the commencement of the construction program.

The project will require a number of training methods to be implemented by the Construction Contractor including:

– All personnel must attend a project site specific induction prior to commencing any work on the site, where general erosion and sediment control and water quality matters will be highlighted, together with responsibilities under relevant legislation.

– Toolbox meetings shall be conducted regularly (at least weekly) to address numerous issues related to operations, safety, the environment etc. Issues relevant to the stage of construction are to be highlighted.
– Formal training covering awareness of soil and water related issues and additional advanced training will be delivered to relevant personnel.

6.4 Construction staging and timing

The Contractor shall be responsible for determining appropriate construction staging.

The works schedule(s) shall take into consideration the expected and predicted rainfall forecast for the region. Clearing and rehabilitation activities shall aim to avoid periods of predicted significant rainfall. These factors are of the greatest importance when works are programmed to occur within or adjacent to sensitive areas, i.e. works near waterways or access tracks traversing waterways. Clearing and rehabilitation activities shall be halted during periods of significant rainfall, and appropriate temporary control measures may be required to be implemented and closely monitored during these events.

The Contractor shall ensure implementation of erosion and sediment controls and shall also keep a record of rainfall forecast for the following week. Rainfall events in excess of 10 mm significantly increases erosion risk. Therefore, the Contractor will have to ensure that there are no unprotected exposed surfaces, and that all sediment controls are functioning and have the required capacity prior to predicted (greater than 50% chance) rainfall events of greater than or equal to 10 mm.

In addition, the following also applies:

– Proposed temporary access tracks are to be marked out. Where re-grading of waterway banks is required, exposed banks are to be covered/stabilised as soon as practicable with appropriate documented scour protection works .
– Progressive stabilisation of work areas and disturbed areas in accordance with permanent stabilisation treatments, as soon as practicable.

6.5 Drainage control

The primary functions of drainage control measures are to minimise the risk of erosion, minimise the risk to the adopted erosion and sediment control measures, control the velocity and location of water flowing through the site, and to appropriately manage ‘clean’ and ‘dirty’ water flows through the site.

The proposed measures for the Project are as follows:

– During all phases of construction, the management of upstream waters must be considered and appropriately managed. Upstream water must be either diverted, bunded or pumped through the Project during periods of low flows. During periods of high flows, the Contractor must ensure upstream flows are diverted via stabilised drainage paths
– Provide diversion works (clean water diversion bunds/drains) to direct clean water flows from external catchments upslope of the proposed construction area towards existing discharge points, where possible. Diversion drains are to be constructed as trapezoidal bunds or channels and appropriately lined to minimise the risk of scour occurring
– Provide diversion works (disturbed diversion drains) to direct dirty water flows from internal catchments towards sediment treatment devices, for off-site discharge
– Provide mid slope diversion bunds to minimise rill erosion and divert runoff to more formalised diversion drains, which contain rock check dams at regular intervals to control flow velocity
– Provide temporary diversion topsoil bunds upslope of stockpile locations
– Sediment weirs or rock check dams are to be placed within exposed diversion and drainage channels at appropriate intervals, where required, to reduce runoff velocities and minimise soil erosion caused during rainfall runoff events.
– Unsealed access tracks must allow stormwater to shed at regular intervals with runoff released as sheet flow via a level spreader (standard drawing provided at Appendix D) into adjacent

grass/bushland or riparian zone (if adjacent a water course). Stormwater must also be able to freely discharge from unsealed roads preferably via outfall drainage). If outfall drainage is installed, any “windrows” that develop along the down-slope side of the track need to be removed.

All drainage control measures must be designed in accordance with Section 4.3.1 of the BPESC Manual.

6.6 Erosion control

6.6.1 Site access

The movement of vehicles around and between construction sites is to be limited to the access and haulage tracks as much as possible.

6.6.2 Minimise disturbance area

Installation of barrier fencing, sediment fencing or Flow diversion banks, as per standard “Sediment Fence SF-01 & SF-02” or “Flow Control Berms CB-01 & DB-01” Appendix D, must be employed to clearly define the limits of works and any “No-Go” zones to minimise or prevent access by personnel or vehicles. Temporary fencing or barricading such as para webbing or perimeter tape is to be utilised on the cleared perimeter with accompanying signage. Site inductions and toolbox meetings must include the importance of observing “No Go” zones, particularly in areas near to any identified sensitive area.

6.6.3 Vegetation clearing

Any vegetation to be retained shall be clearly marked to mitigate the risk of accidental clearing occurring. Where vegetation clearing is necessary, any cleared native vegetation shall be mulched and/or retained for use on site such as to provide a temporary blanket as erosion control on cleared areas. Vegetation clearing adjacent to and within watercourses and waterways shall be reduced to a 20m wide construction corridor and delayed until absolutely necessary. Progressive stabilisation where appropriate and rehabilitation of disturbed riparian areas shall occur as soon as possible after the completion of earthworks and trenching activities.

If vegetation clearing is required to be carried out well in advance of earthworks, the Contractor shall aim to remove only woody vegetation leaving the understory growth. Grubbing and removal of ground cover and understory is to be delayed until immediately prior to earthworks occurring within that stage of works.

Any mulch that is generated from the clearing activities may be used as temporary ground cover however must be placed in a manner that is unlikely to result in mulch entering adjacent waterways.

6.6.4 Groundcover and surface treatments

Rehabilitation and the establishment of low-growing ground cover vegetation can be one of the most effective forms of permanent erosion controls (IECA 2008). Vegetation and groundcover increase surface roughness slowing stormwater runoff, protects the soil against raindrop impact, and reduces the evaporation losses from the underlying soil.

Refer to Table 4.4.7 of the BPESC Manual for best practice measures associated with site rehabilitation depending on the erosion risk based on monthly erosivity (very low – extreme).

Key stabilisation requirements for the project are as follows:

– Stripped topsoil must be reinstated as soon as possible after the completion of earthworks and trenching activities

– Exposed soils, particularly around drainage channels, are to be stabilised and covered with a suitable temporary cover material, such as soil binder as soon as practicable following earthworks in the immediate area.
– A success criterion for ground cover is a minimum of 75% cover.

6.6.5 Construction Entry/Exists

Stabilised entry and exit points shall be established to minimise the risk of construction and site personnel vehicles transporting sediment onto public access roads. Stormwater runoff from access roads and stabilised entry/exit points shall drain to an appropriate sediment control device. The site entry/exit points shall be constructed in accordance with the best practice sediment control measures for construction site entry/exit points presented in Section 4.5.10 of the IECA Manual. Dumped rock or vibration grids may be used at key access points to the site i.e., stockpile sites and laydown areas.

If sediment is transported onto a public road adjoining the project area, supplementary street sweeping may be required and will remain the responsibility of the Contractor.

6.7 Sediment control

6.7.1 General

Sediment control techniques shall be applied across the disturbed areas to limit mobilisation of and settle mobilised soil particles across the site. Sediment control techniques slow the movement of water and allow the influence of gravity to settle out particles before discharging into the receiving environment.

The minimum sediment control standard is determined based on the erosion risk of the site (IECA 2008), which the Contractor is required to complete as part of the site specific ESCP.

6.7.2 Dust suppression

The most effective control measure against wind erosion is through rehabilitation and revegetation of disturbed areas, however during construction this is not reasonably practicable. In the interim, water tankers shall be employed to suppress dust on site during construction periods and other times as necessary. Exposed drainage channel surfaces must be rehabilitated as soon as possible to minimise the potential environmental risk.

6.7.3 Sediment control standard

The minimum sediment control standard is determined based on the erosion risk of the site (IECA, 2008).

Based on the erosion risk, the assumed catchment areas, the preliminary erosion hazard assessment, the proposed timing of works and estimated project duration, as well as the receiving environments, ‘Type 2’ treatments may be required as the sediment control standard for the project. The timing and duration of works, as well as the Contractor’s construction methodology and staging may result in a lesser (or greater) sediment control standard. The Contractor shall therefore determine the appropriate sediment control standard for each disturbed area when developing the construction erosion and sediment control plans for the project.

6.7.4 Sediment control devices

Sediment control measures shall comprise the following, with relevant controls remaining in place until all exposed soil has been stabilised or permanent controls have been constructed:

– Clean water diversion bunds/drains upslope of construction works, where appropriate, to divert undisturbed runoff around the project area

– Disturbed diversion drains along the downslope of all earthwork activities to direct runoff to appropriate sediment controls, prior to off-site discharge
– Rock check dams within all stabilised diversion channels, with sediment weirs within the main drainage channel, to reduce flow velocity and encourage sediment fall-out
– Sediment fencing at the base of small and isolated catchment areas to treat runoff
– Type 2 sediment controls, such as rock filter dams or excavated sediment trap, at the concentrated off-site discharge locations to treat disturbed runoff prior to off-site discharge.

6.7.5 Stockpiles

All stockpiles (uncontaminated material) are to:

– Be separated into soil and use types (topsoil to be kept separate to subsoil)
– Be located further than 40 metres from any waterway
– Be located at least one metre from site boundary fencing
– Not be located at the base of significant trees
– Be watered and or protected through effective erosion control emulsions (Vital Bon-Matt Stonewall or equivalent approved by CPESC), as required, to minimise dust emissions
– Have sediment fences (Appendix D) (where practicable) located down slope to minimise the risk of sediment laden runoff
– Be located up slope of the trench
– Be located down slope of the access track
– Be covered if significant rainfall is expected.

Note that cleared vegetation can be stockpiled on top of topsoil stockpiles so as to act as an additional erosion and sedimentation control (as-is or mulched).

6.8 Pipe trench management

To minimise the effects of erosion and sedimentation within the pipe trench, layout of the construction corridor (40m) should be as follows:

– Spoil stockpile adjacent to trench for ease of trench reinstatement
– Topsoil/vegetation stockpile adjacent spoil stockpile for ease of trench topsoil reinstatement (Note vegetation can be placed on top of topsoil to assist with controlling erosion/sedimentation, as-is or mulched)
– Diversion of clean water away from the trench/stockpiles through the use of sandbag (or other material e.g. spoil) flow diversion banks, as per standard “Flow Diversion Banks DB-01” in Appendix D (bank location dependent on grade of land)

In addition, the trench shall be managed as follows:

– The use of mulch berms will be implemented were available to prevent dirty water leaving the site, as per standard “Mulch Filter Berms MB-01” in Appendix D.
– If rainfall greater than 10mm is imminent, use sandbags to provide trench stops at 70m for flat trenches and 35m for trenches with a steep grade to limit flow length and velocities at the base of the trench; and
– In case dewatering of the trench is required, it will be achieved by employing a dewatering pump with discharge sediment control measures
– Following construction:
    - Trench is to be backfilled according to the requirements as set out in the engineering drawings “Trench Details”
    - Flow control berms are to be installed to reduce flow velocities of water near the trench centre line and help avoid scour problems and trench subsidence, as per standard “Flow Control

Berms CM-01” in Appendix D. Flow control berms can be formed by using sandbags and are to be constructed across the entire alignment at the following intervals:

– Slopes 1% and less – 90m interval
– Slopes between 1% and 2% - 70m interval
– Slopes between 2% and 3% - 50m interval
– Slopes between 3% and 4% - 40m interval
– Slopes greater than 4% - 25m interval

6.9 Pump station management

Permanent infrastructure is not anticipated to require extensive erosion, sediment or drainage control measures. These structures will undergo a detailed design process in which these factors are accounted for at an engineering design level. However, the following must be considered for the temporary control of erosion and sedimentation (during the construction phase).

6.9.1 Soil stabilisation

Specific control of erosion on the banks of the Burdekin River (approximate maximum of 10% grade) may consist of erosion control blankets, mats and/or mesh.

6.9.2 Sediment Control

Downslope sediment control treatments are to be installed to prevent sediment laden water affecting the receiving environment. Sediment fences and isolation barrier are to be installed on the banks of the Burdekin River to prevent sediment from land-based construction activities from entering the watercourse/waterway.

6.9.3 Drainage control

The following drainage controls must be considered:

– Provide diversion channels to direct undisturbed water flows from external catchments upslope of works areas towards existing discharge points.
– Provide diversion works (disturbed water channels) to direct disturbed water flows from ground disturbance catchments towards sediment treatment devices, where necessary.
– Rock check dams are to be placed within the cleared areas on slopes to reduce runoff velocities and minimise soil erosion caused during rainfall runoff events.

The following drainage control techniques are suitable for low-gradient slopes:

– Catch Drain
– Compost Berm
– Diversion Channel
– Flow Diversion Bank
– Straw Bale Flow Diversion Bank

Additionally, Level Spreaders or velocity controls will be used for release of water due to proximity to the Burdekin River and associated riparian zone.

Regarding velocity control structures for channels and drains, the following techniques may be utilised:

– Fibre Roll
– Rock Check Dam
– Sandbag Check Dam

The following channel and chute lining options should be considered:

– Cellular Confinement System
– Erosion Control Mat
– Rock Mattress
– Rock Lining

6.9.4 Instream works

The primary erosion and sediment controls for instream construction and removal of the pump station intake working platform should involve the use of a floating silt curtain (for deepest point greater than 800mm deep) or Sediment Fence Isolation Barrier (for deepest point less than 800mm deep) within the Burdekin River if the level of water and other conditions permit. This curtain/barrier will encapsulate the working platform and surrounding waters to catch and settle all sediment disturbed as part of the construction works. On land controls shall be arranged so that all water is controlled before discharge into the river. Where the floating silt curtain crosses the river and impacts fish passage, the floating silt curtain will only be in place during direct works in the waterway, i.e. construction of working platforms and access tracks (the Sediment Fence Isolation Barrier is unsuitable in this application). Details regarding Pump Station erosion and sediment controls will be developed in the Contractor's Erosion and Sediment Control Plan (ESCP).

6.10 Waterways

All works in and around waterways are to be designed and undertaken following Appendix I of the IECA Guidelines which details Instream Works. Contractors shall also refer to Appendix P – Pipeline Construction of the IECA Guidelines.

6.10.1 Pre-survey and reinstatement

Prior to commencement of any temporary waterway barrier works, invert levels of both waterway banks and grade of waterway bed must be surveyed to allow for proper reinstatement following pipeline construction and placement of pipe cover material. Waterways must be reinstated to pre-disturbance grades and levels to ensure unimpeded water flow as soon as practical after the completion of earthworks and trenching activities.

In addition to the above, the following management procedures shall also be adopted:

– If possible, works within waterways shall be undertaken during dryer months when heavy rainfall is not expected. Weather shall be monitored by the Contractor during the construction works to identify any specific weather related changes to ESC measures as necessary.
– Temporary waterway barrier works within waterways mapped as Queensland waterways for waterway barrier works are to be undertaken in accordance with the '*Accepted development requirements for operational work that is constructing or raising waterway barrier works'* (DAF 2018), including the requirement for pre and post work notifications.
– Permanent waterway barrier works that are accepted development within waterways mapped as Queensland waterways for waterway barrier works must be undertaken in accordance with the '*Accepted development requirements for operational work that is constructing or raising waterway barrier works'* (DAF 2018). If the proposed work does not comply with the accepted development requirements, or the work is not accepted development, a Development Approval must first be obtained under the *Planning Act 2016* and *Fisheries Act 1994*. The work must then be undertaken in accordance with the conditions of the Development Permit.
– Works within waterways where natural flow is persistent must maintain this flow through the waterway for the duration of works. This applies to waterways that are holding water if the waterway is classed as a fish passage. Temporary waterway barrier works must comply with the duration requirements under the '*Accepted development requirements for operational work that is constructing or raising waterway barrier works'* (DAF 2018). The amount of pipes/cross-sectional

area of culverts shall reduce the velocity as close to 0.3m/s as practicable (for low flow). Culverts shall be a minimum of 450mm and the crossing depth shall maintain a depth of 0.2m to 0.5m.

- To maintain fish passage, culverts can be used, however there must be enough to reduce the
- If fish become trapped by any waterway barrier works, fish salvage activities are to be undertaken immediately in accordance with the Fisheries Queensland Guidelines for Fish Salvage (available at www.daf.qld.gov.au). Any fish kills must also be reported to the DES on 1300 130 372.
- Access tracks, if required across waterways, are to be constructed of clean hard rock of adequate size (200mm diameter minimum) to withstand likely flows, placed over non-woven geofabric and with minimal placement of fine aggregate on the top surface. Any temporary culverts are to be sized according to DAF guidelines to maintain fish passage. Causeways are to be profiled to ensure stream flows minimise bank erosion. See Figure 10 and Figure 11. See also “Temporary Culvert Crossing TCC-01 and TCC-02” in Appendix D.
- If cofferdams are to be used when open pipe trenching through the waterway, these shall be constructed as per Figure 12. See also “Cofferdams (General) Dam-01” in Appendix D.
- Floating silt curtain (for deepest point greater than 800mm deep) or Sediment Fence Isolation Barrier (for deepest point less than 800mm deep) shall be used within waterways where sedimentation and high turbidity may occur as a result of construction works. See “Floating Silt Curtain FSC-01, FSC-02 and FSC-03” and “Sediment Fence Isolation Barrier SFB-01 and SFB-02” in Appendix D.
- Isolation Barriers can be used when the pipeline is being installed across a wide watercourse/waterway with contact dry weather flow and where increased channel flows are possible (see Figure 13). If the waterway is a listed fish passage, the isolation barrier may isolate no more than 30% of the stream width at any given time, as a first preference. If this is deemed unreasonable or impracticable, a maximum of 50% isolation may be given. Temporary waterway barrier works must also comply with the duration requirements under the ‘*Accepted development requirements for operational work that is constructing or raising waterway barrier works’* (DAF 2018).

Additionally, topsoil and vegetation stripped prior to commencement of the works must be reinstated as soon as possible in accordance with the Rehabilitation Management Plan for the Project and as part of the erosion and sediment control process.

6.10.2 Waterway with no flow

Waterways/watercourses which are mapped shall have controls designed from the relevant arrangement within P3.3 of IECA,2008 Appendix P regardless of if there is water in them or not. Access tracks shall be made from suitable material and does not need to comply with “Temporary Culvert Crossing TCC-01 and TCC-02” in Appendix D if not utilised when water is present. If access is sought while area is inundated or wet, then the access track shall comply with “Temporary Culvert Crossing TCC-01 and TCC-02” in Appendix D.

