CONSTRUCTION SOIL AND WATER MANAGEMENT SUB-PLAN

St Marys Intermodal

Pacific National

SSD 7308

Rev #	Name	Organisation	Signed	Date
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Amendment Record Sheet

Rev	Date of Rev	Author	Summary of Change
00	28/05/2020	David Stubbs	Initial draft for review
01	30/06/2020	David Stubbs	Updated addressing DPIE comments
02	14/07/2020	David Stubbs	Updated with new stockpiling area
03	16/07/2020	David Stubbs	Updated addressing DPIE comments
04	27/07/2020	David Stubbs	Updated addressing DPIE comments
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06	13/01/2021	Tim Stubbs	Update to reflect Modifications 1 and 4
07	01/02/2021	Tim Stubbs	Updated to reflect approval of MOD 1
08	16/02/2021	Tim Stubbs	Updated to address DPIE comments
09	10/03/2021	Tim Stubbs	Update to address DPIE comments

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Glossary/Abbreviations

Abbreviation	Expanded Text
ANZEEC	Australian and New Zealand Environment and Conservation Council
BMSP	Biodiversity Management Sub-Plan
CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
CNVMSP	Construction Noise and Vibration Management Sub-Plan
CSWMSP	Construction Soil and Water Management Sub-Plan
CTPMSP	Construction Traffic and Pedestrian Management Sub-Plan
CWMSP	Construction Waste Management Sub-Plan
ECM	Environmental Control Plan
EM	Environment Manager
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPA	Environmental Protection Authority
EPL	Environmental Protection License
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FERMP	Flood Emergency Response Management Plan
FM	Site Foreman/Supervisor
Minister, the	Minister of the NSW Department of Planning and Environment (or delegate)
OEH	Office of Environment and Heritage
PD	Project Director
SM	Site Manager

1. Introduction

1.1. Background

The St Marys Freight Intermodal Project is located approximately 43 kilometers (km) north-west of the Sydney Central Business District (CBD) and approximately 48 km north-west of Port Botany.
The St Marys Freight Intermodal Project is a major infrastructure development for Pacific National (PN). The works entail approximately 9.9ha of intermodal (road and rail) terminal and container park with ultimate operation capacity of 301,000 TEU annually. The works will enable container rail shuttle to and from Port Botany and will reduce heavy vehicle truck movements on greater Western Sydney's road network.

The broader site is described as:

- Lot 2 DP 876781;
- Lot 3 DP 876781;
- Lot 196 DP 31912.
- Lot 2031 DP 815293

Please refer to Section 2 of the CEMP for an expanded Project Description.

1.2. Context

This Construction Soil and Water Sub-plan (CSWMSP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the St Marys Intermodal Project (the Project).

This CSWMSP has been prepared to address the requirements of:

the Minister's Conditions of Consent (CoC), the St Marys Freight Hub Environmental Impact Statement (EIS), the Revised Management and Mitigation Measures (RMMM) listed in the St Marys Freight Hub Response to Submissions Report and all applicable guidance and legislation. It also addresses the requirements of MOD 1,2,3 and 4.

1.3. Scope

The scope of this Plan is to describe how McMahon Services proposes to manage erosion and sediment control, surface water quality, site wastewater, potential water contamination, groundwater and flooding issues during the construction of the Project. Operational waste management measures do not fall within the scope of this Plan and therefore are not included within the processes contained within this Plan.

2. Purpose and Objectives

2.1. Purpose

This CEMP and sub-plans have been prepared to outline and describe how McMahon's will, during the construction of the Project, comply with the NSW Minister for Planning's Conditions of Consent (CoC). Additionally, it outlines how McMahon's will minimise environmental risks and achieve environmental outcomes on the Project by providing a structured approach to ensure appropriate revised management and mitigation measures (RMMMs) and controls are implemented.

This CEMP is the overarching document in the Environmental Management System (EMS) for the Project that includes a number of management documents. It is applicable to all staff and Subcontractors associated with the construction of the Project.

Implementing the CEMP and sub-plans effectively will enable the Project to meet the requirements of the Minister's CoC and RMMMs (see Annexure B).

This CEMP will:

- Describe the Project, including the construction activities to be undertaken and their scheduling during construction,
- Identify the environmental obligations applicable to the Project and the hazards and risks associated with the works,
- Outline the environmental management policies, guidelines and principles to be followed in the construction of the Project,
- Describe the roles and responsibilities of personnel in relation to environmental management during construction of the Project,
- Outline specific mitigation measures and controls to be applied on site to avoid or minimise negative environmental impacts and prevent unauthorised environmental harm,
- Provide specific mechanisms for compliance with the applicable policies, approvals, licenses, permits, consultation agreements and legislation, and
- Outline a monitoring and review regime to check the adequacy of controls as they are implemented during construction.

2.2. Environmental Objectives

The key objective of this CSWMSP is to ensure all CoC, RMMMs and license/ permit requirements relevant to soil and water management are described, scheduled and assigned responsibility as outlined in:

- The EIS prepared for St Mary's Intermodal,
- The response to submissions prepared for St Mary's Intermodal,
- Conditions of Consent granted to the Project on 7 May 2020,
- MOD 2 - SSD-7308 approved 21 September 2020
- MOD 3 - SSD-7308 approved 29 October 2020
- MOD 4 - SSD-7308 approved 17 December 2020
- MOD 1 - SSD-7308 approved 29 January 2021
- All relevant legislation and other requirements described in Section 3.1 of this Plan.

2.3. Environmental Performance Outcomes and Targets

The desired environmental performance outcome for soil and water quality management, as outlined and addressed in the EIS, is that erosion and sediment control, surface and groundwater quality, flooding risk and dust are all managed in a manner that protects environmental values.