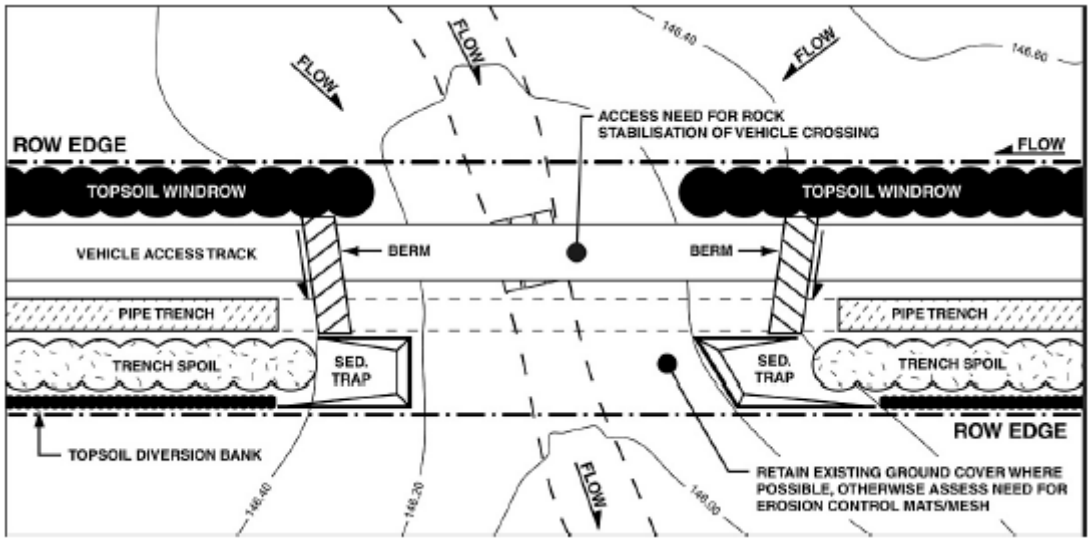


Figure 10 *Possible layout of pipe crossing of waterway with pipe trench located down-slope of the vehicle crossing (IECA, 2008)*

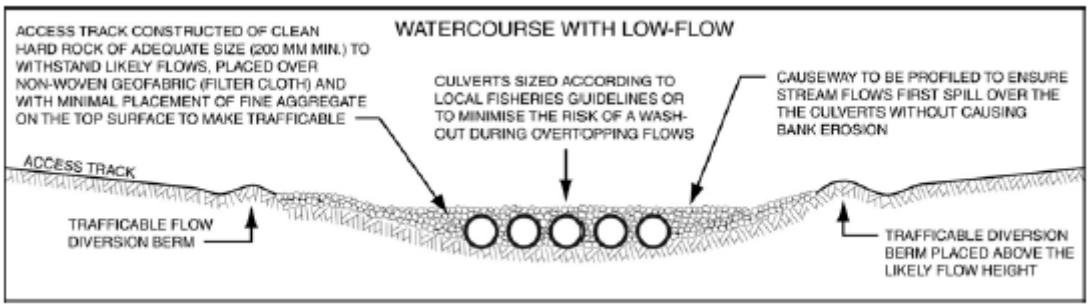


Figure 11 *Typical profile of temporary culvert crossing (cross-section) (IECA, 2008)*

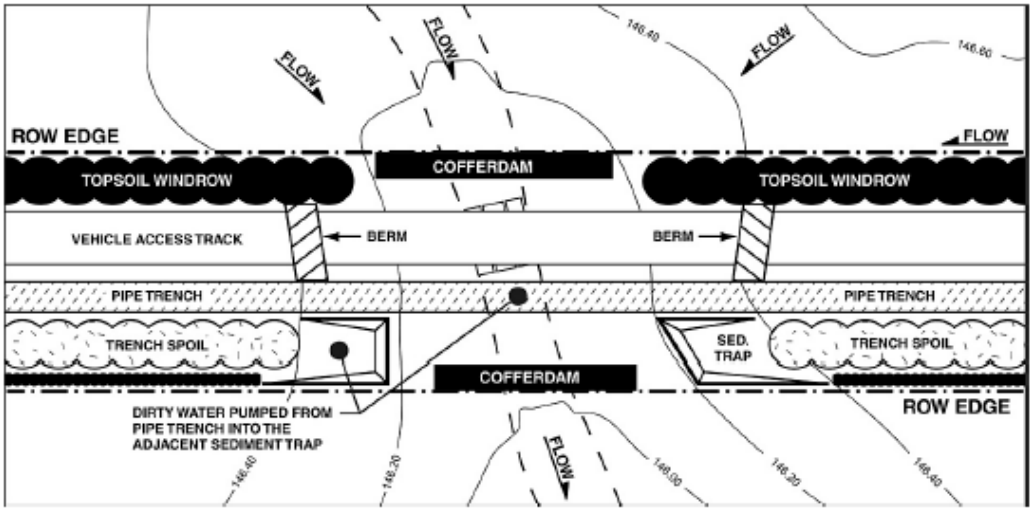


Figure 12 *Typical ESC control measures for a waterway crossing while the pipe trench is open (IECA, 2008)*

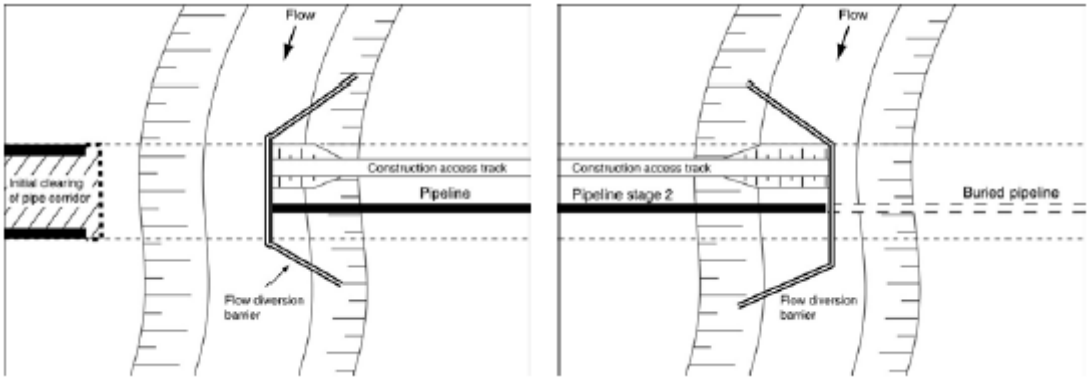


Figure 13 ***Pipe installation across a waterway using an isolation barrier***

7. Monitoring and maintenance

7.1 Site inspections and monitoring

7.1.1 General

In accordance with Section 7.2 of the IECA Manual the Contractor shall prepare a formal monitoring and maintenance program prior to site establishment. The monitoring and maintenance program shall make allowance for required site inspections, monitoring of erosion and sediment control devices (which may include water quality monitoring) and reporting of results, inspections and non-compliance.

7.1.2 Responsible persons

In accordance with Chapter 7 of the IECA Manual, the Contractor shall generally be responsible for all items prescribed in this Report. The Contractor shall identify appropriate persons to ensure compliance with erosion and sediment control requirements and objectives for the project duration.

In addition to the erosion and sediment control elements detailed in this report, the Contractor shall also ensure the following general management practices are incorporated:

– Establish an erosion and sediment control training program for site staff
– Appropriately control subcontractors and material suppliers
– Suitably control site traffic to minimise dust generation and undesirable soil compaction outside designated access roads
– Maintain adequate supplies of emergency erosion and sediment control materials and ensure that these items are always available, particularly prior to imminent rainfall
– Establish an appropriate site inspection routine as well as the staff responsible for these inspections.

For further information regarding general construction practice and the management of construction sites, refer to Chapter 7 of the IECA Manual and the IECA 'Site Management' fact sheet.

7.1.3 Monitoring and reporting requirements

General

Site inspections and monitoring are to be undertaken in accordance with Sections 6.17, 7.4, 7.6 and Appendix I of the IECA Manual and as detailed below. ESCPs are living documents that can and shall be modified as site conditions change, or if the adopted measures fail, to achieve the required treatment standard. When a site inspection detects a notable failure in the adopted ESC measures, the source of the failure must be investigated and appropriate amendments made to the site and the plans.

Inspections

– Appropriate procedures and personnel shall be engaged to plan and conduct site inspections and water quality monitoring throughout the construction
– All ESC measures shall be inspected in accordance with the IECA (2008) guidelines
– All site monitoring data including rainfall records, dates of water quality testing, testing results and records of controlled water releases for the site, shall be documented onsite. The documentation shall be maintained up to date for the duration of the approved works and be available on-site for inspection by the Assessing Authority on request.
– All environmental incidents shall be documented and should remain accessible to the relevant regulatory authorities on request. When an Environmental Incident (i.e. breach of limits or exceedance of trigger value) occurs, it is the responsibility of the environmental manager to investigate and initiate remedial actions commensurate with the severity of the incident

– A system shall be implemented and maintained that monitors and records site compliance and non-compliance with the report requirements.

7.2 Maintenance requirements

– All materials removed from ESC devices during maintenance, whether solid or liquid, shall be disposed of in a manner that does not cause ongoing soil erosion or environmental harm. Solid materials removed from ESC devices are to be stockpiled onsite in accordance with stockpile guidelines
– Written records of ESC monitoring and maintenance activities conducted during the construction and maintenance periods shall be maintained on site. Original copies of such records shall be provided on request to the Assessing Authority
– Maintenance of erosion and sediment control measures must occur in accordance with IECA 2008 guidelines.

7.3 Wet weather preparedness

In accordance with the IECA Manual, the project site shall be appropriately prepared for both likely and unlikely wet weather conditions. The Contractor shall develop a wet weather preparedness plan/procedure to establish appropriate erosion and sediment control measures and actions that is implemented prior to a predicted wet weather event.

The following erosion and sediment control measures may be considered appropriate for inclusion within the wet weather preparedness plan:

– Inspect the condition of all erosion and sediment control devices on site to ensure that these measures are operationally effective prior to the rainfall event
– Establish temporary flow diversion up-slope of open, newly formed batters
– Stabilise all drainage pathways and exposed surfaces still subject to construction with temporary erosion and sediment control techniques (i.e., erosion control blankets, hydraulic blankets, or mulching)

Secure erosion control blankets with additional anchorage such as sandbags, rocks, or timber stakes.

7.4 Non-conformance and corrective actions

Where an environmental non-conformance occurs regarding erosion and sediment control (loss of sediment from the site, accidental discharge of sediment into adjacent waterways, riparian zones, or drainage lines), the Contractor shall immediately inform the Site Manager of the incident. Incident reporting shall be undertaken as soon as practicable and reported. The Contractor must also prepare a monthly report detailing any incidents of environmental nuisance and non-conformance for review by DES, if requested.

The Contractor has a responsibility to report to DES all major environmental incidents that risk causing environmental harm under s320 of the EP Act.

Where an environmental incident occurs, the following mitigation strategies shall be adopted as a minimum:

– All non-conformances and incidents are to be corrected as soon as possible and strategies implemented to reduce the likelihood of the incident reoccurring
– Containment of the sediment laden runoff, where possible
– The environmental representative is to review the erosion and sediment control measures in place for effectiveness and check maintenance records
– The appropriate persons are to review the erosion and sediment control measures in place for effectiveness and check maintenance records
– An incident / accident report is to be completed for all incidents and non-conformances.

Where incidents have occurred, the Contractor shall ensure that all reasonable and practical control measures are implemented for future operations. This may include reviewing water quality monitoring data, where exceedances have been found, and implementing additional and/or alternative controls to achieve the required environmental outcomes.

8. References

Catchments & Creeks Erosion and Sediment Control – A Field Guide for Construction Site Managers Ver 6 (2017)

Catchments & Creeks Erosion and Sediment Control – Standard Drawings, https://www.catchmentsandcreeks.com.au/STDdrawings.html, accessed 16 November 2021

DAF 2018, *Accepted Development requirements for fisheries development: Waterway barrier works*, Department of Agriculture and Fisheries, https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/fisheries-development/accepted-development, accessed 16 November 2021

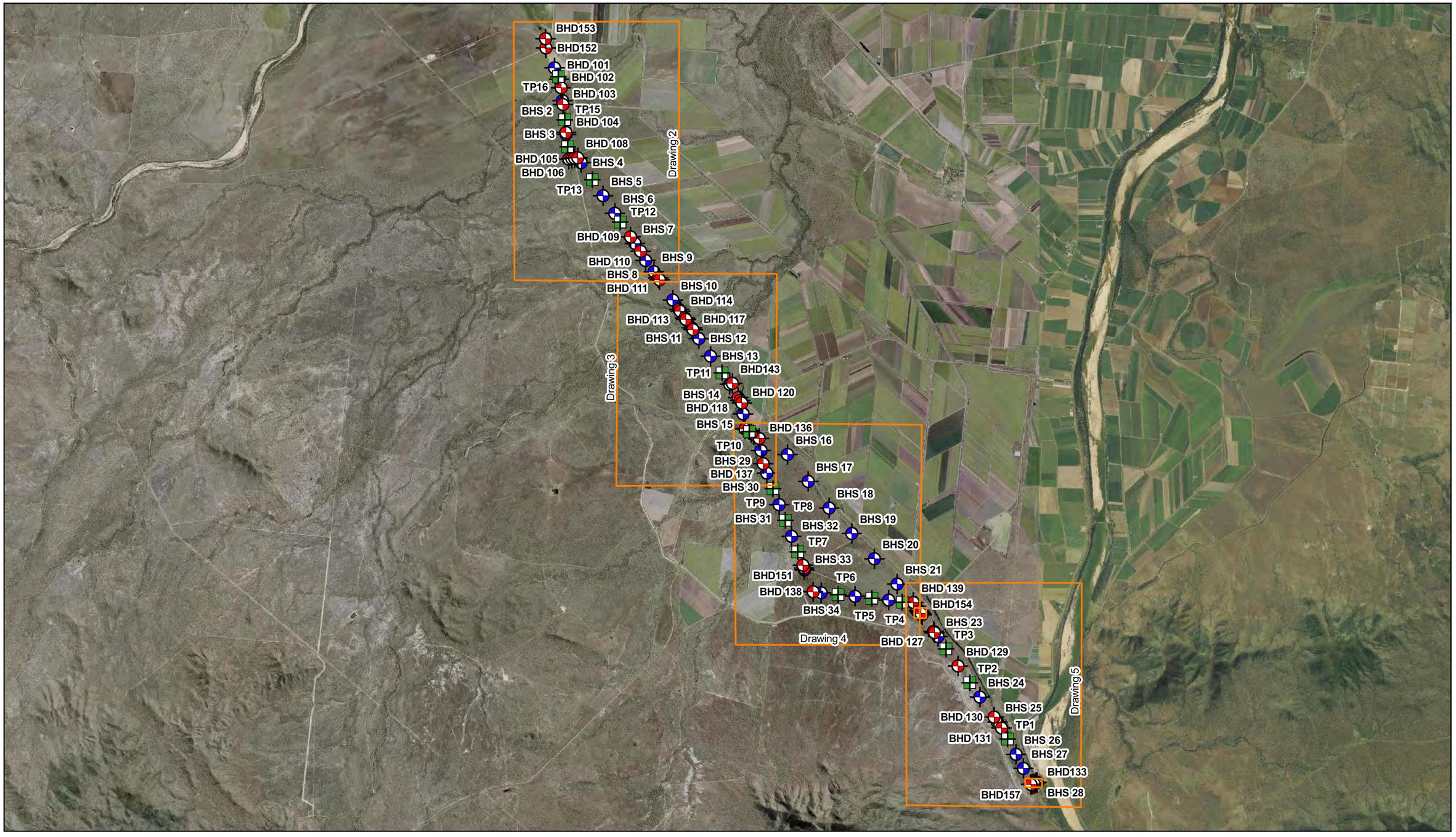
Douglas Partners 2021, Draft Report on Geotechnical Investigation – Haughton Pipeline Stage 2 Pipeline, Crossings and Thrust Piles. Report prepared for GHD Pty Ltd.

IECA 2008, *Best Practice Erosion & Sediment Control – for building and construction sites*, International Erosion Control Association (Australasia), 2008

Appendices

Appendix A

Douglas Partners Borehole Locations



Notes:
1. Base image from QLD Government

Drawing Boundaries and Numbers

0 5 10 15 km

Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: GHD Pty Ltd		TITLE: Drawing Index Haughton Pipeline Duplication Project - Stage 2 Upper Haughton	PROJECT No: 98721.00
	OFFICE: TSV	DRAWN BY: CM	N	DRAWING No: 1
	SCALE: 1:111343	DATE: January 2022		REVISION: 0

Notes:
1. Base image from Queensland Globe.
2. Test locations are approximate only and are shown with reference to existing site features.

Legend
- Deep borehole location and number
- Shallow borehole location and number
- Test pit location and number

0 0.5 1 1.5 km

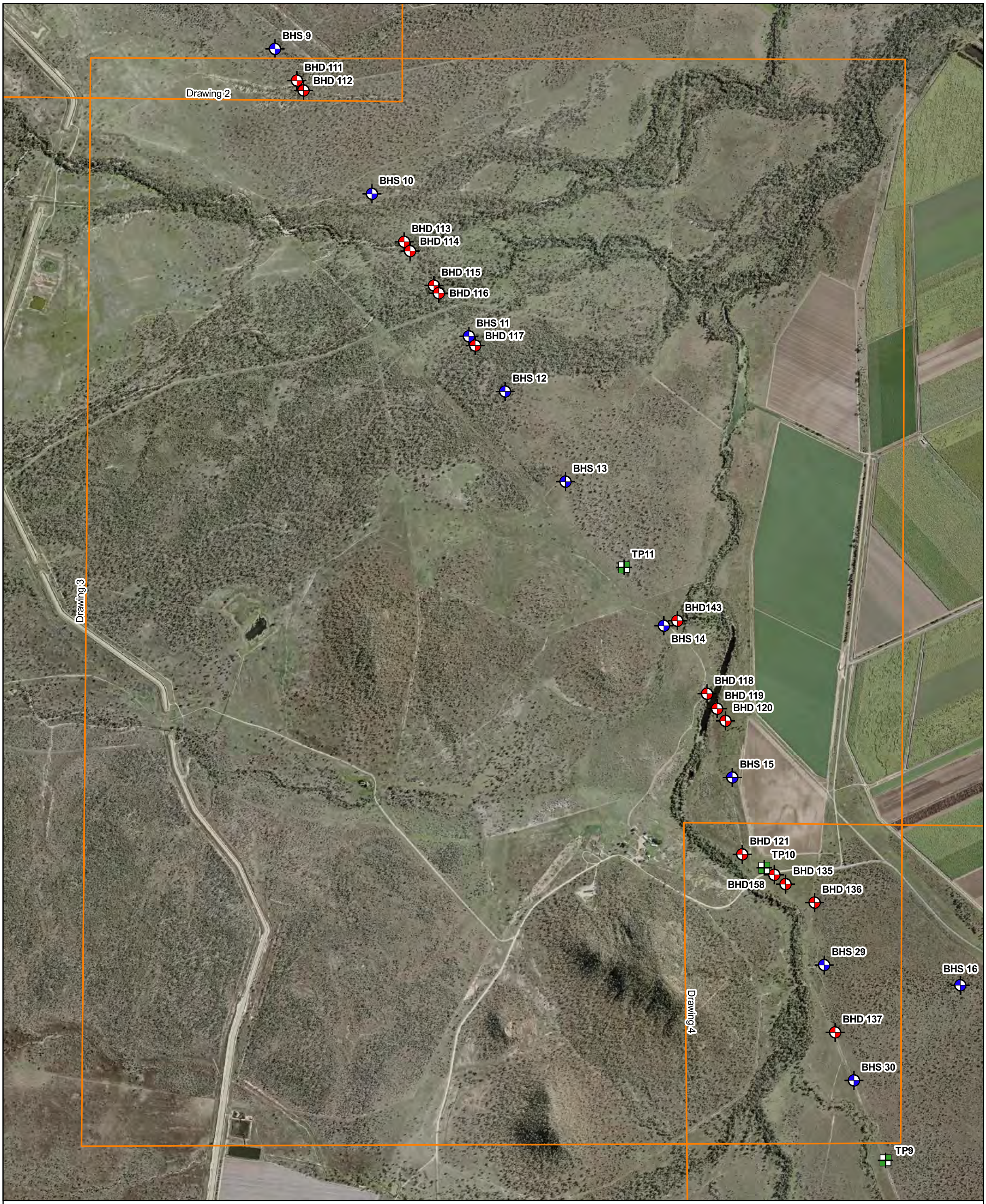
Douglas Partners
Geotechnics · Environment · Groundwater

TITLE: Site and Test Location Plan
Haughton Pipeline Duplication Project - Stage 2
Upper Haughton

N

OFFICE: Townsville
DRAWN BY: CM
DATE: January 2022

CLIENT: GHD Pty Ltd	PROJECT No: 98721.00	DRAWING No: 2	REVISION: 0	SCALE: 1:24944 @ A3



Notes:
1. Base image from Queensland Globe.
2. Test locations are approximate only and are shown with reference to existing site features.

Legend

- Deep borehole location and number
- Shallow borehole location and number
- Test pit location and number

0 0.5 1 1.5 km

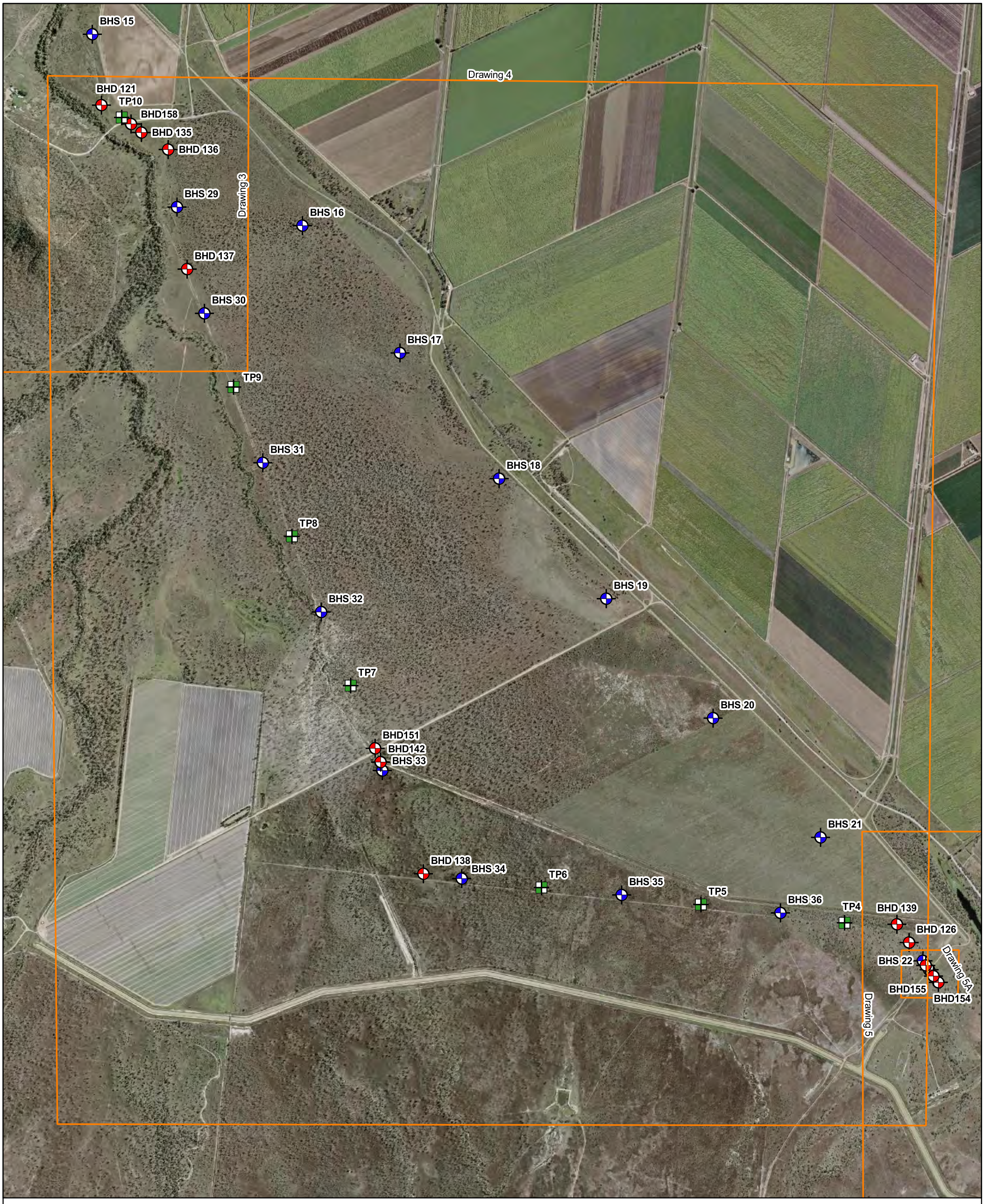
Douglas Partners
Geotechnics · Environment · Groundwater

TITLE: Site and Test Location Plan
Haughton Pipeline Duplication Project - Stage 2
Upper Haughton

N

OFFICE: Townsville
DRAWN BY: CM
DATE: January 2022

CLIENT: GHD Pty Ltd	PROJECT No: 98721.00	DRAWING No: 3	REVISION: 0	SCALE: 1:20327 @ A3



Notes:
1. Base image from Queensland Globe.
2. Test locations are approximate only and are shown with reference to existing site features.

Legend

- Deep borehole location and number
- Shallow borehole location and number
- Test pit location and number

0 0.5 1 1.5 km

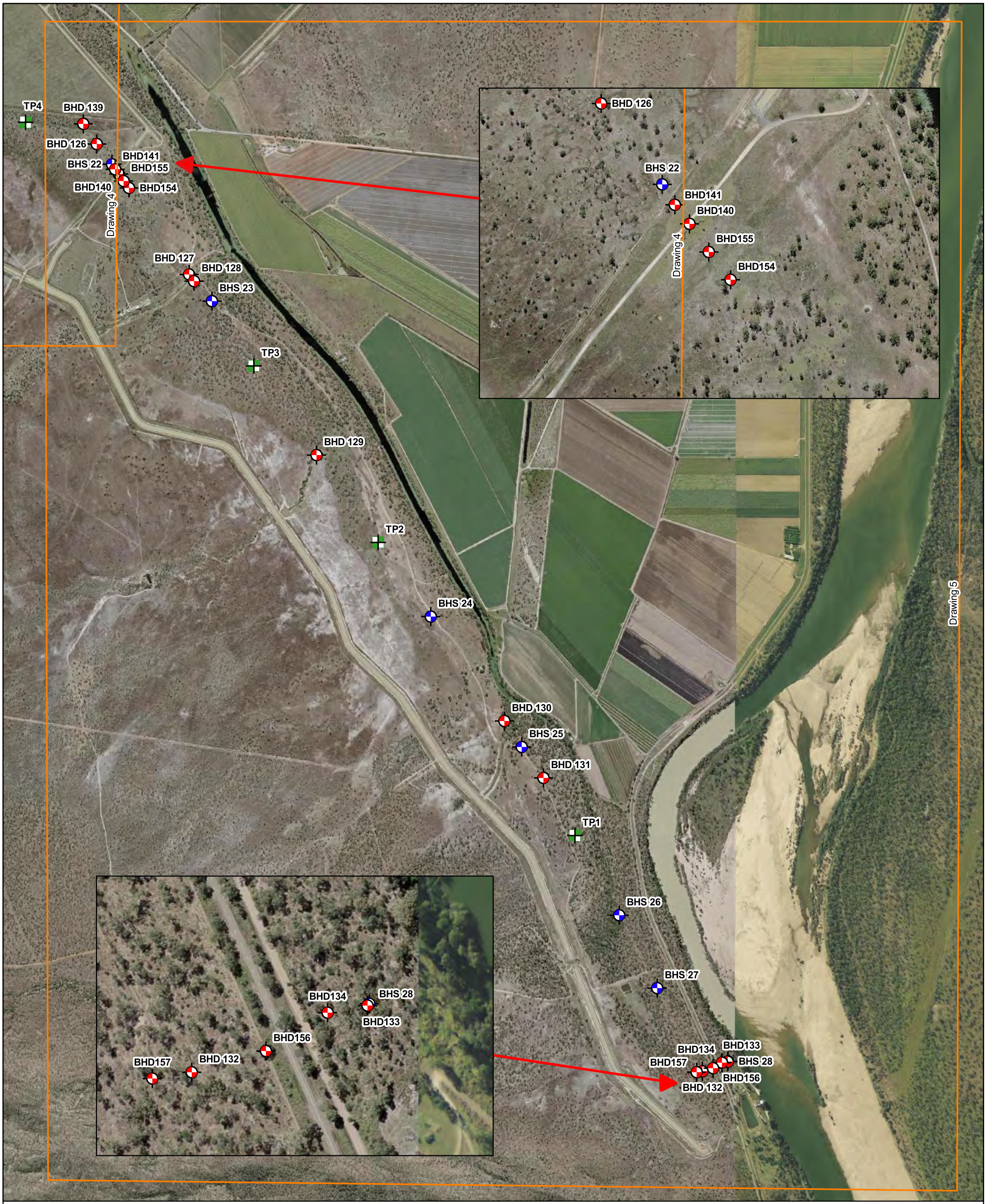
Douglas Partners
Geotechnics · Environment · Groundwater

TITLE: Site and Test Location Plan
Haughton Pipeline Duplication Project - Stage 2
Upper Haughton

N

OFFICE: Townsville
DRAWN BY: CM
DATE: January 2022

CLIENT: GHD Pty Ltd	PROJECT No: 98721.00	DRAWING No: 4	REVISION: 0	SCALE: 1:22013 @ A3



Notes:
1. Base image from Queensland Globe.
2. Test locations are approximate only and are shown with reference to existing site features.

0 0.5 1 1.5 km

Legend

- Deep borehole location and number
- Shallow borehole location and number

Douglas Partners Geotechnics · Environment · Groundwater	TITLE: Site and Test Location Plan Haughton Pipeline Duplication Project - Stage 2 Upper Haughton		N	OFFICE: Townsville
				DRAWN BY: KMF
				DATE: January 2022
CLIENT: GHD Pty Ltd	PROJECT No: 98721.00	DRAWING No: 5	REVISION: 0	SCALE: 1:20,000@ A3

Appendix B

Erosion Hazard Assessment Forms

Erosion Hazard Assessment Form – Pipeline Construction Package 1

Condition	Points	Score	Trigger value
AVERAGE SLOPE OF DISTURBANCE AREA [1]			
• not more than 3% [3% . 33H:1V]	0		
• more than 3% but not more than 5% [5% = 20H:1V]	1	**0**	**4**
• more than 5% but not more than 10% [10% = 10H:1V]	2		
• more than 10% but not more than 15% [15% . 6.7H:1V]	4		
• more than 15%	6		
SOIL CLASSIFICATION GROUP (AS1726) [2]			
• GW, GP, GM, GC	0		
• SW, SP, OL, OH	1	**3**	
• SM, SC, MH, CH	2		
• ML, CL, or if *imported fill* is used, or if soils are untested	3		
EMERSON (DISPERSION) CLASS NUMBER [3]			
• Class 4, 6, 7, or 8	0		
• Class 5	2	**4**	**6**
• Class 3, (default value if soils are untested)	4		
• Class 1 or 2	6		
DURATION OF SOIL DISTURBANCE [4]			
• not more than 1 month	0		
• more than 1 month but not more than 4 months	2	**2**	**6**
• more than 4 months but not more than 6 months	4		
• more than 6 months	6		
AREA OF DISTURBANCE [5]			
• not more than 1000 m^2	0		
• more than 1000 m^2 but not more than 5000 m^2	1	**2**	**4**
• more than 5000 m^2 but not more than 1 ha	2		
• more than 1 ha but not more than 4 ha	4		
• more than 4 ha	6		
WATERWAY DISTURBANCE [6]			
• No disturbance to a watercourse, open drain or channel	0	**2**	**2**
• Involves disturbance to a constructed open drain or channel	1		
• Involves disturbance to a natural watercourse	2		
REHABILITATION METHOD [7]			
Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).			
• not more than 1%	0	**0**	
• more than 1% but not more than 5%	1		
• more than 5% but not more than 10%	2		
• more than 10%	4		
RECEIVING WATERS [8]			
• Saline waters only	0	**2**	
• Freshwater body (e.g. creek or freshwater lake or river)	2		
SUBSOIL EXPOSURE [9]			
• No subsoil exposure except of service trenches	0	**2**	
• Subsoils are likely to be exposed	2		
EXTERNAL CATCHMENTS [10]			
• No external catchment	0	**1**	
• External catchment diverted around the soil disturbance	1		
• External catchment not diverted around the soil disturbance	2		
ROAD CONSTRUCTION [11]			
• No road construction	0	**0**	
• Involves road construction works	2		
pH OF SOILS TO BE REVEGETATED [12]			
• more than pH 5.5 but less than pH 8	0	**1**	
• other pH values, or if soils are untested	1		
Total Score [13]		**19**	

Erosion Hazard Assessment Form – Pipeline Construction Package 2

Condition	Points	Score	Trigger value
AVERAGE SLOPE OF DISTURBANCE AREA [1]			
• not more than 3% [3% . 33H:1V]	0		
• more than 3% but not more than 5% [5% = 20H:1V]	1	**0**	**4**
• more than 5% but not more than 10% [10% = 10H:1V]	2		
• more than 10% but not more than 15% [15% . 6.7H:1V]	4		
• more than 15%	6		
SOIL CLASSIFICATION GROUP (AS1726) [2]			
• GW, GP, GM, GC	0		
• SW, SP, OL, OH	1	**3**	
• SM, SC, MH, CH	2		
• ML, CL, or if *imported fill* is used, or if soils are untested	3		
EMERSON (DISPERSION) CLASS NUMBER [3]			
• Class 4, 6, 7, or 8	0		
• Class 5	2	**4**	**6**
• Class 3, (default value if soils are untested)	4		
• Class 1 or 2	6		
DURATION OF SOIL DISTURBANCE [4]			
• not more than 1 month	0		
• more than 1 month but not more than 4 months	2	**2**	**6**
• more than 4 months but not more than 6 months	4		
• more than 6 months	6		
AREA OF DISTURBANCE [5]			
• not more than 1000 m^2	0		
• more than 1000 m^2 but not more than 5000 m^2	1	**2**	**4**
• more than 5000 m^2 but not more than 1 ha	2		
• more than 1 ha but not more than 4 ha	4		
• more than 4 ha	6		
WATERWAY DISTURBANCE [6]			
• No disturbance to a watercourse, open drain or channel	0	**2**	**2**
• Involves disturbance to a constructed open drain or channel	1		
• Involves disturbance to a natural watercourse	2		
REHABILITATION METHOD [7]			
Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).			
• not more than 1%	0	**0**	
• more than 1% but not more than 5%	1		
• more than 5% but not more than 10%	2		
• more than 10%	4		
RECEIVING WATERS [8]			
• Saline waters only	0	**2**	
• Freshwater body (e.g. creek or freshwater lake or river)	2		
SUBSOIL EXPOSURE [9]			
• No subsoil exposure except of service trenches	0	**2**	
• Subsoils are likely to be exposed	2		
EXTERNAL CATCHMENTS [10]			
• No external catchment	0	**1**	
• External catchment diverted around the soil disturbance	1		
• External catchment not diverted around the soil disturbance	2		
ROAD CONSTRUCTION [11]			
• No road construction	0	**0**	
• Involves road construction works	2		
pH OF SOILS TO BE REVEGETATED [12]			
• more than pH 5.5 but less than pH 8	0	**1**	
• other pH values, or if soils are untested	1		
Total Score [13]		**19**	

Erosion Hazard Assessment Form – Pump Station Inlet Structure

Condition	Points	Score	Trigger value
AVERAGE SLOPE OF DISTURBANCE AREA [1]			
• not more than 3% [3% . 33H:1V]	0		
• more than 3% but not more than 5% [5% = 20H:1V]	1	**2**	**4**
• more than 5% but not more than 10% [10% = 10H:1V]	2		
• more than 10% but not more than 15% [15% . 6.7H:1V]	4		
• more than 15%	6		
SOIL CLASSIFICATION GROUP (AS1726) [2]			
• GW, GP, GM, GC	0		
• SW, SP, OL, OH	1	**3**	
• SM, SC, MH, CH	2		
• ML, CL, or if *imported fill* is used, or if soils are untested	3		
EMERSON (DISPERSION) CLASS NUMBER [3]			
• Class 4, 6, 7, or 8	0		
• Class 5	2	**4**	**6**
• Class 3, (default value if soils are untested)	4		
• Class 1 or 2	6		
DURATION OF SOIL DISTURBANCE [4]			
• not more than 1 month	0		
• more than 1 month but not more than 4 months	2	**4**	**6**
• more than 4 months but not more than 6 months	4		
• more than 6 months	6		
AREA OF DISTURBANCE [5]			
• not more than 1000 m^2	0		
• more than 1000 m^2 but not more than 5000 m^2	1	**1**	**4**
• more than 5000 m^2 but not more than 1 ha	2		
• more than 1 ha but not more than 4 ha	4		
• more than 4 ha	6		
WATERWAY DISTURBANCE [6]			
• No disturbance to a watercourse, open drain or channel	0	**2**	**2**
• Involves disturbance to a constructed open drain or channel	1		
• Involves disturbance to a natural watercourse	2		
REHABILITATION METHOD [7] Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).			
• not more than 1%	0	**1**	
• more than 1% but not more than 5%	1		
• more than 5% but not more than 10%	2		
• more than 10%	4		
RECEIVING WATERS [8]			
• Saline waters only	0	**2**	
• Freshwater body (e.g. creek or freshwater lake or river)	2		
SUBSOIL EXPOSURE [9]			
• No subsoil exposure except of service trenches	0	**2**	
• Subsoils are likely to be exposed	2		
EXTERNAL CATCHMENTS [10]			
• No external catchment	0	**1**	
• External catchment diverted around the soil disturbance	1		
• External catchment not diverted around the soil disturbance	2		
ROAD CONSTRUCTION [11]			
• No road construction	0	**0**	
• Involves road construction works	2		
pH OF SOILS TO BE REVEGETATED [12]			
• more than pH 5.5 but less than pH 8	0	**1**	
• other pH values, or if soils are untested	1		
Total Score [13]		**24**	

Erosion Hazard Assessment Form – Pump Station Site

Condition	Points	Score	Trigger value
AVERAGE SLOPE OF DISTURBANCE AREA [1]			
• not more than 3% [3% . 33H:1V]	0		
• more than 3% but not more than 5% [5% = 20H:1V]	1	**0**	**4**
• more than 5% but not more than 10% [10% = 10H:1V]	2		
• more than 10% but not more than 15% [15% . 6.7H:1V]	4		
• more than 15%	6		
SOIL CLASSIFICATION GROUP (AS1726) [2]			
• GW, GP, GM, GC	0		
• SW, SP, OL, OH	1	**3**	
• SM, SC, MH, CH	2		
• ML, CL, or if *imported fill* is used, or if soils are untested	3		
EMERSON (DISPERSION) CLASS NUMBER [3]			
• Class 4, 6, 7, or 8	0		
• Class 5	2	**4**	**6**
• Class 3, (default value if soils are untested)	4		
• Class 1 or 2	6		
DURATION OF SOIL DISTURBANCE [4]			
• not more than 1 month	0		
• more than 1 month but not more than 4 months	2	**6**	**6**
• more than 4 months but not more than 6 months	4		
• more than 6 months	6		
AREA OF DISTURBANCE [5]			
• not more than 1000 m^2	0		
• more than 1000 m^2 but not more than 5000 m^2	1	**2**	**4**
• more than 5000 m^2 but not more than 1 ha	2		
• more than 1 ha but not more than 4 ha	4		
• more than 4 ha	6		
WATERWAY DISTURBANCE [6]			
• No disturbance to a watercourse, open drain or channel	0	**1**	**2**
• Involves disturbance to a constructed open drain or channel	1		
• Involves disturbance to a natural watercourse	2		
REHABILITATION METHOD [7]			
Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).			
• not more than 1%	0	**1**	
• more than 1% but not more than 5%	1		
• more than 5% but not more than 10%	2		
• more than 10%	4		
RECEIVING WATERS [8]			
• Saline waters only	0	**2**	
• Freshwater body (e.g. creek or freshwater lake or river)	2		
SUBSOIL EXPOSURE [9]			
• No subsoil exposure except of service trenches	0	**2**	
• Subsoils are likely to be exposed	2		
EXTERNAL CATCHMENTS [10]			
• No external catchment	0	**1**	
• External catchment diverted around the soil disturbance	1		
• External catchment not diverted around the soil disturbance	2		
ROAD CONSTRUCTION [11]			
• No road construction	0	**0**	
• Involves road construction works	2		
pH OF SOILS TO BE REVEGETATED [12]			
• more than pH 5.5 but less than pH 8	0	**0**	
• other pH values, or if soils are untested	1		
Total Score [13]		**22**	

Explanatory notes

Requirements: Specific issues or actions required by the proponent.