To achieve this outcome, McMahon Services will undertake the following, as identified in Table 1.

Table 1 Performance outcomes

No.	Requirement	Document Reference	How Addressed
1	The Applicant must take all reasonable steps to minimise dust generated during all works authorised by this consent.	CoC C18	Section 5.3, SWMP15, & 16
2	During construction, the Applicant must ensure that: (a) exposed surfaces and stockpiles are suppressed by regular watering; (b) all trucks entering or leaving the site with loads have their loads covered; (c) trucks associated with the development do not track dirt onto the public road network; (d) public roads used by these trucks are kept clean; and (e) land stabilisation works are carried out progressively on site to minimise exposed surfaces.	CoC C19	SWMP2, 12, 13, 15, 16 & 33
3	All erosion and sediment control measures must be effectively implemented and maintained at or above design capacity for the duration of the construction works and until such time as all ground disturbed by the works have been stabilised and rehabilitated so that it no longer acts as a source of sediment. Erosion and sediment control techniques, as a minimum, are to be in accordance with the publication Managing Urban Stormwater: Soils & Construction (4th edition, Landcom, 2004) commonly referred to as the 'Blue Book'.	CoC C20	SWMP11, 14 & 31
4	The Applicant must: (a) ensure that only VENM, ENM, or other material approved in writing by EPA is brought onto the site; (b) keep accurate records of the volume and type of fill to be used; and (c) make these records available to the Certifier upon request	CoC C21	SWMP18
5	Adequate provisions must be made to collect and discharge stormwater drainage during construction to the satisfaction of the Certifier. The prior	CoC C22	SWMP14

	written approval of Council must be obtained to connect or discharge site stormwater to Council's stormwater drainage system or street gutter.		

3. Environmental Requirements

3.1. Relevant Legislation

3.1.1. Legislation

Legislation relevant to soil and water quality management for this project includes:

- Protection of the Environment Operations Act 1997 (POEO Act)
- Protection of the Environment Operations (Clean Air) Regulations 2010 (NSW)
- Environmental Planning and Assessment Act 1979 (EP&A Act)
- Water Management Act 2000
- Fisheries Management Act 1994 (NSW)
- Contaminated Land Management Act 1997 (NSW)
- Dangerous Goods Act 1975 (NSW)

Relevant provisions of the above legislation are explained in the legal and compliance tracking register included in Annexure A of the CEMP.

3.1.2. Additional approvals, licenses, permits and requirements

3.1.3. Guidelines and Standards

The main guidelines, specifications and policy documents relevant to this plan include:

- Acid Sulfate Soils Management Advisory Committee August 1998 (ASSMAC 1998)
- Acid Sulfate Soil Assessment Guidelines August 1998 (ASSMAC 1998)
- Waste Classification Guidelines (EPA 2014),
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000).
- Department of Environment and Conservation (DEC): Bunding & Spill Management. Insert to the Environment Protection Manual for Authorised Officers - Technical section "Bu" November 1997.
- National Code of Practice for the Storage and Handing of Workplace Dangerous Goods [NOHSC: 2017 (2001)]
- Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) March 2004 (the “BlueBook”). Volume 1 and Volume 2. - Volume 2A
- Best Practice Erosion and Sediment Control (International Erosion Control Association (IECA), 2008).
- Transport for NSW – Water Discharge and Reuse Guidelines

3.2. Minister’s Conditions of Consent

The requirements of the Planning Approval relevant to this plan are shown in Table 2 with cross reference to indicate where each requirement is addressed within this plan.

Additional conditions of relevance to work under this plan, and where this plan addresses the condition, is included in Annexure A.

Table 2 CoC Requirements for this plan

CoC No.	Requirement	Document Reference	How Addressed
A1	In addition to meeting the specific performance measures and criteria in this consent, all reasonable and feasible measures must be implemented to prevent, and, if prevention is not reasonable and feasible, minimise any material harm to the environment that may result from the construction and operation of the development.	This document	This plan has been prepared in accordance with this condition and describes how McMahon propose to manage soil and water during construction of the Project.
B11	Prior to the commencement of construction, the Applicant must submit a Construction Environmental Management Plan (CEMP) to the Certifier and to the Planning Secretary for approval. The CEMP must include, but not be limited to, the following: (a) Details of: (i) hours of work; (ii) 24-hour contact details of site manager; (iii) management of dust and odour to protect the amenity of theneighbourhood; (iv) stormwater control and discharge; (v) measures to ensure that sediment and other materials are not tracked onto the roadway by vehicles leaving the site; (vi) groundwater management plan including measures to prevent groundwater contamination; (vii) external lighting in compliance with AS 4282-2019 Control of the obtrusive effects of outdoor lighting; (viii) community consultation and complaints handling; (b) **Construction Traffic and Pedestrian Management Sub-Plan** (see conditionB13	Section 5.1, 5.2, 5.3 and SWMP2, 6, 8, 12, 13, 15, 16, 21, 23, 24, 25 & 27	This plan has been prepared in accordance with this condition and describes how McMahon propose to manage soil and water during construction of the Project.