Warnings: Issues that should be considered by the proponent.

Comments: General information relating to the topic.

[1] **REQUIREMENTS:**
For sites with an average slope of proposed land disturbance greater than 10%, a preliminary ESCP must be submitted to the regulatory authority for approval during planning negotiations.

Proponents must demonstrate that adequate erosion and sediment control measures can be implemented on-site to effectively protect downstream environmental values.

If site or financial constraints suggest that it is not reasonable or practicable for the prescribed water quality objectives to be achieved for the proposal, then the proponent must demonstrate that alternative designs or construction techniques (e.g. pole homes, suspended slab) cannot reasonably be implemented on the site.

WARNINGS:
Steep sites usually require more stringent drainage and erosion controls than flatter grade sites.

COMMENTS:
The steeper the land, the greater the need for adequate drainage controls to prevent soil and mulch from being washed from the site.

[2] **REQUIREMENTS:**
If the actual soil K-factor is known from soil testing, then the Score shall be determined from Table 1.

If a preliminary ESCP is required during planning negotiations, then it must be demonstrated that adequate space is available for the construction and operation of any major sediment traps, including the provision for any sediment basins and their associated embankments and spillways. It must also be demonstrated that all reasonable and practicable measures can be taken to divert the maximum quantity of sediment-laden runoff (up to the specified design storm) to these sediment traps throughout the construction phase and until the contributing catchment is adequately stabilised against erosion.

WARNINGS:
The higher the point score, the greater the need to protect the soil from raindrop impact and thus the greater the need for effective erosion control measures. A point score of 2 or greater will require a greater emphasis to be placed on revegetation techniques that do not expose the soil to direct rainfall contact during vegetation establishment, e.g. turfing and *Hydromulching*.

COMMENTS:
Table 2 provides an *indication* of soil conditions likely to be associated with a particular Soil group based on a statistical analysis of soil testing across NSW. This table provides only an initial estimate of the likely soil conditions.

The left-hand-side of the table provides an indication of the type of sediment basin that will be required (Type C, F or D). The right-hand-side of the table provides an indication of the likely erodibility of the soil based on the Revised Universal Soil Loss Equation (RUSLE) K-factor.

Table 3 provides some general comments on the erosion potential of the various soil groups.

Table 1 – Score if soil K-factor is known

	RUSLE soil erodibility K-factor			
	K < 0.02	**0.02<K<0.04**	**0.04<K<0.06**	**K > 0.06**
Score	0	1	2	3

Table 2 – Statistical analysis of NSW soil data [1]

Unified Soil Class System	Likely sediment basin classification (%)			Probable soil erodibility K-factor (%) [2]			
	Dry	Wet		Low	Moderate	High	Very High
	Type C	Type F	Type D	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
GM	30	**58**	12	12	**51**	26	12
GC	**42**	33	25	13	**71**	17	0
SW	40	**48**	12	**49**	39	12	0
SP	**53**	32	15	**76**	18	5	1
SM	21	**67**	12	26	**48**	25	1
SC	26	**50**	24	16	**64**	18	2
ML	5	**63**	32	4	35	**45**	16
CL	9	**51**	39	12	**56**	19	13
OL	2	**80**	18	34	**61**	5	1
MH	12	41	**48**	15	19	**41**	25
CH	5	44	**51**	39	**43**	11	7

Notes: [1] Analysis of soil data presented in Landcom (2004).
[2] Soil erodibility based on Revised Universal Soil Loss Equation (RUSLE) K-factor.

Unified Soil Classification System (USCS)

GW Well graded gravels, gravel-sand mixtures, little or no fines
GP Poorly graded gravels, gravel-sand mixture, little or no fines
GM Silty gravels, poorly graded gravel-sand-silt mixtures
GC Clayey gravels, poorly graded gravel-sand-clay mixtures
SW Well graded sands, gravelly sands, little or no fines
SP Poorly graded sands, gravelly sands, little or no fines
SM Silty sands, poorly graded sand-silt mixtures
SC Clayey sands, poorly graded sand-clay mixtures
ML Inorganic silts & very fine sands, rock flour, silty or clayey fine sands with slight plasticity
CL Inorganic clays, low–medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL Organic silts and organic silt-clays of low plasticity
MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH Inorganic clays of high plasticity, fat clays
OH Organic clays of medium to high plasticity

Table 3 – Typical properties of various soil groups [1]

Soil Groups	Typical properties [2]
GW, GP	• Low erodibility potential.
GM, GC	• Low to medium erodibility potential. • May create turbid runoff if disturbed as a result of the release of silt and clay particles.
SW, SP	• Low to medium erodibility potential.
SM, SC	• Medium erodibility potential. • May create turbid runoff if disturbed as a result of the release of silt and clay particles.
MH, CH	• Highly variable (low to high) erodibility potential. • Will generally create turbid runoff if disturbed.
ML, CL	• High erodibility potential. • Tendency to be dispersive. • May create some turbidity in runoff if disturbed.

Note: [1] After Soil Services & NSW DLWC (1998).
[2] Any soil can represent a high erosion risk if the binding clays or silts are unstable.

Table 4 provides **general** guidelines on the suitability of various soil groups to various engineering applications.

Table 4 – Engineering suitability based on Unified Soil Classification [1]

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non water retaining			
Well graded gravels	GW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded gravel	GP	Unsuitable	Average	Excellent	Average	Unsuitable
Silty gravels	GM	Unsuitable	Average	Good	Average	Average
Clayey gravels	GC	Suitable	Average	Good	Average	Excellent
Well graded sands	SW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded sands	SP	Unsuitable	Average	Good	Average	Unsuitable
Silty sands	SM	Suitable [2]	Average	Average	Average	Poor
Clayey sands	SC	Suitable	Average	Average	Average	Good
Inorganic silts	ML	Unsuitable	Poor	Average	Poor	Unsuitable
Inorganic clays	CL	Suitable [2]	Good	Average	Good	Poor
Organic silts	OL	Unsuitable	Unsuitable	Poor	Unsuitable	Unsuitable
Inorganic silts	MH	Unsuitable	Poor	Poor	Poor	Unsuitable
Inorganic clays	CH	Suitable [2]	Average	Unsuitable	Average	Unsuitable
Organic clays	OH	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Highly organic soils	Pt	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Notes: [1] Modified from Hazelton & Murphy (1992)
[2] Suitable only after modifications to soil such as compaction and/or erosion protection

[3] If the soils have not been tested for Emerson Class, then adopt a score of 4.

REQUIREMENTS:
Works proposed on sites containing Emerson Class 1 or 2 soils have a very high pollution potential and must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

WARNINGS:
Class 3 and 5 soils disturbed by cut and fill operations or construction traffic are highly likely to discolour stormwater (i.e. cause turbid runoff). Chemical stabilisation will likely be required if these soils are placed immediately adjacent to a retaining wall. Any disturbed Class 1, 2, 3 and 5 soils that are to be revegetated must be covered with a non-dispersive topsoil as soon as possible (unless otherwise agreed by the regulatory authority).

Class 1 and 2 soils are highly likely to discolour (pollute) stormwater if exposed to rainfall or flowing water. Treatment of these soils with gypsum (or other suitable substance) will most likely be required. These soils should not be placed directly behind a retaining wall unless it has been adequately treated (stabilised) or covered with a non-dispersible soil.

[4] The duration of disturbance refers to the total duration of soil exposure to rainfall up until a time when there is at least 70% coverage of all areas of soil.

REQUIREMENTS:
All land developments with an expected soil disturbance period greater than 6 months must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

COMMENTS:
Construction periods greater than 3 months will generally experience at least some significant storm events, independent of the time of year that the construction (soil disturbance) occurs.

[5] **REQUIREMENTS:**
Development proposals with an expected soil disturbance in excess of 1ha must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

The area of disturbance refers to the total area of soil exposed to rainfall or dust-producing winds either as a result of:

(a) the removal of ground cover vegetation, mulch or sealed surfaces;
(b) past land management practices;
(c) natural conditions.

WARNINGS:
A *Sediment Basin* will usually be required if the disturbed area exceeds 0.25ha (2500m^2) within any sub-catchment (i.e. land flowing to one outlet point).

COMMENTS:
For soil disturbances greater than 0.25ha, the revegetation phase should be staged to minimise the duration for which soils are exposed to wind, rain and concentrated runoff.

[6] **REQUIREMENTS:**
All developments that involve earthworks or construction within a natural watercourse (whether that watercourse is in a natural or modified condition) must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

Permits and/or licences may be required from the State Government, including possible submission of the ESCP to the relevant Government department.

[7] **REQUIREMENTS:**
No areas of soil disturbance shall be left exposed to rainfall or dust-producing winds at the end of a development without an adequate degree of protection and/or an appropriate action plan for the establishment of at least 70% cover.

COMMENTS:
Grass seeding without the application of a light mulch cover is considered the least favourable revegetation technique. A light mulch cover is required to protect the soil from raindrop impact, excessive temperature fluctuations, and the loss of essential soil moisture.

[8] **COMMENTS:**
All receiving waters can be adversely affected by unnatural quantities of sediment-laden runoff. Freshwater ecosystems are generally more susceptible to ecological harm resulting from the inflow of fine or dispersible clays than saline water bodies. The further inland a land disturbance is, the greater the potential for the released sediment to cause environmental harm as this sediment travels towards the coast.

For the purpose of this clause it is assumed that all sediment-laden runoff will eventually flow into saline waters. Thus, sediment-laden discharges that flow first into freshwater are likely to adversely affect both fresh and saline water bodies and are therefore considered potentially more damaging to the environment.

This clause does **not** imply that sediment-laden runoff will not cause harm to saline waters.

[9] **COMMENTS:**
This clause refers to subsoils exposed during the construction phase either as a result of past land practices or proposed construction activities. The exposure of subsoils resulting from the excavation of minor service trenches should not be considered.

[10] **WARNINGS:**
The greater the extent of external catchment, the greater the need to divert up-slope stormwater runoff around any soil disturbance.

COMMENTS:
The ability to separate “clean” (i.e. external catchment) stormwater runoff from “dirty” site runoff can have a significant effect on the size, efficiency and cost of the temporary drainage, erosion, and sediment control measures.

[11] **REQUIREMENTS:**
Permission must be obtained from the owner of a road reserve before placing any erosion and sediment control measures within the road reserve.

WARNINGS:
Few sediment control techniques work efficiently when placed on a road and/or around roadside stormwater inlets. Great care must be taken if sediment control measures are located on a public roadway, specifically:

- safety issues relating to road users;
- the risk of causing flooding on the road or within private property.

The construction of roads (whether temporary or permanent) will usually modify the flow path of stormwater runoff. This can affect how "dirty" site runoff is directed to the sediment control measures.

COMMENTS:
"On-road" sediment control devices are at best viewed as secondary or supplementary sediment control measures. Only in special cases and/or on very small projects (e.g. kerb and channel replacement) might these controls be considered as the "primary" sediment control measure.

[12] **WARNINGS:**
Soils with a pH less than 5.5 or greater than 8 will usually require treatment in order to achieve satisfactory revegetation. Soils with a pH of less than 5 (whether naturally acidic or in acid sulfate soil areas) may also limit the choice of chemical flocculants (e.g. Alum) for use in the flocculation of *Sediment Basins*.

[13] **REQUIREMENTS:**
A preliminary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded.

Appendix C

Regional Ecosystems

Paper Size ISO A3

0 325 650

Meters

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

Townsville City Council
Haughton Pipeline Stage 2 - MNES Assessment

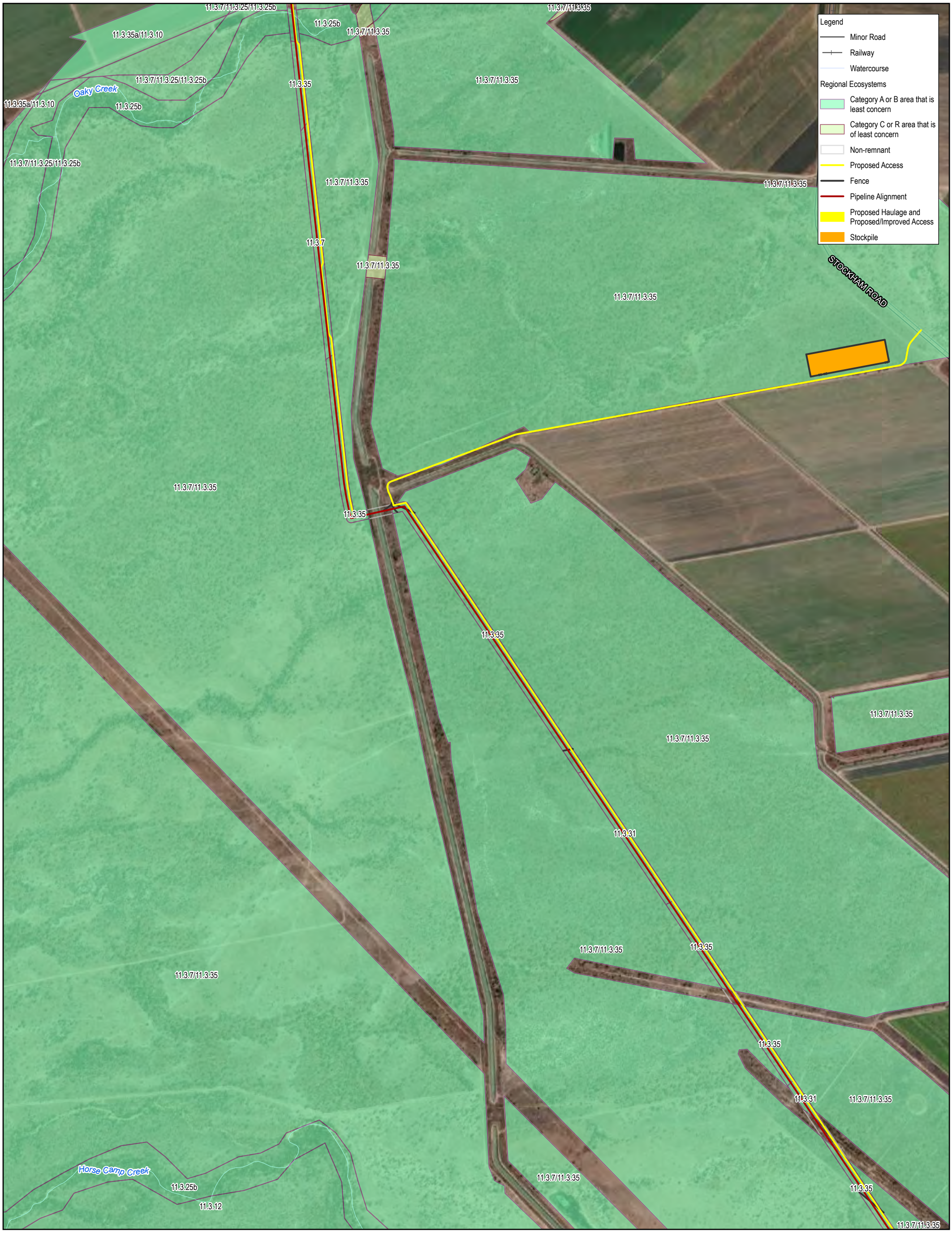
Vegetation communities (regional ecosystems)

Project No. **12537606**
Revision No. **1**
Date **7/15/2022**

FIGURE 4-1

\\ghdnet\ghd\AU\Townsville\Projects\42\12537606\GIS\Maps\APRX\12537606\12537606_Ecology.aprx 12537606_MNES_004_Vegetation_Communities_Rev2
Print date: 15 Jul 2022 - 10:37c

Data source: DoR: Roads, Railway, Watercourses (2021); GHD: Site Layout, Regional Ecosystems v12 with Field-verified Edits (2022); World Imagery: Maxar.
Created by: shart2



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Meters

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Townsville City Council
Haughton Pipeline Stage 2 - MNES Assessment

Vegetation communities (regional ecosystems)

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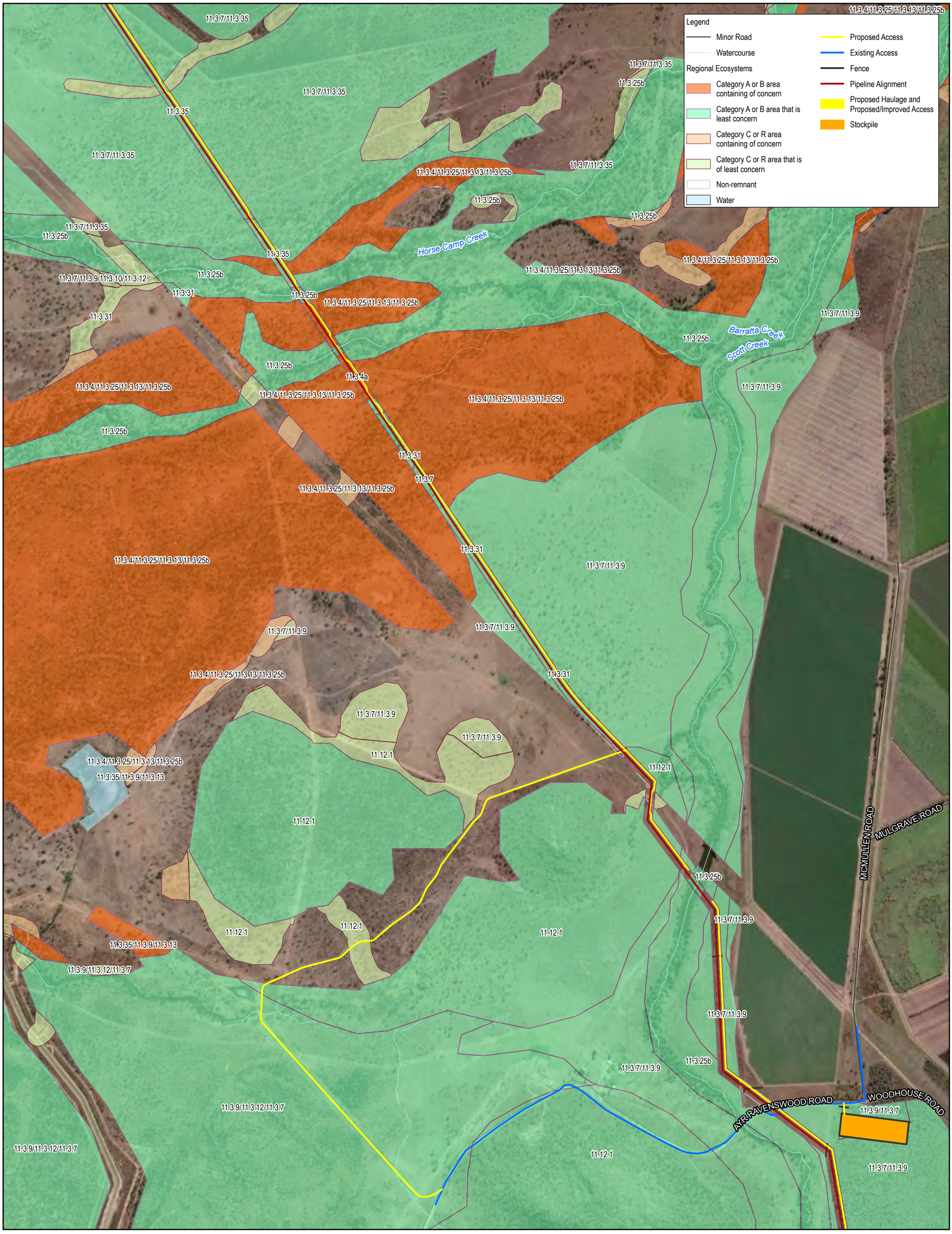

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Townsville City Council
Haughton Pipeline Stage 2 - MNES Assessment

Vegetation communities (regional ecosystems)

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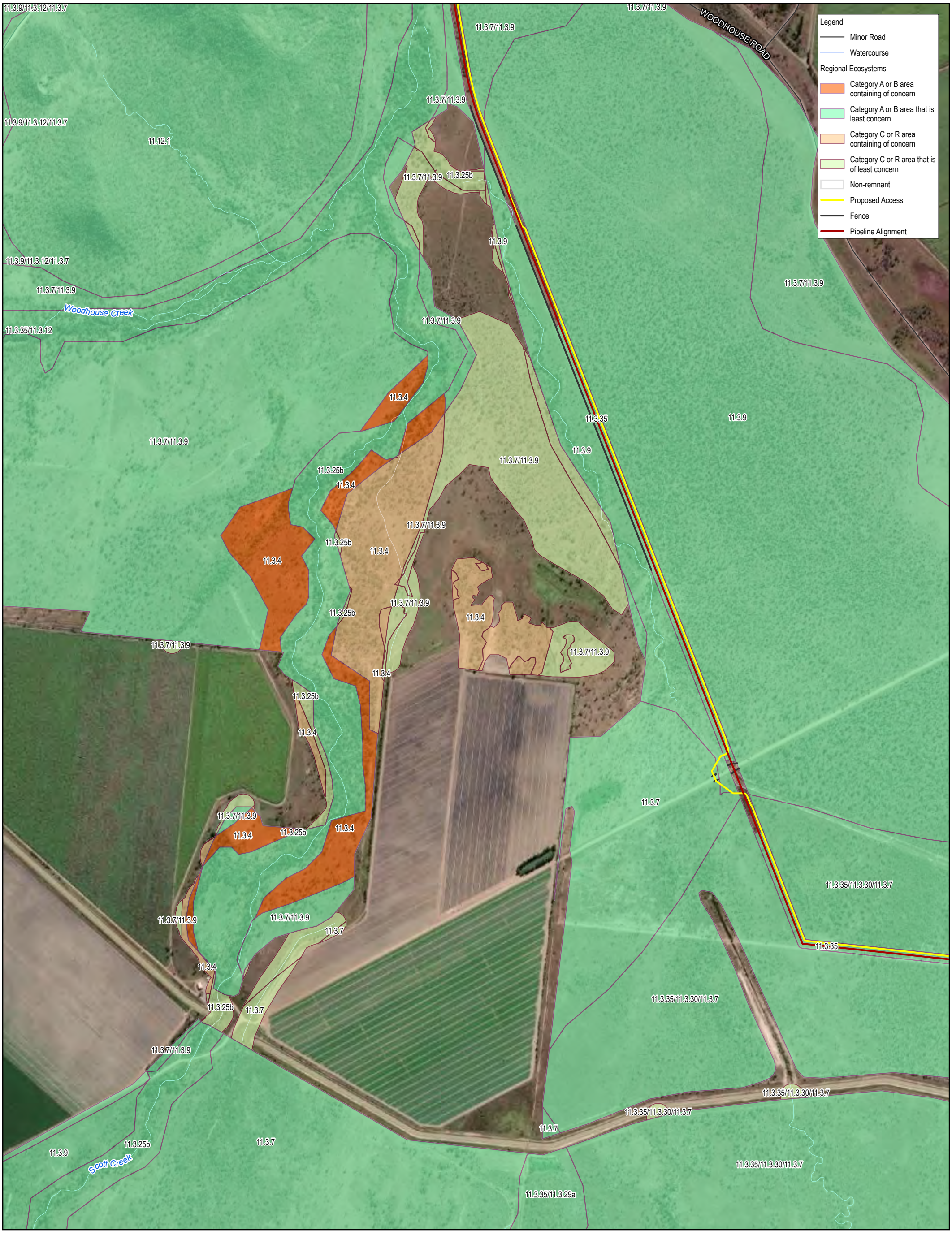

Based on or contains data provided by the State of QLD 2021. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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GHD

Townsville City Council
Haughton Pipeline Stage 2 - MNES Assessment

Vegetation communities (regional ecosystems)

Project No. **12537606**
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Date **7/15/2022**

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Townsville City Council
Haughton Pipeline Stage 2 - MNES Assessment

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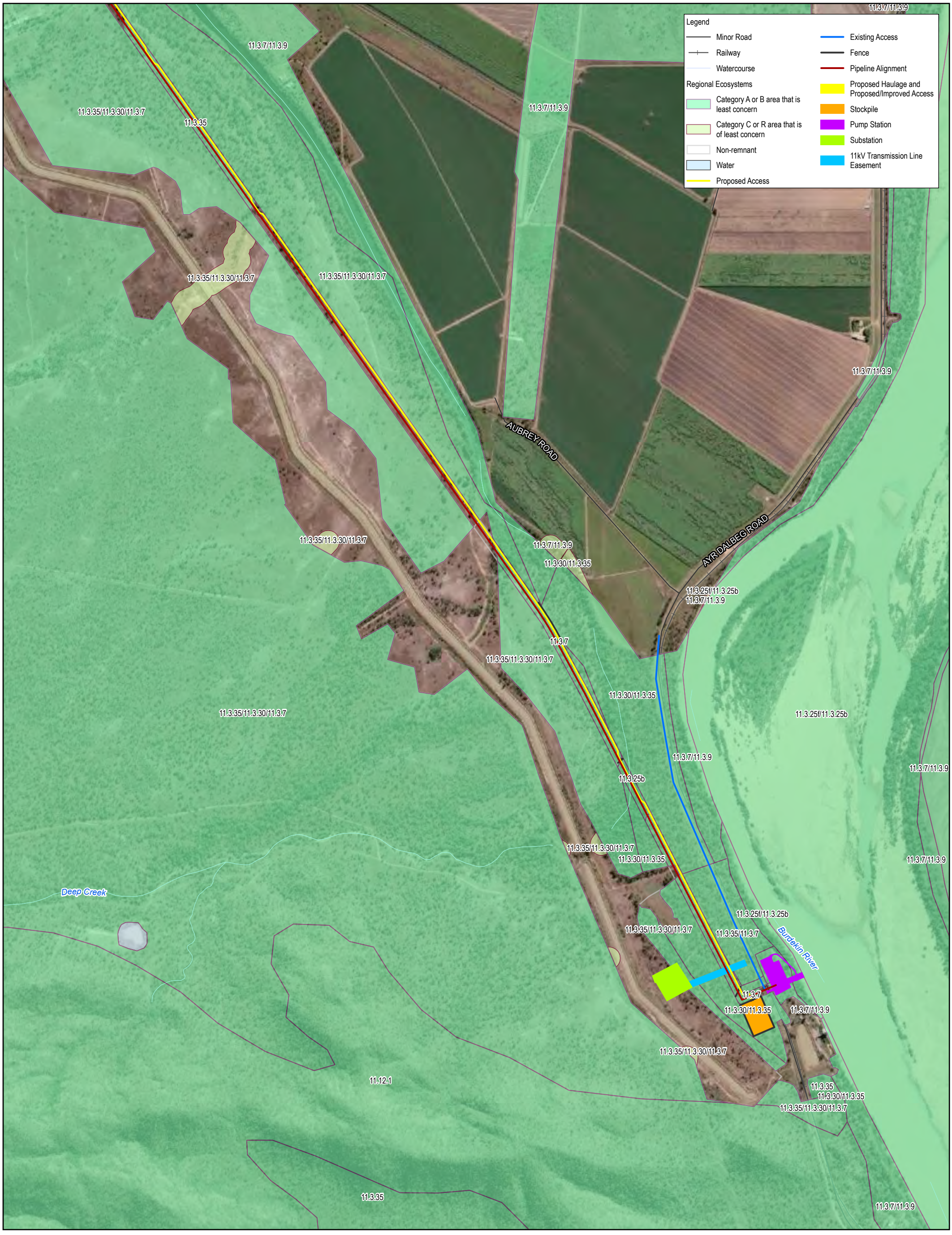

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Haughton Pipeline Stage 2 - MNES Assessment

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Created by: shart2

Appendix D

Erosion and Sediment Control Standard Drawings

Cofferdams (General) Dam-01

MATERIALS

EARTH FILL: NON-DISPERSIVE EARTH FREE OF ORGANIC DEBRIS. EMERSON'S AGGREGATE CLASS 6, 7 OR 8.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH (MINIMUM 'BIDIM' A34 OR EQUIVALENT).

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONDUCT THE NECESSARY WORKS INCLUDING PERMITS FOR THE DISTURBANCE OF RIPARIAN AND AQUATIC VEGETATION, AND THE CONSTRUCTION OF ALL PERMANENT OR TEMPORARY INSTREAM BARRIERS AND INSTREAM SEDIMENT CONTROL MEASURES.

2. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. IF THERE IS FLOW WITHIN THE WATERCOURSE OR DRAINAGE CHANNEL AT THE TIME OF INSTALLATION OF THE COFFERDAM, THEN INSTALL APPROPRIATE DOWNSTREAM SEDIMENT CONTROL DEVICES AND/OR FLOW DIVERSION SYSTEMS PRIOR TO INSTALLATION OF THE DAM. SUCH MEASURES SHOULD ONLY BE INSTALLED IF CONSIDERED APPROPRIATE FOR THE LOCAL CONDITIONS, AND ONLY IF THEIR INSTALLATION IS JUDGED TO PROVIDE A NET OVERALL ENVIRONMENTAL BENEFIT.

4. TO THE MAXIMUM DEGREE PRACTICAL, CONSTRUCTION ACTIVITIES AND EQUIPMENT MUST NOT OPERATE WITHIN OPEN FLOWING WATERS.

5. ENSURE CLEARING AND EXCAVATION OF ACCESS PATHS AND THE BANKS AND BED OF THE WATERCOURSE ARE LIMITED TO THE MINIMUM PRACTICABLE.

6. IF DISPERSIVE, HIGHLY UNSTABLE, OR HIGHLY EROSIVE SOILS ARE EXPOSED, THEN PRIORITY MUST BE GIVEN TO THE PROMPT STABILISATION OF ALL SUCH AREAS.

7. REMOVE ANY CLEARED ORGANIC MATTER OR DEBRIS FROM THE CHANNEL AND DISPOSE OF IT PROPERLY. DO NOT USE ORGANIC MATTER OR DEBRIS TO BUILD THE COFFERDAM.

8. TO ASSIST IN THE EVENTUAL REMOVAL OF ALL MATERIALS USED IN THE CONSTRUCTION OF A TEMPORARY COFFERDAM, A PROTECTIVE LAYER OF GEOTEXTILE FILTER CLOTH (PREFERABLY IN THE FORM OF A SINGLE SHEET) SHOULD BE PLACED OVER THE CHANNEL PRIOR TO INSTALLATION OF THE COFFERDAM. IF MORE THAN ONE SHEET OF FABRIC IS REQUIRED, OVERLAP THE FABRIC BY AT LEAST 600mm.

9. IF THE COFFERDAM IS TO BE CONSTRUCTED OF FREE-STANDING COMPACTED FILL, THE SIDES OF THE COFFERDAM MUST BE NO STEEPER THAN 2:1 (H:V).

10. STABILISE ALL DISTURBED AREAS SUBJECT TO FLOWING WATER, INCLUDING FLOW BYPASS AND OVERFLOW AREAS, WITH ROCK OR OTHER SUITABLE MATERIALS IF EXPECTED FLOW VELOCITIES EXCEEDS THAT ALLOWABLE FOR THE IN-SITU MATERIAL. THE MINIMUM ROCK SIZE PLACED WITHIN THE MAIN CHANNEL SHALL BE 200mm.

MAINTENANCE

1. WHILE CONSTRUCTION WORKS CONTINUE ON THE SITE, INSPECT THE COFFERDAM PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF PRODUCING RAINFALL, OR OTHERWISE ON A WEEKLY BASIS.

2. ENSURE THAT COFFERDAM IS STABLE AND UNDAMAGED.

3. DISPOSE OF EXCESSIVE ACCUMULATIONS OF SEDIMENT OR DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

4. REPAIR ANY PLACES IN THE COFFERDAM THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM STREAM FLOWS OR OVERTOPPING WATER.

5. IF A BYPASS FLOODWAY EXISTS, CHECK THAT THE FLOODWAY IS STABLE AND CAPABLE OF OPERATING AT ITS DESIGN CAPACITY.

REMOVAL

1. COFFERDAMS SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER THEY ARE NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED UPSTREAM OF THE COFFERDAM, REMOVE SUCH MATERIAL BEFORE THE DAM IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. IF THERE IS FLOW WITHIN THE WATERCOURSE OR DRAINAGE CHANNEL AT THE TIME OF REMOVAL OF THE COFFERDAM, THEN INSTALL APPROPRIATE DOWNSTREAM SEDIMENT CONTROL DEVICES AND/OR FLOW DIVERSION SYSTEMS PRIOR TO REMOVAL OF THE DAM. SUCH MEASURES SHOULD ONLY INSTALLED IF CONSIDERED APPROPRIATE FOR THE LOCAL CONDITIONS, AND ONLY IF THEIR INSTALLATION IS JUDGED TO PROVIDE A NET OVERALL ENVIRONMENTAL BENEFIT.

4. ENSURE ANY CHANNEL WATER CONTAINED WITHIN THE ENCLOSED CHANNEL AREA IS SUITABLY TREATED BEFORE EITHER THE WATER IS DISCHARGED FROM THE ENCLOSURE OR THE COFFERDAMS ARE REMOVED.

5. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE COFFERDAMS.

6. REMOVE ALL CONSTRUCTION MATERIALS, SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Apr-10	Cofferdams (General)	Dam-01

Catchments & Creeks Pty Ltd

Erosion Control Blankets ECB-01

MATERIALS

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING MATERIAL SPECIFICATIONS SHOULD APPLY.

GEOTEXTILE BLANKETS:
(i) WOVEN POLYPROPYLENE FABRIC.
(ii) MINIMUM THICKNESS OF 1.5mm.
(iii) MINIMUM WIDTH OF 3.6m.

STAPLES:
(i) MINIMUM 11 GAUGE STEEL WIRE.
(ii) U-SHAPED WITH 200mm LEG LENGTH AND 50mm CROWN.

EXCELSIOR BLANKETS:
(i) CURLED WOOD FIBRE BLANKET WITH 80% OF FIBRES LONGER THAN 150mm.
(ii) MINIMUM ROLL WIDTH OF 1200mm.
(iii) AVERAGE WEIGHT OF 0.43kg/m^2 +/-10%.

STRAW BLANKETS:
(i) MINIMUM ROLL WIDTH OF 2m.
(ii) MINIMUM WEIGHT OF 0.27kg/m^2.

COCONUT FIBRE BLANKETS:
(i) MINIMUM ROLL WIDTH OF 2m.
(ii) MINIMUM WEIGHT OF 0.27kg/m^2.

INSTALLATION

THE METHOD OF INSTALLATION VARIES WITH THE TYPE OF MATERIAL USED AND THE TASK BEING PERFORMED BY THE BLANKET. INSTALLATION PROCEDURES SHOULD BE SUPPLIED BY THE MANUFACTURER OR DISTRIBUTOR OF THE PRODUCT. A TYPICAL INSTALLATION PROCEDURE FOR ROLLED EROSION CONTROL PRODUCTS IS DESCRIBED BELOW.

APPLICATION OF ROLLED BLANKETS ON SLOPES NOT SUBJECTED TO CONCENTRATED FLOW:

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR AWAY TRASH AND LARGE STONES, AND GRADE SMOOTHLY TO ELIMINATE FOOTPRINTS, TRACKS AND RUTS.

3. PREPARE A SMOOTH SEEDBED OF APPROXIMATELY 75mm OF TOPSOIL.

4. APPLY SEED, SOIL AMELIORANTS AND WATER AS SPECIFIED, THEN RAKE TO REMOVE ANY REMAINING SURFACE IRREGULARITIES.

5. COMMENCE PLACEMENT OF THE BLANKETS AT THE TOP OF THE SLOPE. BURY THE UPPER EDGE OF THE BLANKET WITHIN A 300mm DEEP TRENCH AND STAPLE AT 200 TO 250mm CENTRES.

6. THE BLANKETS CAN BE PLACED LENGTHWISE EITHER ALONG THE SLOPE (PARALLEL TO THE CONTOURS) OR DOWN THE SLOPE (TRANSVERSE TO THE CONTOURS), BUT NOT DIAGONALLY ACROSS THE SLOPE.

7. OVERLAP THE SIDES OF EACH BLANKET BY AT LEAST 100mm.

8. BURY THE EDGE OF THE BLANKET LOCATED ALONG THE OUTER MOST EDGE OF THE TREATED AREA WITHIN A 300mm DEEP TRENCH AND STAPLE THE BLANKET WITHIN THE TRENCH AT 200 TO 250mm CENTRES.

9. WHERE MORE THAN ONE BLANKET IS USED DOWN THE SLOPE, OVERLAP EACH BLANKET BY AT LEAST 300mm WITH THE UPPER BLANKET PLACED OVER THE LOWER BLANKET (SHINGLE STYLE).

10. WHEN SPREADING THE BLANKETS, AVOID STRETCHING THE FABRIC. THE BLANKETS SHOULD REMAIN IN GOOD CONTACT WITH THE SOIL.

11. STAPLE THE EXPOSED FABRIC SURFACE AT 1m CENTRES.

12. BLANKETS, ONCE FIXED, MAY BE ROLLED WITH A ROLLER WEIGHING 60 TO 90kg/m LENGTH, THEN WATERED.

13. THE INSTALLATION PROCEDURE MUST ENSURE THAT THE BLANKET ACHIEVES AND RETAINS INTIMATE CONTACT WITH THE SOIL.

14. DAMAGED FABRIC SHALL BE REPAIRED OR REPLACED.

15. WHERE DIRECTED, AN ADDITIONAL MESH (JUTE OR COIR) ANCHOR MAY NEED TO BE PLACED OVER THE BLANKETS TO MINIMISE DISPLACEMENT BY STRONG WINDS.

ADDITIONAL REQUIREMENTS ASSOCIATED WITH USE NEAR AIRPORT PAVEMENTS:

1. ONLY BLANKETS THAT ARE DOUBLE NETTED SHALL BE ALLOWED WITHIN 3m OF ANY AIRPORT PAVEMENT USED BY AIRCRAFT WITH THE EXCEPTION OF AIRPORTS CLASSIFIED AS AIR CARRIER OR CORPORATE/TRANSPORT. IF THE AIRPORT IS CLASSIFIED AS AN AIR CARRIER OR CORPORATE/TRANSPORT, THERE WILL BE NO BLANKETS ALLOWED WITHIN 9m OF PAVEMENT USED BY AIRCRAFT.