	(c) **Construction Noise and Vibration Management Sub-Plan** (see condition B14); (d) **Construction Waste Management Sub-Plan** (see condition B15); (e) **Construction Soil and Water Management Sub-Plan** (see condition B16); (f) **Biodiversity Management Sub-Plan** (see condition B17); (g) **Flood Emergency Response Sub-Plan** (see condition B18); (h) an unexpected finds protocol for contamination and associated communications procedure; (i) an unexpected finds protocol for Aboriginal and non-Aboriginal heritage and associated communications procedure; (j) waste classification (for materials to be removed) and validation (for materials to remain) be undertaken to confirm the contamination status in these areas of the site; and (k) sustainability measures and practices to be implemented during the construction process.		
B16	The Applicant must prepare a **Construction Soil and Water Management Plan (CSWMP)** and the plan must address, but not be limited to the following: (a) be prepared by a suitably qualified expert, in consultation with Council and DPIE Fisheries; (b) describe all erosion and sediment controls to be implemented during construction; (c) provide a plan of how all construction works will be managed in a wet-weather events (i.e. storage of equipment, stabilisation of the Site); (d) detail all off-Site flows from the Site; and	Section 3.4, 5.2, 5.3, 7.3 ESCP (Appendix A, B, C & D), SWMP7, 9, 10, 14, 17, 27, 28, 29, 30, 32 & 36.	This CSWMP and the FERMP have been prepared in accordance with this condition and describes how McMahon propose to manage soil and water during construction of the Project.

	(e) describe the measures that must be implemented to manage stormwater and flood flows for small and large sized events, including, but not limited to 1 in 1-year ARI, 1 in 5-year ARI and 1 in 100-year ARI.		
B16A	Within one month of the approval of SSD-7308-MOD-3 and SSD-7308-MOD-1, the Construction Soil and Water Management Sub-Plan (CSWMSP) referred to in condition B16 is to be updated to the satisfaction of the Certifier to include any changes required to address the amendments to the development as modified by SSD-7308-MOD-3and SSD-7308-MOD-1.	This updated document	All documents have been updated in accordance with this condition
B21	Prior to the commencement of construction, the Applicant must: (a) install erosion and sediment controls on the site to manage wet weather events; and (b) divert existing clean surface water around operational areas of the site.	ESCP (Appendix A), SWMP10	The Primary ESCP has been prepared in accordance with this condition and describes how McMahon propose to manage soil and water during construction of the Project.
B22	Prior to the commencement of construction, erosion and sediment controls must be installed and maintained, as a minimum, in accordance with the publication Managing Urban Stormwater: Soils & Construction (4th edition, Landcom 2004) commonly referred to as the 'Blue Book'.	ESCP section 8.3 (Appendix A), SWMP1, 14,	The Primary ESCP has been prepared in accordance with this condition and describes how McMahon propose to manage soil and water during construction of the Project.
B23	Prior to the commencement of construction, the Applicant describe the measures that must be implemented to manage stormwater and flood flows for small and large sized events, including, but not limited to 1 in 1-year ARI, 1 in 5-year ARI and 1 in 100-year ARI and incorporate those measures into the CEMP.	B16, ESCP (Appendix A), FERMP, SWMP7, 30 & 32	The Primary ESCP and FERMP have been prepared in accordance with this condition and describes how McMahon propose to manage flood events during construction of the Project.
			The CEMP Unexpected

B24	Prior to the commencement of construction, the Applicant must implement measures to manage Acid Sulfate Soils. These measures must include handling, treatment, monitoring of water quality at treatment areas and disposal of Acid Sulfate Soils.	Unexpected finds protocol in CEMP, Section 4.5, 3.1.3 & SWMP19	Finds Protocol has been prepared in accordance with this condition and describes how McMahon propose to manage Acid Sulfate Soils

B25	Prior to the commencement of construction, the Applicant must prepare and implement for the duration of construction (a) flood warning and notification procedures for construction workers on site. (b) evacuation and refuge protocols; and (c) the Flood Emergency Response Sub-Plan required under condition B18.		describes how McMahon propose to manage flood events during construction of the Project.
B25A	.Within one month of the approval of SSD-7308-MOD-2, the procedures, protocols and Flood Emergency Response Sub-Plan (FERSP) referred to in condition B25 are to be updated to the satisfaction of the Certifier to include any changes required to address the amendments to the development as modified by SSD-7308-Mod-2.		Relates to FERSP not this Plan
B36	Post-developed stormwater management and design is to be in accordance with the *St Marys Freight Hub – Stormwater Management Report Revision E,* prepared by BG&E Consulting dated 30 September 2019.		Relates to design and operations, not this plan
C18	The Applicant must take all reasonable steps to minimise dust generated during all works authorised by this consent.	Section 5.3, 5.4 SWMP15, 16 and 33	Control measures have been identified to describe how McMahon propose to manage this during construction
C19	During construction, the Applicant must ensure that: (c) exposed surfaces and stockpiles are suppressed by regular watering; (d) all trucks entering or leaving the site with loads have their loads covered; (e) trucks associated with the development do not track dirt onto the public road network; (f) public roads used by these trucks are kept clean; and (g) land stabilisation works are carried out progressively on site to minimise exposed surfaces.	Section 5.3, 5.4, 5.5, 5.6, SWMP2, 12, 13, 15, 16 & 33, Annexure C and Appendix E	Control measures have been identified to describe how McMahon propose to manage this during construction

C20	All erosion and sediment control measures must be effectively implemented and maintained at or above design capacity for the duration of the construction works and until such time as all ground disturbed by the works have been stabilised and rehabilitated so that it no longer acts as a source of sediment. Erosion and sediment control techniques, as a minimum, are to be in accordance with the publication Managing Urban Stormwater: Soils & Construction (4th edition, Landcom, 2004) commonly referred to as the 'Blue Book'.	ESCP & SWMP11, 14 & 31	The Primary ESCP and conditions have been prepared in accordance with this condition and describes how McMahon propose to manage soil and water during construction of the Project.
C21	The Applicant must: a) ensure that only VENM, ENM, or other material approved in writing by EPA is brought onto the site; a) keep accurate records of the volume and type of fill to be used; and make these records available to the Certifier upon request.	Section 5.7, SWMP18 & Table 7	The control measure has been identified to describe how McMahon propose to manage this during construction
C22	Adequate provisions must be made to collect and discharge stormwater drainage during construction to the satisfaction of the Certifier. The prior written approval of Council must be obtained to connect or discharge site stormwater	ESCP, SMP, SWMP14	The Primary ESCP, SMP and conditions have been prepared in accordance with this

	to Council's stormwater drainage system or street gutter.		condition and describes how McMahon propose to manage soil and water during construction of the Project.