2. ONLY BIODEGRADABLE ANCHORING DEVICES SHALL BE ALLOWED IN THE INSTALLATION OF ANY BLANKET FOR AIRPORT APPLICATIONS. NO METAL STAPLES WILL BE ALLOWED.

MAINTENANCE

1. DURING THE ACTIVE CONSTRUCTION PERIOD, INSPECT THE TREATED AREA FORTNIGHTLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND MAKE REPAIRS AS NEEDED.

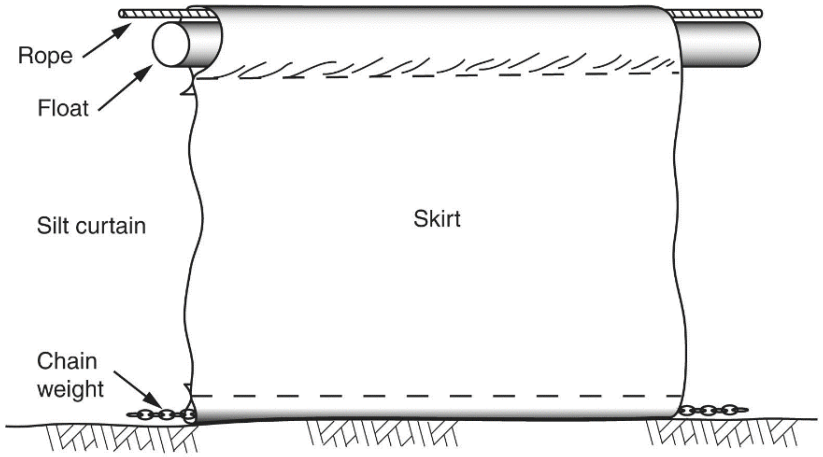
2. THE TREATED AREA SHOULD BE INSPECTED AT LEAST FORTNIGHTLY FOR THE FIRST 3 MONTHS.

3. INSPECT THE TREATED AREA TO SEE IF:
(i) CONSTRUCTION ACTIVITY OR FALLING DEBRIS HAVE DAMAGED THE BLANKETS;
(ii) RUNOFF IS UNDERMINING THE FABRIC;
(iii) THE BLANKETS ARE IN GOOD CONTACT WITH THE SOIL; AND
(iv) THE BLANKETS MAINTAIN ADEQUATE OVERLAP.

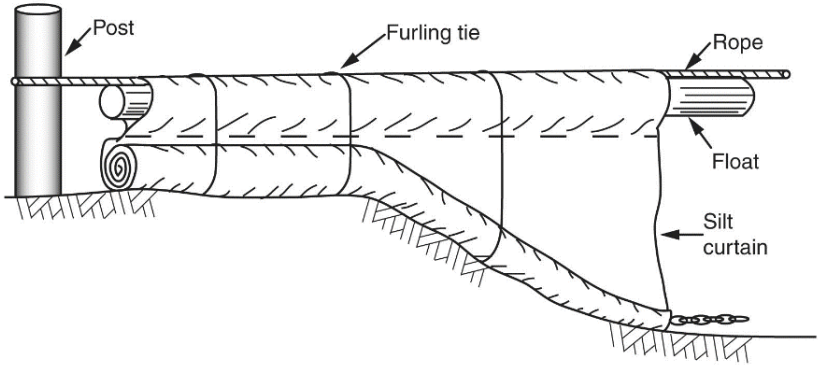
4. IF DAMAGED, REPAIR OR REPLACE THE DAMAGED SECTION. IF WATER IS UNDERMINING THE FABRIC, REPAIR ANY HOLES OR JOINTS OR RE-BURY THE UPPER ENDS OF THE DAMAGED SECTIONS.

Drawn:	Date:		
GMW	May-10	Erosion Control Blankets	ECB-01

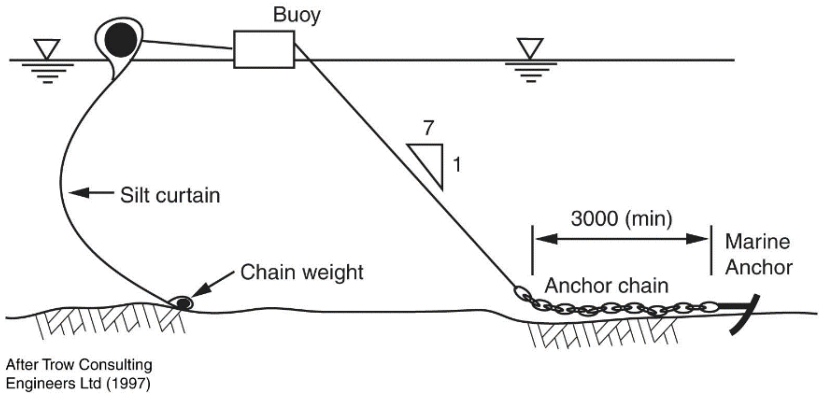
Floating Silt Curtain FSC-01, FSC-02 & FSC-03



(a) Components of a floating silt curtain

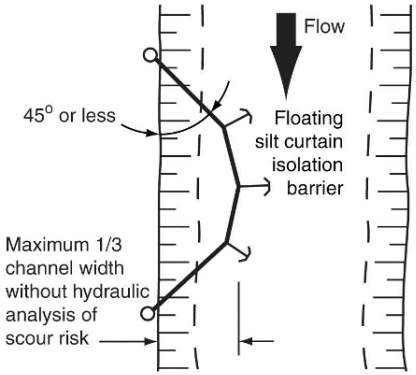


(b) Typical land anchorage system

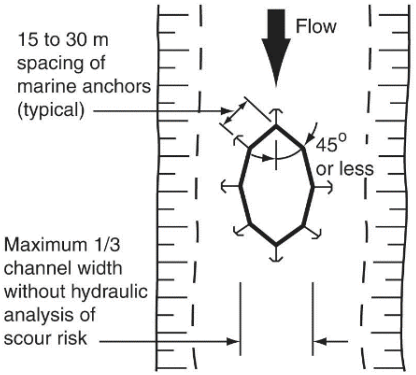


After Trow Consulting Engineers Ltd (1997)

(c) Typical marine anchorage system



(d) Typical installation of floating silt curtain



(e) Typical installation of floating silt curtain

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-01

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONDUCT THE NECESSARY WORKS INCLUDING PERMITS FOR THE DISTURBANCE OF RIPARIAN AND AQUATIC VEGETATION, AND THE CONSTRUCTION OF ALL PERMANENT OR TEMPORARY INSTREAM BARRIERS AND INSTREAM SEDIMENT CONTROL MEASURES.

2. PRIOR TO THE INSTALLATION, CHECK WEATHER REPORTS FOR A SUITABLE WINDLESS, CALM DAY. DO NOT PROCEED WITH THE INSTALLATION UNLESS SAFE TO DO SO.

3. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

4. CLEAR THE IMMEDIATE LAUNCHING AREA OF ROCK AND DEBRIS. AVOID DISTURBING GROUNDCOVER VEGETATION.

5. LAYOUT A PLASTIC LAUNCHING PAD (SPILLWAY) AT RIGHT ANGLES TO THE WATERCOURSE BANK AND PEG OR ANCHOR IT DOWN. THIS IS TO PROTECT THE CURTAIN AND REDUCE FRICTION WHEN LAUNCHING.

6. UNFOLD THE CURTAIN IN AN OPEN AREA PRIOR TO ITS INSTALLATION. ENSURE THE BARRIER IS FABRICATED WITH SUFFICIENT DIMENSIONS TO BE IN GOOD CONTACT WITH THE BOTTOM OF THE CHANNEL. THE DEPTH OF THE BARRIER SHOULD BE APPROXIMATELY 10% GREATER THAN THE WATER DEPTH TO ENSURE IT RESTS ON THE BED.

7. IDEALLY, THE LENGTH OF THE BARRIER IS 10 TO 20% LONGER THAN THE MEASURED LENGTH OF THE PROPOSED ENCLOSURE.

8. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

9. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

10. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

11. PULL THROUGH THE ROPE USING THE DRAW CORD.

12. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE CURTAIN BEING DRAGGED ALONG THE CHANNEL BED.

13. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

14. DEPLOY THE BARRIER FROM THE END OF A BOAT. FASTEN THE FREE END OF THE BARRIER TO THE DOWNSTREAM ANCHOR POINT, THEN ANCHOR THE BARRIER AT INTERMEDIATE POINTS.

15. TAPER THE ENDS OF THE BARRIER TO THE SHAPE OF THE SHORELINE, OTHERWISE TIE THE ENDS OF THE BARRIER WITH FURLING STRAPS SO THE DEPTH OF THE BARRIER CAN BE ADJUSTED TO THE SHAPE OF THE BANK.

16. AFTER THE BARRIER HAS BEEN ANCHORED, CHECK TO SEE THAT THE SKIRT IS NOT TWISTED AROUND THE FLOTATION UNITS. WHEN THE BARRIER IS PROPERLY DEPLOYED, CUT THE TIE ROPES AND LET THE BALLAST WEIGHTS SINK TO THE BED.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-02

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

ALTERNATIVE LAND-BASED INSTALLATION PROCEDURE

1. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

2. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

3. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

4. PULL THROUGH THE ROPE USING THE DRAW CORD.

5. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE WEIGHTS BEING DRAGGED ALONG THE BOTTOM.

6. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

7. INSTALL AN EXTRA LENGTH OF ROPE OR CABLE IN THE FINAL CURTAIN POSITION IN THE WATER.

8. TIE THE END OF THE CURTAIN ROPE TO THE EXTRA LENGTH ALREADY IN POSITION AND PULL THE CURTAIN INTO THE WATER STOPPING WHEN THE END OF THE FIRST SECTION OF CURTAIN IS STILL ON THE BANK.

9. UNFOLD THE SECOND SECTION OF CURTAIN ON THE SLIPWAY MAKING SURE THE CURTAIN IS CORRECTLY ORIENTATED WITH THE FIRST SECTION OF CURTAIN

10. INSERT THE FLOATS, CHAIN AND ROPE AS BEFORE.

11. USING THE DRAW CORD FROM THE FIRST SECTION, TIE UP THE ENDS USING THE EYELETS ALREADY IN THE CURTAIN.

12. GATHER UP THE CURTAIN AND TIE TOGETHER WITH TWINE OR THIN ROPE.

13. LAUNCH AS BEFORE.

14. CONTINUE UNTIL THE ENTIRE CURTAIN IS INSTALLED.

15. ANCHOR WELL TO SHORE ANCHORS.

16. USING A SUITABLE BOAT, MOVE ALONG THE CURTAIN AND CUT THE TIES HOLDING THE CHAIN AND CURTAIN AND ALLOW THE WEIGHTED END TO SINK.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

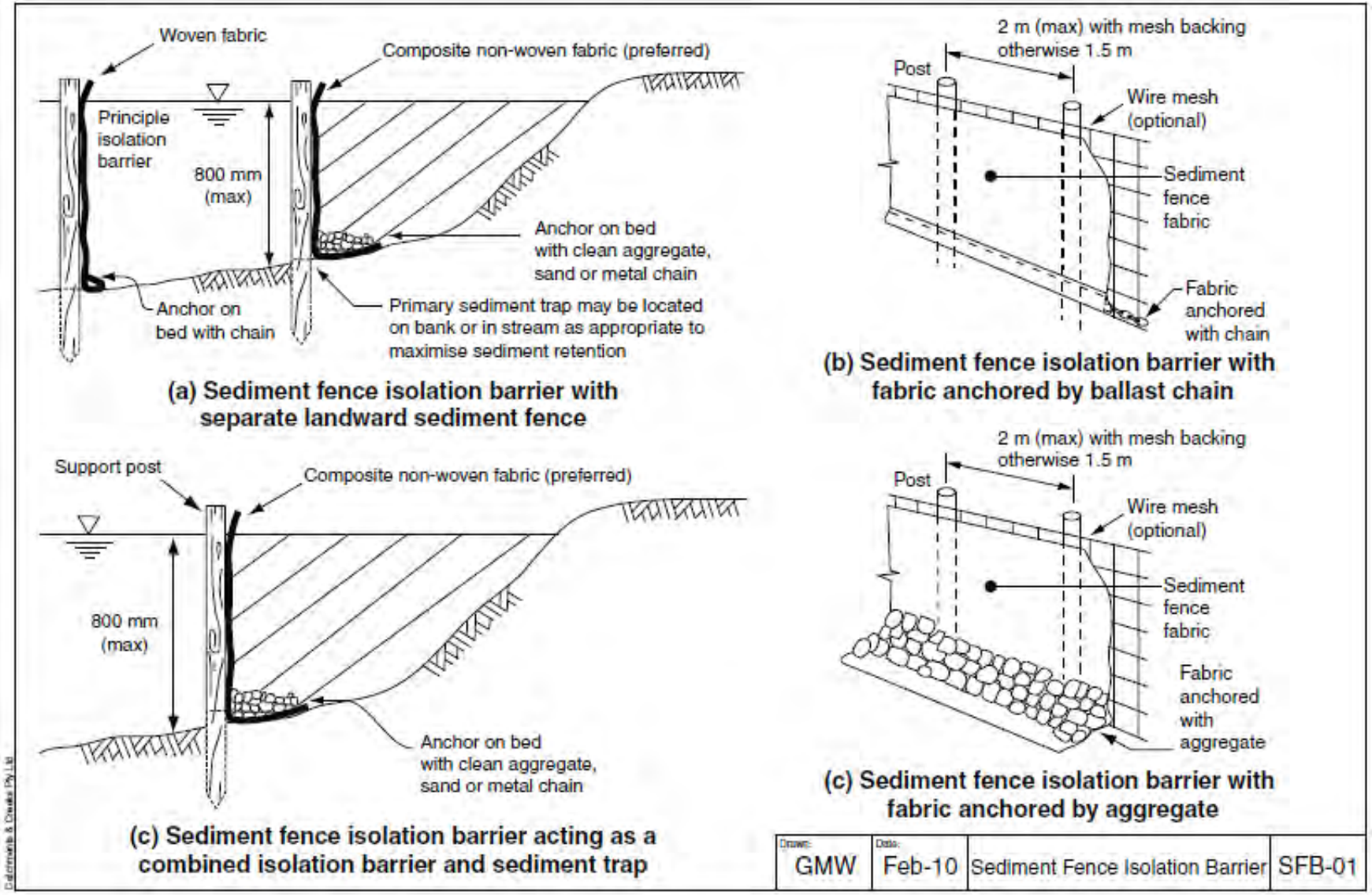
5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain (alt)	FSC-03

Sediment Fence Isolation Barrier SFB-01, SFB-02



MATERIALS

FABRIC: POLYPROPYLENE, POLYAMIDE, NYLON, POLYESTER, OR POLYETHYLENE WOVEN OR NON-WOVEN FABRIC, AT LEAST 700mm IN WIDTH AND A MINIMUM UNIT WEIGHT OF 140GSM. ALL FABRICS TO CONTAIN ULTRAVIOLET INHIBITORS AND STABILISERS TO PROVIDE A MINIMUM OF 6 MONTHS OF USEABLE CONSTRUCTION LIFE (ULTRAVIOLET STABILITY EXCEEDING 70%).

FABRIC REINFORCEMENT: WIRE OR STEEL MESH MINIMUM 14-GAUGE WITH A MAXIMUM MESH SPACING OF 200mm.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

BALLAST (OUTER BARRIER): MINIMUM 8mm CHAIN OR EQUIVALENT, OR MINIMUM 50mm AGGREGATE.

STAPLES: HEAVY DUTY WIRE STAPLES AT LEAST 25mm LONG, OR WIRE TIES.

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONDUCT THE NECESSARY WORKS INCLUDING PERMITS FOR THE DISTURBANCE OF RIPARIAN AND AQUATIC VEGETATION, AND THE CONSTRUCTION OF ALL PERMANENT OR TEMPORARY INSTREAM BARRIERS AND INSTREAM SEDIMENT CONTROL MEASURES.

2. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. CONFIRM IF A SINGLE OR DOUBLE FENCE IS REQUIRED.

4. IF THERE IS FLOW WITHIN THE WATERCOURSE OR DRAINAGE CHANNEL AT THE TIME OF INSTALLATION OF THE ISOLATION BARRIER, THEN TAKE APPROPRIATE MEASURES TO MINIMISE THE RELEASE OF SEDIMENT DURING ITS INSTALLATION. SUCH MEASURES SHOULD ONLY INSTALLED IF CONSIDERED APPROPRIATE FOR THE LOCAL CONDITIONS, AND ONLY IF THEIR INSTALLATION IS JUDGED TO PROVIDE A NET OVERALL ENVIRONMENTAL BENEFIT.

5. TO THE MAXIMUM DEGREE PRACTICABLE, CONSTRUCTION ACTIVITIES AND EQUIPMENT SHOULD NOT OPERATE WITHIN OPEN FLOWING WATERS.

6. IDENTIFY THE APPROPRIATE LOCATION OF THE OUTER ISOLATION BARRIER. FOR REASONS OF SAFETY, THE OUTER BARRIER SHOULD NOT BE PLACED IN WATER DEPTHS EXCEEDING 1.2m.

7. IF PLACED IN LARGE OPEN WATERS, INSTALL THE ISOLATION BARRIERS SUCH THAT THE TOP OF EACH FENCE IS AT LEAST 300mm ABOVE THE WATERLINE TO PREVENT OVER-TOPPING BY WAVES OR FLUCTUATIONS IN WATER LEVEL.

8. PLACE THE SUPPORT POSTS (OUTER BARRIER) AT A MAXIMUM SPACING OF 2m WITH WIRE MESH BACKING, OR 1.5m WITHOUT WIRE MESH BACKING. DRIVE THE POSTS 600mm INTO THE CHANNEL BED OR UNTIL THE POST ARE SECURE. IF THE SUPPORT POST CANNOT BE DRIVEN 600mm INTO THE BED, THEN ADDITIONAL BRACING MAYBE REQUIRED.

9. ATTACH ANY FENCE REINFORCEMENT (WIRE MESH) AS SPECIFIED IN THE APPROVED PLANS OR AS DIRECTED.

10. PRIOR TO INSTALLING THE FABRIC, SECURE (SEW) A BALLAST CHAIN INTO THE BOTTOM OF THE FABRIC.

11. ATTACH THE SPECIFIED FABRIC TO THE CHANNEL SIDE OF THE POSTS. WHERE POSSIBLE, USED A CONTINUOUS ROLL OF FABRIC. IF THIS IS NOT POSSIBLE, CONSTRUCT SUITABLE LEAK-PROOF JOINTS IN THE FABRIC.

12. FASTEN THE FABRIC SECURELY USING HEAVY-DUTY STAPLES OR NAILS (WITH A WASHER) AT A MAXIMUM SPACING OF 50mm. USE WIRE TIES TO SECURELY ATTACH THE FABRIC TO THE WIRE MESH (IF USED).

13. IF IT IS NOT PRACTICABLE TO ATTACH A BALLAST TO THE BOTTOM OF THE FABRIC, THEN SECURE THE BOTTOM 300mm OF FABRIC TO THE CHANNEL BED USING A CONTINUOUS PLACEMENT (MINIMUM 50mm) OF LARGE AGGREGATE OR CLEAN ROCK FILL.