3.3. Revised Management and Mitigation Measures

Please refer to Annexure B for a list of relevant management and mitigation measures.

3.4. Consultation

As required in condition B16 both DPIE Fisheries and Penrith City Council have been consulted regarding the CSWMSP. Both regulators were sent the draft plan the 01/06/2020 for their review and comment.

A reply was received from Council the 10/06/2020, and from DPIE Fisheries on the 29/06/2020 their comments and resolutions can be seen in Table 3 below.

Table 3 Comments and response from Penrith City Council and DPIE Fisheries

Comments	Response
Penrith City Council	
All works are to comply with the Blue Book (Managing Urban Stormwater All volumes as applicable)	Addressed in SWMP 1 & 9
The Erosion and Sediment Control plans are noted as draft and should be finalized 'For Construction" in the final sub-plan.	Erosion and Sediment Control plans in Annexure C Noted as Revision 2.
It is noted that the sub-plan does not specifically detail complaints handling and response, however, this aspect of site management is likely to be addressed by the overarching CEMP for the development. This should be ensured.	Addressed in the CEMP and Community Consultation Plan.
DPIE Fisheries	
The only point that DPI Fisheries raises for address in the final version of this sub-plan or the over arching CEMP is that all works are to comply with the Blue Book (Managing Urban Stormwater – all volumes as applicable).	Addressed in SWMP 1 & 9

4. Existing Conditions

4.1 Existing Hydrology and Water Quality

The project site is located within the catchment of Little Creek which runs along the northern boundary of the site and discharges into South Creek located around 250m west of the site. The project site is relatively flat with an overall topographic relief of approximately 24 to 30m AHD, descending from South to North. Overall slope is approximately 1%. Surface water will generally follow the topographical slope and much of it drains into the existing basin/dam, draining towards Little Creek.

Runoff from surrounding upstream catchments is conveyed around and through the site by an existing pit and stormwater pipe network.

Groundwater levels as described in the Groundwater Level Investigation Report, Douglas Partners March 2019 are generally at a depth greater than 3 metres below existing surface levels. These levels could vary however with changing climatic conditions or possible upgradient activities.

The water of the existing dam on site, as reported in the Dam Dewatering Plan, (Ecosure September 2019) was tested and found to have levels of Ammonia and Total Nitrogen that exceeded ANZEEC trigger values. This was better than the quality of the downstream South Creek (250m from the site) which exceeded trigger values for Copper, Zink, Total Nitrogen, total Phosphorus, Dissolved Oxygen and Conductivity.

4.2 Existing Soils and contamination

The Penrith 1:100,000 Soil Landscape Series Sheet indicates the site is located near the boundary between the Blacktown (southern portion of the site) and South Creek (north-north western portion of the site) soil landscape groups. The soils of the Blacktown soil landscape are moderately reactive with low fertility, poor soil drainage and highly plastic subsoil. The soils of the South Creek soil landscape are identified as erosion hazard and are prone to flooding.

The area has in the past been covered with fill material which ranges from 0.4-3.5 metres which varies in composition from silty clay and gravelly clay to sandy gravel, with anthropogenic materials scattered throughout.

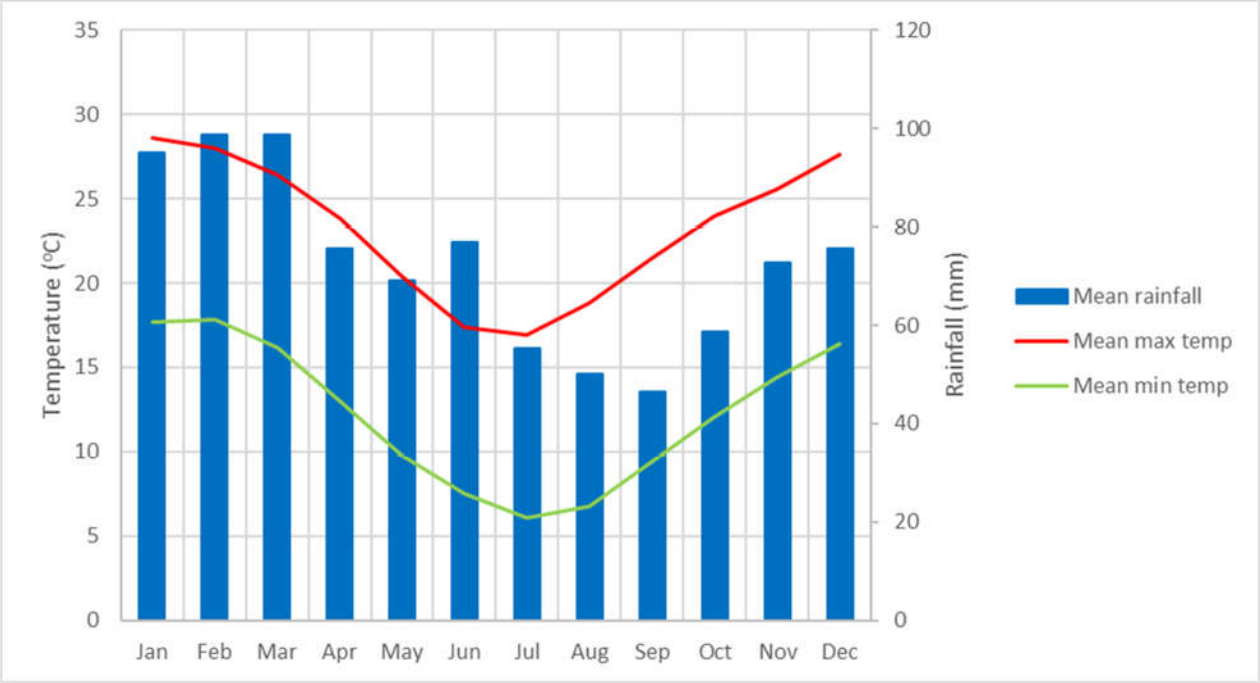
Two areas were identified as needing remediation in the Douglas Partners August 2019 Remediation Action Plan. The far northern end of the site has an estimated 200m^2 of fill containing ACM concentrations that require remediation. The southern end of Stockpile 4 was identified as having been impacted by pesticides (DDT, DDD and DDE) at levels exceeding scheduled chemical waste criteria.