14. AFTER INSTALLING THE OUTER ISOLATION BARRIER, INSTALL THE SECOND LANDWARD BARRIER (IF REQUIRED). THE LANDWARD BARRIER IS USUALLY LOCATED JUST ABOVE THE NORMAL WATER LINE, BUT SHOULD BE LOCATED SO AS NOT TO INTERFERE WITH ADJACENT CONSTRUCTION ACTIVITIES.

15. ENSURE THE TOP OF THE FABRIC OF THE OUTER BARRIER IS AT LEAST 200mm ABOVE THE MAXIMUM EXPECTED, DRY WEATHER (I.E. NON-FLOOD FLOW) WATER LEVEL.

16. INSTALL THE LANDWARD SEDIMENT FENCE IN ACCORDANCE WITH THE NORMAL INSTALLATION PROCEDURES FOR A SEDIMENT FENCE, EXCEPT THE MAXIMUM SPACING OF SUPPORT POSTS IS 2m WITH OR WITHOUT A WIRE MESH BACKING. ENSURE THE FABRIC IS ATTACHED TO THE LANDWARD SIDE OF THE POSTS.

MAINTENANCE

1. INSPECT THE ISOLATION BARRIER DAILY AND AFTER ANY SIGNIFICANT CHANGE IN STREAM FLOW. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. INSPECT THE BARRIER FOR TURBIDITY LEAKS THAT MIGHT BE CAUSED BY HOLES IN THE BARRIER OR DAMAGE TO THE FABRIC-STREAMBED CONTACT.

3. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC FROM POST TO POST.

4. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

REMOVAL

1. ALL COMPONENTS OF THE SEDIMENT FENCE ISOLATION BARRIER SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE ANY CHANNEL WATER CONTAINED WITHIN THE ENCLOSED CHANNEL AREA IS SUITABLY TREATED BEFORE EITHER THE WATER IS DISCHARGED FROM THE ENCLOSURE OR THE ISOLATION BARRIER IS REMOVED.

4. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

5. STARTING FROM THE UPSTREAM END, REMOVE ALL MATERIALS USED TO FORM THE ISOLATION BARRIER AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

6. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	May-10	Sediment Fence Isolation Barrier	SFB-02

Flow Control Berms CB-01

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BERM, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY.

4. FORM THE BERM FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

6. CHECK THE ALIGNMENT OF THE BERM TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

7. ENSURE THE BERM DISCHARGES TO A STABLE OUTLET.

8. ENSURE THE BERM DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW CONTROL BERMS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BERM FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BERM THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW CONTROL BERM SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

Table 1 - Recommended dimensions of flow control berms

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

Drawn:	Date:		
GMW	Dec-09	Flow Control Berms	CB-01

Flow Diversion Banks DB-01

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BANK, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. FORM THE BANK FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF EARTH IS USED, THEN ENSURE THE SIDES OF THE BANK ARE NO STEEPER THAN A 2:1 (H:V) SLOPE, AND THE COMPLETED BANK MUST BE AT LEAST 500mm HIGH.

6. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

7. CHECK THE BANK ALIGNMENT TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

8. THE BANK SHOULD BE VEGETATED (TURFED, SEEDED AND MULCHED), OR OTHERWISE STABILISED IMMEDIATELY, UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS OR IF SIGNIFICANT RAINFALL IS NOT EXPECTED DURING THE LIFE OF THE BANK.

9. ENSURE THE EMBANKMENT DRAINS TO A STABLE OUTLET, AND DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW DIVERSION BANKS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BANK FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BANK THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW DIVERSION BANK SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

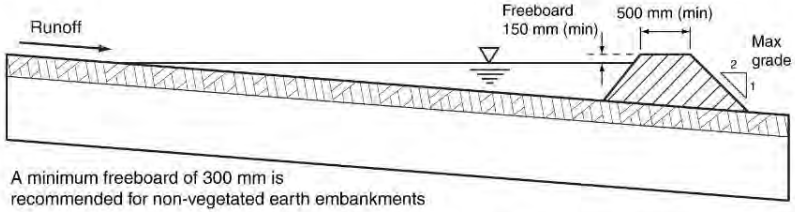


Figure 1 - Typical profile of flow diversion bank formed from earth

Table 1 - Recommended dimensions of flow diversion banks

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

Drawn:	Date:		
GMW	Dec-09	Flow Diversion Banks	DB-01

Gravelling Gravel – 01

MATERIAL

GRAVEL: 20–50mm HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. SPREAD ENOUGH GRAVEL TO COMPLETELY COVER THE SURFACE OF THE SOIL AT THE DENSITY OR THICKNESS SPECIFIED IN THE APPROVED PLANS. IF THE APPLICATION DENSITY IS NOT SUPPLIED, THEN APPLY AT A THICKNESS OF AT LEAST TWICE THE MEAN ROCK SIZE.

3. MAKE ALL NECESSARY ADJUSTMENTS TO ENSURE ANY RUN-ON STORMWATER FLOW IS ALLOWED TO PASS FREELY ACROSS THE TREATED AREA FOLLOWING ITS NATURAL DRAINAGE PATH.

MAINTENANCE

1. INSPECT ALL TREATED SURFACES FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CHECK FOR RILL EROSION, OR DISLODGMENT OF THE GRAVEL.

3. REPLACE ANY DISPLACED GRAVEL TO MAINTAIN THE REQUIRED COVERAGE.

4. IF WASH-OUTS OCCUR, REPAIR THE SLOPE AND REINSTALL SURFACE COVER.

5. IF THE GRAVELLING IS NOT EFFECTIVE IN CONTAINING THE SOIL EROSION IT SHOULD BE REPLACED, OR AN ALTERNATIVE EROSION CONTROL PROCEDURE ADOPTED.

Drawn:	Date:		
GMW	Dec-09	Gravelling	Gravel-01

Mulch Filter Berms MB-01

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

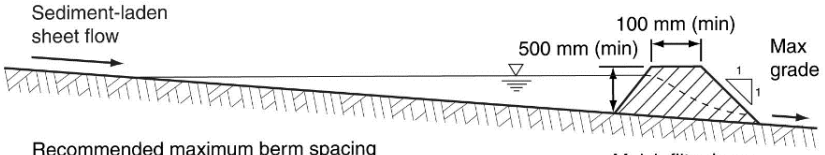
5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.



Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

Catchments & Creeks Pty Ltd

Revegetation – General R-01

CAUTION; SPECIFICATIONS FOR SITE REVEGETATION VARY CONSIDERABLY FROM SITE TO SITE. SITE SUPERVISORS SHOULD OBTAIN SITE SPECIFIC PLANTING SPECIFICATIONS.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER, LANDSCAPE ARCHITECT OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. APPLY SOIL CONDITIONERS AND FERTILISER AS SPECIFIED ON THE APPROVED PLANS. RIP THE SOIL 100 TO 150mm TO MIX THE COMPONENTS INTO THE SOIL AND TO LOOSEN AND ROUGHEN THE SOIL SURFACE BEFORE SEEDING.

4. WHERE POSSIBLE, THERE SHOULD BE SUFFICIENT SOIL DEPTH TO PROVIDE AN ADEQUATE ROOT ZONE. THE DEPTH TO ROCK OR IMPERMEABLE LAYERS SUCH AS HARDPANS SHOULD BE 300mm OR MORE, EXCEPT ON SLOPES STEEPER THAN 2:1(H:V) WHERE SUCH SOIL DEPTH MAY NOT BE FEASIBLE.

5. ENSURE THE SOIL pH IS WITHIN THE SPECIFIED RANGE.

6. APPLY SEED UNIFORMLY BY HAND OR WITH A CYCLONE SEEDER, DROP-TYPE SPREADER, DRILL, HYDROSEEDER, HYDROMULCHER, OR OTHER SUITABLE EQUIPMENT AS SPECIFIED.

7. WHEN USING BROADCAST-SEEDING METHODS, SUBDIVIDE THE AREA INTO WORKABLE SECTIONS AND APPLY ONE-HALF THE SPECIFIED QUANTITY OF SEED WHILE MOVING BACK AND FORTH ACROSS THE AREA, MAKING A UNIFORM PATTERN. THEN APPLY THE SECOND HALF IN THE SAME WAY, BUT MOVING AT RIGHT ANGLES TO THE FIRST PASS. COVER BROADCAST SEED BY RAKING OR CHAIN DRAGGING; THEN FIRM THE SURFACE WITH A ROLLER TO PROVIDE GOOD SEED CONTACT.

8. APPLY SEED AT THE RECOMMENDED RATE, AND DISC OR OTHERWISE MECHANICALLY TREAT THE SURFACE TO BRING THE SEED INTO CONTACT WITH THE SOIL.

9. THE SEEDED AREA SHOULD BE MULCHED AS SPECIFIED IN THE APPROVED PLAN.

MAINTENANCE

1. DURING THE CONSTRUCTION PHASE, INSPECT THE TREATED AREA FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL. MAKE REPAIRS AS NEEDED.

2. WATERING THE VEGETATION PERIODICALLY IS ESSENTIAL, ESPECIALLY IN THE FIRST 7 DAYS AFTER ESTABLISHMENT. USE LOW-PRESSURE SPRAYS BECAUSE HIGH-PRESSURE JETS CAN WASH AWAY THE SEED AND MULCH COVER.

3. WATERING SHOULD START IMMEDIATELY AFTER PLANTING. WATERING SHOULD COMPLY WITH SPECIFICATIONS PROVIDED WITH THE APPROVED PLANS. GENERALLY WATERING SHOULD VARY ACCORDING TO WEATHER AND SOIL CONDITIONS. A TYPICAL WATERING SCHEDULE MAY CONSIST OF THE FOLLOWING:
(i) 25mm EVERY SECOND DAY FOR THE FIRST THREE WATERINGS;
(ii) 25mm TWICE A WEEK FOR THE NEXT THREE WEEKS; AND
(iii) 25mm ONCE WEEKLY FOR A FURTHER TWO WEEKS.

4. MONITOR SITE REVEGETATION, PARTICULARLY AFTER RAINFALL, AND APPROPRIATE MAINTENANCE AND/OR AMENDMENT TO ENSURE THAT THE REVEGETATION IS CONTROLLING EROSION AND STABILISING SOIL SLOPES AS REQUIRED.

5. WHERE PRACTICABLE, FILL IN, OR LEVEL OUT, ANY RILL EROSION BETWEEN PLANTS. IF EXCESSIVE EROSION OCCURS, THEN CONSIDER INCREASING THE PLANTING DENSITY, APPLYING APPROPRIATE EROSION CONTROL MEASURES, OR INTRODUCING ALTERNATIVE, NON-CLUMPING PLANT SPECIES.

6. AREAS MUST BE RE-SEEDED AND MULCHED IF THE VEGETATION FAILS TO ESTABLISH OR IS DAMAGED BY RUNOFF OR CONSTRUCTION ACTIVITIES.

7. IF THE TEMPORARY VEGETATION COVER OR EROSION CONTROL MEASURE (e.g. MULCH COVER) SHOULD FAIL FOR ANY REASON BEFORE ESTABLISHMENT OF THE PERMANENT VEGETATION COVER, THEN IT MUST BE REPLACED WITH AN APPROPRIATE TYPE OF COVER SUFFICIENT TO CONTROL SOIL EROSION.

8. IF THE PERMANENT VEGETATION SHOULD FAIL TO ESTABLISH OR TO ADEQUATELY RESTRAIN EROSION FOR ANY REASON DURING THE CONSTRUCTION OR MAINTENANCE PERIOD, THE AREA SHOULD BE REVEGETATED OR PROTECTED WITH OTHER EROSION CONTROL MEASURES AS APPROPRIATE.

9. IN AREAS WHERE THE OBTAINED VEGETATION COVER IS CONSIDERED INADEQUATE FOR EROSION CONTROL, THE AFFECTED AREA SHOULD BE OVER-SEEDED AND FERTILISED USING HALF THE ORIGINALLY SPECIFIED RATES, OR AS DIRECTED.

10. MAINTAIN GRASS BLADE LENGTH AT A MINIMUM 50mm HEIGHT WITHIN MEDIUM TO HIGH VELOCITY DRAINAGE AREAS, AND 20 TO 50mm WITHIN LOW VELOCITY FLOW PATHS.

11. WHERE NECESSARY, OR AS DIRECTED BY THE SITE SUPERVISOR, SLASH THE TEMPORARY CROP/GRASS COVER TO ALLOW THE SUCCESSFUL GROWTH OF THE UNDERLYING PERMANENT VEGETATION COVER.

12. CONTROL WEED GROWTH WITHIN 1m OF I-MMATURE TREES FOR 6 TO 12 MONTHS FOR FAST GROWING SPECIES, AND 18 TO 20 MONTHS FOR SLOWER GROWING SPECIES, OR UNTIL THE END OF THE SPECIFIED MAINTENANCE PERIOD.

13. WHERE MULCH IS USED TO CONTROL WEED GROWTH, INSPECT AND WHERE NECESSARY, RENEW AT MAINTENANCE PERIODS NOT EXCEEDING 4 TO 6 MONTHS.

14. APPLY ADDITIONAL SEED, MULCH AND/OR SOIL CONDITIONING AS REQUIRED. MULCHES USUALLY NEED TO BE MAINTAINED OR RENEWED (AS NECESSARY) 2 TO 3 TIMES A YEAR.

15. INSPECT AND WHERE NECESSARY REPAIR PROTECTIVE FENCING AT MAINTENANCE PERIODS NOT EXCEEDING 1 MONTH.

16. RE-FIRM PLANTS LOOSENED BY WIND-ROCK, LIVESTOCK OR WILDLIFE.

17. REPLACE DEAD OR SEVERELY RETARDED PLANTS.

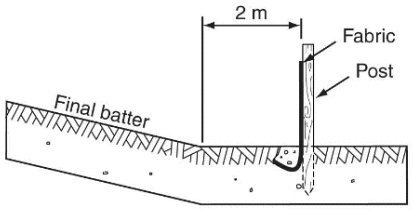
18. PRUNE ANY PLANTS OF DEAD OR DISEASED PARTS. CUT OFF ALL DAMAGED TREE LIMBS ABOVE THE TREE COLLAR AT THE TRUNK OR MAIN BRANCH. USE SEVERAL CUTS INCLUDING UNDERCUTTING TO AVOID PEELING BARK FROM THE HEALTHY AREAS OF THE TREE.

19. DISPOSE OF CLEARED VEGETATION IN AN APPROPRIATE MANNER SUCH AS CHIPPING OR MULCHING, ON-SITE BURIAL, OR OFF-SITE DISPOSAL. CLEARED VEGETATION SHOULD NOT BE DUMPED NEAR A WATERCOURSE OR ON A FLOODPLAIN WHERE IS COULD BE REMOVED BY FLOODWATERS. VEGETATION SHOULD NOT BE BURNT ON-SITE WITHOUT SPECIFIC APPROVAL FROM THE LOCAL AUTHORITY.

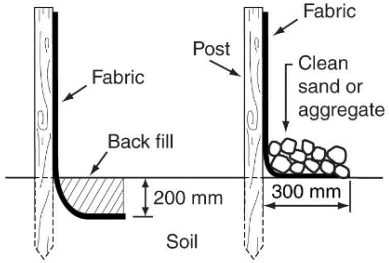
20. REPAIR DAMAGED TREE ROOTS BY CUTTING OFF THE DAMAGED AREAS AND SEALING THEM WITH AN APPROVED PRODUCT. SPREAD MOIST TOPSOIL OVER EXPOSED ROOTS.

Drawn:	Date:		
GMW	Dec-09	Revegetation - General	R-01

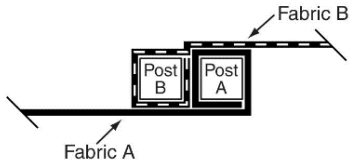
Sediment Fence SF-01 & SF-02



(a) Location of fence relative to base of slope

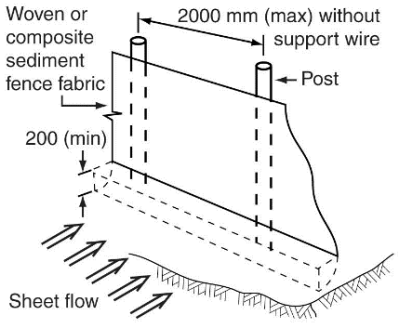


(b) Anchoring base of fabric

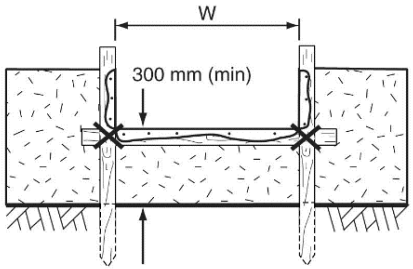


Fabric to fold around each stake one full turn.
Stake B to be drive tightly against Stake A.
The tops of both stakes to be secured with wire.

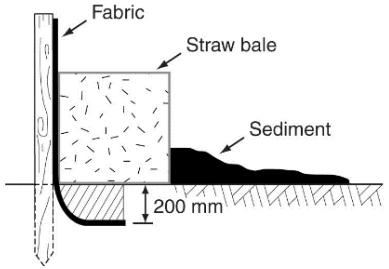
(c) Joining fabric - Method 1



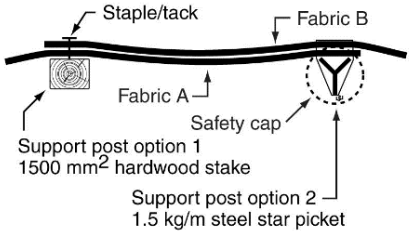
(d) Installation without backing support



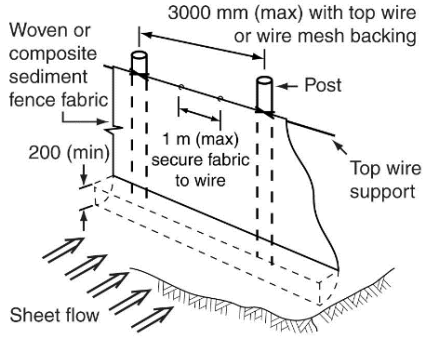
(e) Spill-through weir



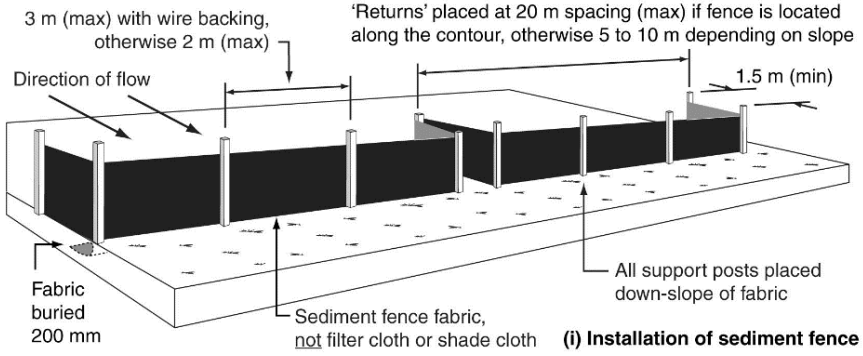
(f) Placement of up-slope straw bale



(g) Joining fabric - Method 2



(h) Installation with top wire support



(i) Installation of sediment fence

Notes:

1. Sediment fence to be installed along a line of constant ground elevation wherever practical.
2. Both end of the sediment fence to extend up the slope at least 1m.
3. Support post to be spaced a maximum 2m unless the fence is supported by a top wire or wire mesh backing, in which case 3m maximum spacing.
4. Fence 'returns' shall be installed at maximum 20m spacing if fence is installed along the contour, otherwise 5 to 10m maximum spacing.
5. Minimum 4 staples or tie wires per stake.