4.3 Rainfall

The Bureau of Meteorology climate statistics for the nearby Prospect Reservoir (BOM Site number 067019), located approximately 12 km to the south-east of the project site, report the following:

- Mean annual rainfall of 873 mm
- The highest mean monthly rainfall experienced between January and March
- Mean monthly rainfall for the construction period (July – December) is between 45 and 75 mm per month (BOM 2020)

Figure 1 Prospect reservoir Climate (BOM2020)



4.4 Erosion Risk

Erosion risk refers to the evaluation of the “risk” of soil erosion when consideration is given to both the degree of erosion and the likelihood of the erosion occurring (IECA 2008). In the absence of a site-specific risk assessment procedure, erosion risk is determined from the average monthly rainfall depth for Prospect Reservoir (BOM 2020). Erosion risk for all months is rated as moderate.

4.5 Acid Sulfate Soil

Both the Atlas of Australian Acid Sulfate Soils from CSIRO Australian Soil Resource Information System (ASRIS) and the NSW Acid Sulfate Soils Risk Map indicate that there is an extremely low likelihood of acid sulfate soil being present at the site. In the event of Penitential Acid Sulfate Soil (PASS) or Acid Sulfate Soil (ASS) being detected the unexpected finds protocol that forms part of the CEMP will be implemented. If it was confirmed to be PASS/ASS the Acid Sulfate Soil Assessment Guidelines August 1998 (ASSMAC 1998) would be followed.

5. Environmental Aspects and Impacts

5.1 Groundwater Management

The March 2019 DP Groundwater Level Investigation found that the groundwater level is generally at a depth of 3 metres below ground level. Works are not expected to exceed this depth as the containment cell is only planned to be 2m deep and all services are expected to be above this level. If any excavations are to go below a depth of 3m from the pre-construction ground level additional groundwater monitoring and assessment is to be undertaken.

In the event that groundwater is intercepted during construction works and dewatering is required, written approval and relevant licences must be obtained from the relevant authorities (such as the Water Group within the Department (i.e. DPIE) or Council's Public Domain Unit for any discharge of groundwater into Council's stormwater system).

To mitigate the risk of groundwater contamination all existing on-site contaminated material are to be managed in line with the Douglas Partners August 2019 Remediation Action Plan. All fuels, chemicals, and liquids will be stored in a sealed bunded area in accordance with the requirements of all relevant Australian Standards, and/or EPA's Storing and Handling Liquids: Environmental Protection – Participants Handbook.

5.2 Water Discharge

The initial dewatering of the existing dam must be carried out according to the Dam Dewatering Plan found in Annexure D. Sediment dam management should follow the actions set out in the PESCP found in Annexure C. Dewatering will employ a floating foot valve to ensure that water is only taken from near the surface of the waterbody during dewatering. This will include a mechanism to prevent the foot valve falling to the floor of the dam (i.e. foot valve will not fall lower than 0.4m from the dam floor). All water discharges will be authorised through an internal dewatering permit process, ensuring that water quality discharge criteria are met prior to water release. Dewatering permit can be seen below in figure 2. The dewatering process will be undertaken by a works team that has been trained by the Environment Manager in water testing, permit usage and discharge set up. Both the intake and outlets of the dewatering operation must be supervised by trained workers to ensure water quality entering the inlet and exiting the outlet remains within the parameters specified in table 4. As outlined in the Dam Dewatering Plan (Annexure D) the water should be pumped at a slow rate and the outlet must also be set up with scour protection and monitored to ensure that the discharge does not cause sediment movement itself. The scour protection should also minimise impacts on the remnant vegetation surrounding the existing dam at the northern end of the site. The vegetation should be flagged off, and to ensure all personnel are aware of the boundary and the importance of the vegetation it will be covered in the induction.

Any water discharges from the site are required to be tested using a calibrated hand-held multiprobe water quality meter to ensure the parameters in Table 4 are met before leaving the site. All information including dates, test results, amount discharged, discharge point etc. must be recorded on a dewatering permit.

The sludge removed from the existing dam at the northern end of the site will be either:

- Managed onsite in sludge drying bays located outside the flood flow zones identified in figure 3 below and then used on site. Or
- Removed by vacuum truck and taken to an appropriate waste facility following the waste guidelines set out in the Construction Waste Management Sub-Plan.