Drawn:	Date:		
GMW	Dec-09	Sediment Fence	SF-01

MATERIALS

FABRIC: POLYPROPYLENE, POLYAMIDE, NYLON, POLYESTER, OR POLYETHYLENE WOVEN OR NON-WOVEN FABRIC, AT LEAST 700mm IN WIDTH AND A MINIMUM UNIT WEIGHT OF 140GSM. ALL FABRICS TO CONTAIN ULTRAVIOLET INHIBITORS AND STABILISERS TO PROVIDE A MINIMUM OF 6 MONTHS OF USEABLE CONSTRUCTION LIFE (ULTRAVIOLET STABILITY EXCEEDING 70%).

FABRIC REINFORCEMENT: WIRE OR STEEL MESH MINIMUM 14-GAUGE WITH A MAXIMUM MESH SPACING OF 200mm.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND REQUIRED TYPE OF FABRIC (IF SPECIFIED). IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, FABRIC TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. TO THE MAXIMUM DEGREE PRACTICAL, AND WHERE THE PLANS ALLOW, ENSURE THE FENCE IS LOCATED:
(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;
(ii) ALONG A LINE OF CONSTANT ELEVATION WHEREVER PRACTICAL;
(iii) AT LEAST 2m FROM THE TOE OF ANY FILLING OPERATIONS THAT MAY RESULT IN SHIFTING SOIL/FILL DAMAGING THE FENCE.

3. INSTALL RETURNS WITHIN THE FENCE AT MAXIMUM 20m INTERVALS IF THE FENCE IS INSTALLED ALONG THE CONTOUR, OR 5 TO 10m MAXIMUM SPACING (DEPENDING ON SLOPE) IF THE FENCE IS INSTALLED AT AN ANGLE TO THE CONTOUR. THE 'RETURNS' SHALL CONSIST OF EITHER:
(i) V-SHAPED SECTION EXTENDING AT LEAST 1.5m UP THE SLOPE; OR
(ii) SANDBAG OR ROCK/AGGREGATE CHECK DAM A MINIMUM 1/3 AND MAXIMUM 1/2 FENCE HEIGHT, AND EXTENDING AT LEAST 1.5m UP THE SLOPE.

4. ENSURE THE EXTREME ENDS OF THE FENCE ARE TURNED UP THE SLOPE AT LEAST 1.5m, OR AS NECESSARY, TO MINIMISE WATER BYPASSING AROUND THE FENCE.

5. ENSURE THE SEDIMENT FENCE IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE FENCE, AND THE UNDESIRABLE DISCHARGE OF WATER AROUND THE ENDS OF THE FENCE.

6. IF THE SEDIMENT FENCE IS TO BE INSTALLED ALONG THE EDGE OF EXISTING TREES, ENSURE CARE IS TAKEN TO PROTECT THE TREES AND THEIR ROOT SYSTEMS DURING INSTALLATION OF THE FENCE. DO NOT ATTACH THE FABRIC TO THE TREES.

7. UNLESS DIRECTED BY THE SITE SUPERVISOR OR THE APPROVED PLANS, EXCAVATE A 200mm WIDE BY 200mm DEEP TRENCH ALONG THE PROPOSED FENCE LINE, PLACING THE EXCAVATED MATERIAL ON THE UP-SLOPE SIDE OF THE TRENCH.

8. ALONG THE LOWER SIDE OF THE TRENCH, APPROPRIATELY SECURE THE STAKES INTO THE GROUND SPACED NO GREATER THAN 3m IF SUPPORTED BY A TOP SUPPORT WIRE OR WEIR MESH BACKING, OTHERWISE NO GREATER THAN 2m.

9. IF SPECIFIED, SECURELY ATTACH THE SUPPORT WIRE OR MESH TO THE UP-SLOPE SIDE OF THE STAKES WITH THE MESH EXTENDING AT LEAST 200mm INTO THE EXCAVATED TRENCH. ENSURE THE MESH AND FABRIC IS ATTACHED TO THE UP-SLOPE SIDE OF THE STAKES EVEN WHEN DIRECTING A FENCE AROUND A CORNER OR SHARP CHANGE OF DIRECTION.

10. WHEREVER POSSIBLE, CONSTRUCT THE SEDIMENT FENCE FROM A CONTINUOUS ROLL OF FABRIC. TO JOIN FABRIC EITHER:
(i) ATTACH EACH END TO TWO OVERLAPPING STAKES WITH THE FABRIC FOLDING AROUND THE ASSOCIATED STAKE ONE TURN, AND WITH THE TWO STAKES TIED TOGETHER WITH WIRE; OR
(ii) OVERLAP THE FABRIC TO THE NEXT ADJACENT SUPPORT POST.

11. SECURELY ATTACH THE FABRIC TO THE SUPPORT POSTS USING 25 X 12.5mm STAPLES, OR TIE WIRE AT MAXIMUM 150mm SPACING.

12. SECURELY ATTACH THE FABRIC TO THE SUPPORT WIRE/MESH (IF ANY) AT A MAXIMUM SPACING OF 1m.

13. ENSURE THE COMPLETED SEDIMENT FENCE IS AT LEAST 450mm, BUT NOT MORE THAN 700mm HIGH. IF A SPILL-THOUGH WEIR IS INSTALLED, ENSURE THE CREST OF THE WEIR IS AT LEAST 300mm ABOVE GROUND LEVEL.

14. BACKFILL THE TRENCH AND TAMP THE FILL TO FIRMLY ANCHOR THE BOTTOM OF THE FABRIC AND MESH TO PREVENT WATER FROM FLOWING UNDER THE FENCE.

ADDITIONAL REQUIREMENTS FOR THE INSTALLATION OF A SPILL-THROUGH WEIR

1. LOCATE THE SPILL-THROUGH WEIR SUCH THAT THE WEIR CREST WILL BE LOWER THAN THE GROUND LEVEL AT EACH END OF THE FENCE.

2. ENSURE THE CREST OF THE SPILL-THROUGH WEIR IS AT LEAST 300mm THE GROUND ELEVATION.

3. SECURELY TIE A HORIZONTAL CROSS MEMBER (WEIR) TO THE SUPPORT POSTS/ STAKES EACH SIDE OF THE WEIR. CUT THE FABRIC DOWN THE SIDE OF EACH POST AND FOLD THE FABRIC OVER THE CROSS MEMBER AND APPROPRIATELY SECURE THE FABRIC.

4. INSTALL A SUITABLE SPLASH PAD AND/OR CHUTE IMMEDIATELY DOWN-SLOPE OF THE SPILL-THROUGH WEIR TO CONTROL SOIL EROSION AND APPROPRIATELY DISCHARGE THE CONCENTRATED FLOW PASSING OVER THE WEIR.

MAINTENANCE

1. INSPECT THE SEDIMENT FENCE AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC FROM POST TO POST.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. IF THE FENCE IS SAGGING BETWEEN STAKES, INSTALL ADDITIONAL SUPPORT POSTS.

5. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 1/3 THE HEIGHT OF THE FENCE.

6. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. REPLACE THE FABRIC IF THE SERVICE LIFE OF THE EXISTING FABRIC EXCEEDS 6-MONTHS.

REMOVAL

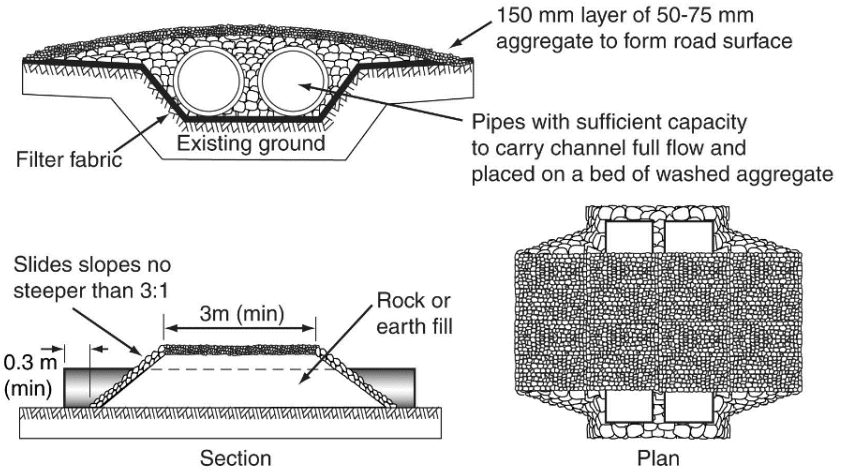
1. WHEN DISTURBED AREAS UP-SLOPE OF THE SEDIMENT FENCE ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE FENCE MUST BE REMOVED.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

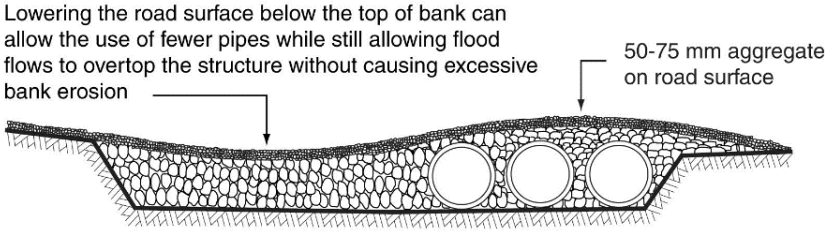
3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Drawn:	Date:		
GMW	Apr-10	Sediment Fence	SF-02

Temporary Culvert Crossing TCC-01 and TCC-02

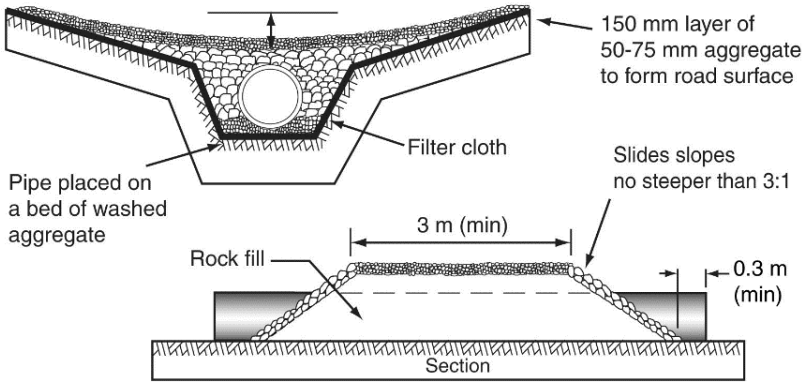


(a) Preferred arrangement for temporary culvert crossings

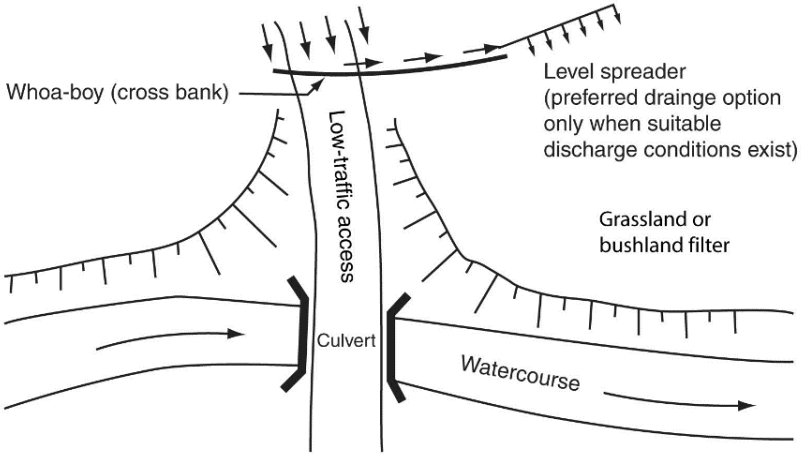


(b) Typical profile of temporary culvert crossings of wide channels

In situations where it is not practicable to allow overflows to initially passing around the culvert on a stable (well vegetated) stream bank, then the center must be set low to allow flow to pass over the culvert along the centreline of the channel



(c) Alternative layout for the crossing of confined channels



(d) Typical arrangement of surface runoff controls associated with approach ramps

Drawn:	Date:		
GMW	Dec-09	Temporary Culvert Crossing	TCC-01

Catchments & Creeks Pty Ltd

MATERIALS

CULVERTS: ANY COMMERCIAL CONDUIT THAT IS SUITABLE FOR THE REQUIRED TRAFFIC LOADING.

ROCK: MINIMUM 150mm NOMINAL ROCK SIZE.

AGGREGATE: 50–75mm CLEAN AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH (MINIMUM BIDIM A34 OR EQUIVALENT).

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONSTRUCT THE TEMPORARY WATERCOURSE CROSSING, INCLUDING PERMITS FOR THE DISTURBANCE OF BANK VEGETATION, AQUATIC VEGETATION (e.g. MANGROVES) AND ANY TEMPORARY INSTREAM FLOW DIVERSION BARRIERS OR SEDIMENT CONTROL MEASURES.

2. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. ENSURE THAT THE LOCATION OF THE CROSSING WILL NOT INTERFERE WITH FUTURE CONSTRUCTION WORKS.

4. PRIOR TO SIGNIFICANT LAND CLEARING OR CONSTRUCTION OF THE APPROACH RAMPS, ESTABLISH ALL NECESSARY SEDIMENT CONTROL MEASURES AND FLOW DIVERSION WORKS (INSTREAM AND OFF-STREAM AS REQUIRED), CLEARING ONLY THOSE AREAS NECESSARY FOR INSTALLATION OF THESE MEASURES.

5. TO THE MAXIMUM DEGREE PRACTICABLE, CONSTRUCTION ACTIVITIES AND EQUIPMENT MUST NOT OPERATE WITHIN OPEN FLOWING WATERS.

6. MAINTAIN CLEARING AND EXCAVATION OF THE WATERCOURSE BED AND BANKS TO A MINIMUM. INITIALLY CLEAR ONLY THE AREA NECESSARY TO ALLOW ACCESS FOR CONSTRUCTION. CLEAR THE REMAINDER OF THE APPROACH RAMPS ONLY WHEN ADEQUATE DRAINAGE AND SEDIMENT CONTROLS ARE IN PLACE.

7. IF FLOW DIVERSION SYSTEMS CANNOT BE INSTALLED, THEN CONDUCT BANK EXCAVATIONS BY PULLING THE SOIL AWAY FROM THE CHANNEL.

8. WHERE PRACTICABLE, CONSTRUCT THE WATERCOURSE CROSSING PERPENDICULAR TO THE CHANNEL.

9. WHERE PRACTICABLE, THE APPROACH RAMPS SHOULD BE STRAIGHT FOR AT LEAST 10m AND SHOULD BE ALIGNED WITH THE CROSSING.

10. WHERE PRACTICABLE, DIRECT STORMWATER RUNOFF FROM THE APPROACH RAMPS INTO STABLE DRAINS, ADJACENT VEGETATION, OR APPROPRIATE SEDIMENT TRAPS TO MINIMISE THE RELEASE OF SEDIMENT INTO THE WATERCOURSE.

11. SHAPE THE CHANNEL, IF NECESSARY, TO RECEIVE THE PIPE/S.

12. IF HIGHLY EROSIVE SOILS ARE DETECTED, THEN APPROPRIATELY STABILISE SUCH SOILS AS SOON AS PRACTICABLE.

13. COVER THE CROSSING FOOTING WITH HEAVY-DUTY FILTER CLOTH.

14. COVER THE FILTER CLOTH WITH A MINIMUM 150mm OF CLEAN, 50 TO 75mm AGGREGATE.

15. PLACE THE SPECIFIED SIZE AND NUMBER OF CULVERT CELLS AND ALIGN THEM WITH THE DIRECTION OF THE DOWNSTREAM CHANNEL.

16. ENSURE THE PIPES EXTEND AT LEAST 300mm BEYOND THE PROPOSED EXTEND OF ROCK FILL.

17. FILL BETWEEN THE PIPE/S WITH 75 TO 100mm AGGREGATE.

18. COVER PIPE/S WITH SUFFICIENT ROCK (MINIMUM 300mm LAYER) TO SATISFY MANUFACTURER'S LOADING REQUIREMENTS TO AVOID DAMAGE TO THE PIPE/S RESULTING FROM THE EXPECTED TRAFFIC LOAD. SLOPE OF ROCK FACE UPSTREAM AND DOWNSTREAM OF THE CULVERT NO STEEPER THAN 3:1 (H:V).

19. FORM THE SHAPE OF THE ROAD SURFACE IN ACCORDANCE WITH THE PLANS AND/OR STANDARD DRAWINGS.

20. APPLY A SUITABLE COVER OF AGGREGATE OVER THE ROCK FILL TO FORM THE TRAFFICABLE ROAD SURFACE.

21. FINISH CONSTRUCTION AND STABILISATION OF THE APPROACH ROADS INCLUDING THE APPROACH RAMPS EACH SIDE OF THE BRIDGE CROSSING.

22. TAKE ALL REASONABLE MEASURES TO PREVENT EXCESS ROCK, DEBRIS AND CONSTRUCTION MATERIAL FROM ENTERING THE WATERCOURSE, ESPECIALLY ANY STILL OR FLOWING WATER.

23. IF IT IS NOT PRACTICABLE TO STABILISE THE ACCESS RAMPS AGAINST EROSION, THEN INSTALL FLOW DIVERSION BANKS ACROSS THE WIDTH OF EACH ACCESS RAMP ADJACENT THE TOP OF THE CHANNEL BANK, AND AT REGULAR INTERVALS DOWN THE RAMPS (AS REQUIRED) TO PREVENT OR MINIMISE SEDIMENT-LADEN RUNOFF FLOWING DIRECTLY INTO THE WATERCOURSE.

24. APPROPRIATELY STABILISE ANY DISTURBED WATERCOURSE BANKS.

25. STABILISE ALL DISTURBED AREAS THAT ARE LIKELY TO BE SUBJECTED TO FLOWING WATER, INCLUDING BYPASS AND OVERFLOW AREAS, WITH ROCK OR OTHER SUITABLE MATERIALS.

MAINTENANCE

1. TEMPORARY WATERCOURSE CROSSINGS SHOULD BE INSPECTED WEEKLY AND AFTER ANY SIGNIFICANT CHANGE IN STREAM FLOW.

2. DEBRIS TRAPPED ON OR UPSTREAM OF THE CROSSING SHOULD BE REMOVED.

3. REPAIR ANY DAMAGE CAUSED BY CONSTRUCTION TRAFFIC. IF TRAFFIC HAS EXPOSED BARE SOIL, STABILISED AS APPROPRIATE. MAINTAIN A MINIMUM 200mm COVER OVER THE CULVERTS.

4. CHECK FOR EROSION OF THE FORMED EMBANKMENT, CHANNEL SCOUR, OR ROCK DISPLACEMENT. MAKE ALL NECESSARY REPAIRS IMMEDIATELY.

5. CHECK THE BYPASS FLOODWAY MAKING SURE THE BANKS ARE STABLE.

6. CHECK FOR EXCESSIVE EROSION ON THE APPROACH ROADS.

7. CHECK THE CONDITIONS OF ANY FLOW DIVERSION CHANNELS/BANKS AND THE OPERATING CONDITIONS OF ASSOCIATED SEDIMENT TRAPS.

REMOVAL

1. TEMPORARY WATERCOURSE CROSSINGS SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER ALTERNATIVE ACCESS IS ACHIEVED OR THE CULVERT IS NO LONGER NEEDED.

2. REMOVE ALL SPECIFIED MATERIALS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Dec-09	Temporary Culvert Crossing	TCC-02

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