Table 4 Discharge Parameters

Discharge to Stormwater / Watercourse			Dispersed Discharge to Land	
Water Parameter	**Objective**	**Units**	**Objective**	**Units**
pH	6.5 – 8.5	pH	6.5 – 8.5	pH
Total Suspended Solids (TSS)	<50	TSS	N/A	N/A
Turbidity	*To be determined following commencement of works and verification through sampling	NTU		
Hydrocarbons	No hydrocarbon sheens observed	N/A	No hydrocarbon sheens observed	N/A

**Measurement of turbidity can only be used where a correlation between TSS (number and type of particles suspended in the water column) and Turbidity (NTU) (the ability of light to penetrate the water column) has been established through sampling and analysis at a NATA accredited laboratory has been established. Until this occurs, a test for TSS must be conducted as a minimum.*

Figure 2 Water discharge permit

Permit No.		**Project name/number:** St Marys Freight Terminal	**Site:**
Start Date:	**Expiry Date:**	**Approx. Volume to be released (ML):**	**Receiving environment:**
WET WEATHER EVENT ***(please complete this section if this permit is in response to a wet weather event)***			
Rainfall (mm):			**Radar/weather station:**
Has the sediment basin overflowed:			

CONTROL MEASURE	**YES**	**NO**	**COMMENTS**
Pumping equipment checked and operational			
Float or similar device installed to prevent pump inlet from sucking up sediment			
Discharge outlet sited to avoid scouring or environmental damage at discharge point			
Sediment basin is compliant with Blue Book			

FIELD TEST			
pH (6.5 – 8.5)		**Sampler**	
Total Suspended Solids (TSS) 50 mg/L		**Water Quality Monitor ID**	
Oil/Grease (none visible)		**Calibration date**	

DISCHARGE APPROVED BY (Environment Team): NAME:_____ SIGNED: _____ **PERMIT ISSUED TO:** NAME:_____ POSITION:_____SIGNED:_____	**PERMIT HOLDER NOTES** Pump Is Running OK (Y/N) _____ Suction Hose is Clear of Silt (Y/N) _____ Discharge is going to where it should (Y/N) _____ Discharge is not causing any discolouration/oily film (Y/N) Pump to be checked every mins.

5.3 Flood Management

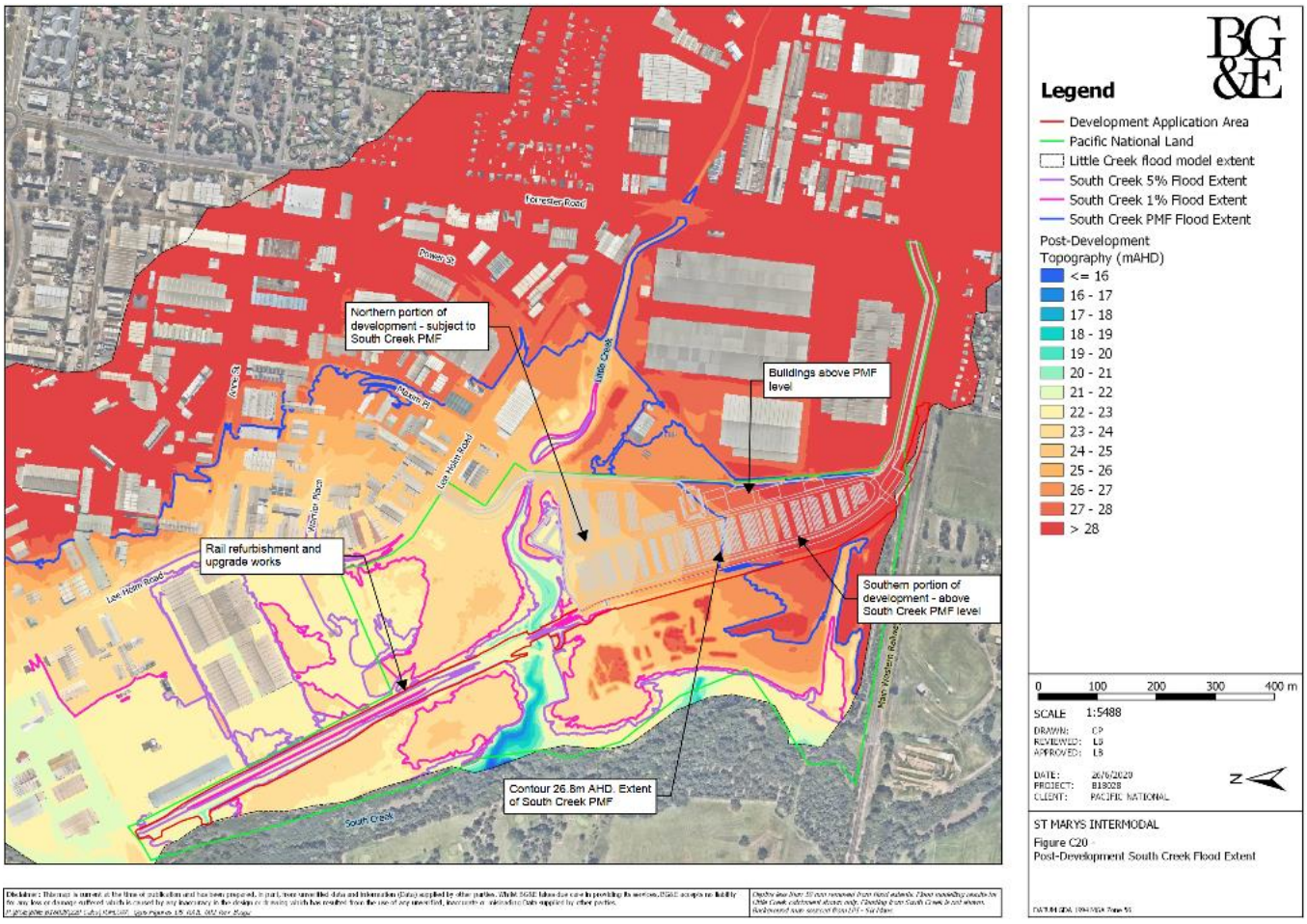
The development site grades from the South (30.5m AHD) to the North (23.9m AHD). Site inundation is not expected for floods less than the Little Creek Probable Maximum Flood (PMF), where shallow inundation of less than 100mm could occur, which would not impact site facilities and operations significantly.

The PMF for South Creek is expected to reach 26.8m AHD, this results in the Northern end of the site to be inundated by up to 2.9m (existing basin) and flood half of the site as shown below in Figure 3 (BG&E 2019).

Portable site facilities, laydowns, the containment cell, dam sludge storage, chemical and fuel storage areas, concrete washouts will be located in areas that are not considered to be of high flood risk. Therefore, they will need to be placed South of contour 26.8m AHD.

The BoM will be monitored daily and the forecast included in morning pre-starts/toolboxes. If intense, heavy, or long periods of rainfall are predicted then the Flood Emergency Response Management Plan (FERMP) will be implemented.

Figure 3 Proposed site surface levels and South Creek PMF contour, BG&E, 2019



5.4 Dust control

Table 4 illustrates the dust reduction strategies that will be adopted to achieve the project Environmental Outcomes. These are detailed in McMahons procedure SWI148.

Table 5 Dust Reduction Strategies

#	Major Step	Key Point (Success / Safety / Ease)	Reason to Follow Key Point	Illustration
1	Light Watering to Suppress Dust	Regularly and lightly watering dust-prone areas, i.e. Access tracks and roads and stockpiles. *Sprinklers or water trucks to wet down stockpiles*	Suppress dust	

		Water Truck Wetting down an excavated area		
2	Compact / Cover Access tracks	Compacting (where possible) to minimise dust levels and provide a hardwearing surface to access tracks. *Quarry stones layered on the access road to a construction site.*	Contain soil under hard wearing surface	

3	Grow Grass	Grass seeds can be sprayed onto stockpiles when it is expected that the pile will be in position for an extended period of time. *Fast Grass seeded into stockpile to reduce dust.*	Contain dirt under grass cover	
4	Reschedule Dust Producing Work	During windy periods, limiting the movement of soil, construction work such as earth moving, and the use of high-speed abrasive disc saws and sanders. *Reschedule task to a less windy time.*	Eliminate dust producing process during windy periods	
5	Control Dust Release	Minimising the lifting height of the loader bucket when transferring soil or rubble from front-end loaders to trucks and controlling its unloading speed to reduce wind-borne dust. *Keep bucket as low as possible and reduce the unloading speed.*	Prevent excessive dust release	

6	Limit Vehicle Traffic & Reduce Vehicle Speed	Limiting vehicle traffic to essential vehicles only and applying speed limits—slower speeds produce less dust and road wear. *Speeds in excess of 10 km/h are not recommended on sites next to residential premises because of dust impact - on large sites, speed limit signs should be posted.*	Reduce dust release	

5.5 Vehicle Movements to and From the Site

All vehicles entering or leaving the site are to have their loads covered to help ensure no loss of materials and minimise dust generated. The stabilised access/egress and rumble grids at both Lee Holm and Forrester Roads will be monitored by the gate traffic controller and site foreman/supervisor regularly, and the environmental manager/site environmental representative at a minimum weekly during the ESC inspection to ensure minimal dirt tracking onto the public road network. Truck drivers and haulage contractors will be made aware that they are also accountable for tracking as outlined in the Driver Code Of Conduct (CTPMSP). If tracking does begin to occur, then a refresh/revision of the controls must be undertaken. A street sweeper is to be available to the project to ensure a speedy clean-up of any tracking on public roads from the project.

5.6 Site Stabilisation

To minimise the potential for erosion and to reduce the risk of dust the site will be progressively stabilised by the constructed pavements, building, lined drainage and landscaping, as per applicable engineering plans. Following the completion of construction activities, long-term protection of the entire site from erosion will be achieved.

Once site stabilisation has reached the point where the sediment basins are deemed to no longer be necessary according to Blue Book guidelines, and runoff can be managed through smaller controls, the construction of the bio-retention basin, which will maintain water quality to Penrith City Council standards can begin.

Erosion and sediment controls are to remain in place until minimum 75% self-sustaining groundcover (or equivalent) is achieved for disturbed areas (80% for drainage channels).

Erosion and sediment controls must be updated regularly to reflect the changing conditions of the site. Erosion and sediment controls must be set out in compliance with the most current ESCP. A copy of this is contained in Annexure C of this plan.

The BG&E Stormwater Management Plan had the original erosion and sediment control plans for construction however subsequent to the development of these Tim Elder has been on site and has produced a more current Erosion and Sediment Control Plan and this is included in Annexure C of this plan. As the job progresses the ESCP will be regularly updated so it best manages the issues on site.

5.7 Material Importation

All imported material will be certified VENM or ENM under the NSW waste classification guidelines. Any other material will be approved in writing by the EPA.

When an order is placed for fill material it is to be made clear to the supplier that the material needs to be EPA approved. Prior to the fill arriving at site the classification, EPA written certification and confirmation of the amount of fill being sent to the site has to be received from the supplier. As the material enters the site the truck registration, the material being imported, load weight and where it was loaded will be recorded. All imported materials will be checked by a site engineer to ensure they meet the classification requirements. The engineer will also record where on site the fill will be used. If the fill is to be stockpiled for future use, then the stockpile location will be recorded so that the placement location can be recorded in the future. All of this information will be entered into the import register which will be checked periodically by the Environment Manager to ensure the process adheres to CoC 21.

6. Environmental Control Measures

Table 6 Environmental Control Measures

Pre-Construction						
ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference	Evidence
SWMP1	Prior to works commencing, erosion and sediment controls are to be installed and existing clean water diverted around the works area in accordance with the Blue Book - Managing Urban Stormwater: Soils and Construction (fourth edition Landcom 2004) and the ESCP in Appendix C of this SWMP.	ESCP	Prior to construction	PM/EM/SM	B22	Weekly ESC Inspection Checklist
SWMP2	Stabilised haul roads and construction access / egress with rumble grids or wash bays will be established where construction traffic enters or leaves Forrester and Lee Holm Roads.	ESCP	Prior to construction	PM/EM/SM	B11,C19, RMMM 3.1	Weekly ESC Inspection Checklist
SWMP3	As per the Construction Plan clearing of vegetation shall be undertaken in stages to ensure a minimum amount of bare ground is exposed at any one time.	Construction Plan	At start of works	PM/SM	Best practice, RMMM 3.1	Weekly ESC Inspection Checklist
SWMP4	Clearly mark out the development footprint including signage to ensure clearing and earthworks remain within these boundaries.	Design Drawings	Prior to construction	SM/EM	Best practice	Site inspection
During Construction						
ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference	Evidence
SWMP5	Training will be provided to relevant Project personnel, including relevant sub- contractors on Soil and Water Management requirements from this plan through the induction.	Induction	During Construction	EM	Best practice	Induction Records

SWMP6	During induction, all personnel to be made aware of positioning and how to use spill kits in response to spills or leaks.	Induction	During construction	EM	B11	Induction Records
SWMP7	During civil and excavation works, plant will be required to park in designated lay-down zones when not in use, located in a central location on the site and beyond the 1% AEP flood line where significant rain events are predicted. Refer to Environmental Control Map.	ECP	During construction	SM/FM	B16, B23	Weekly ESC Inspection Checklist
SWMP8	Washout facilities must be in place and used for cleaning plant and equipment, concrete, paint, or other environmentally hazardous substances	ECP	During construction	EM/SM	B11	Weekly ESC Inspection Checklist
SWMP9	The Erosion and Sediment Control Plan and on site controls must be updated as the site changes through construction, in line with the Blue Book - Managing Urban Stormwater: Soils and Construction (fourth edition Landcom 2004), with all personnel being made aware of this through the induction and it being displayed in prominent locations on site.	ESCP	During construction	EM	B16, B20	Weekly ESC Inspection Checklist
SWMP10	Erosion and sediment as well as water diversion controls must be continually monitored to avoid water and pollutants entering the site and to ensure their effectiveness in controlling erosion and sediment movement from exposed earth.	ESCP	During construction	EM/FM	B16, B21	Weekly ESC Inspection Checklist
SWMP11	Erosion and sediment controls shall be effectively implemented, maintained and refreshed or replaced if damaged or before they exceed 60% of their capacity in accordance with the Blue Book - Managing Urban Stormwater: Soils and Construction (fourth edition Landcom 2004)	ESCP	During construction	EM/SM/FM	B22, C20	Weekly ESC Inspection Checklist
SWMP12	Sediment tracking onto Lee Holm or Forrester Road must be monitored and if occurring the stabilised exits and rumble grids/wash bays must be improved or refreshed to reduce tracking.	ESCP	During construction	EM/SM/FM	B1, C19	Weekly ESC Inspection Checklist

SWMP13	Lee Holm, Forrester and surrounding roads must be kept clear of sediment from the site using street sweepers.		During construction	EM/FM	B11, C19	Weekly ESC Inspection Checklist
SWMP14	All stormwater drainage inlets within the site and other discharge points where there is potential for sedimentation to occur as a result of construction activity shall be protected by geofabric and/or sandbags as appropriate in accordance with the ESCP.	ESCP	During construction	EM/FM	B16, B22, C20, C22	Weekly ESC Inspection Checklist
SWMP15	Earthworks, stockpiles and access tracks to be monitored and water or a bonding agent used to supress dust movement from the site.		During construction	EM/FM	B11, C18, C19, RMMM 3.1, 16	Weekly ESC Inspection Checklist
SWMP16	Permeant stockpiles are to be adequately stabilised progressively to minimise dust and sediment movement.		During construction	EM/FM	B11, C18, C19, RMMM 3.1, 16	Weekly ESC Inspection Checklist
SWMP17	Stockpile locations will be kept to the southern portion of the site in areas not prone to flash flooding and away from drainage lines and diversion drains as far as practicable.	ESCP & Flood Emergency Response Plan	During construction	EM/SM/FM	B16	Weekly ESC Inspection Checklist
SWMP18	Imported fill must be VENM, ENM. Any other material must be approved in writing by EPA. Accurate records of the volume and type of fill must be kept and be easily accessible.		During construction	EM/SM/FM	C21	Imported Material Register
SWMP19	If Acid Sulphate Soils (ASS) or Potential Acid Sulphate Soils (PASS) are thought to be uncovered throughout construction, they will be dealt with under the unexpected finds protocol.	Unexpected Finds Protocol	During construction	EM/SM/FM	B24	Unexpected Finds Register
SWMP20	Different excavated materials must be separately stockpiled then stabilised or bunded.		During construction	SM/FM	Best practice	Stockpile Register.
SWMP21	All existing on-site contaminated material is to be managed in line with the Douglas Partners August 2019 Remediation Action Plan.	Remediation Action Plan	During construction	EM/SM/FM	B11	Validation Assessment Report

SWMP22	Tracking of the movement of material off-site would be undertaken as part of waste tracking procedures under the Waste Management Sub-Plan.	Waste Management Sub-Plan	During construction	EM/FM	Best practice	Waste Tracking Register
SWMP23	All fuels, chemicals, and liquids will be stored at least 20 meters away from waterways (including existing stormwater drainage system) and will be stored in a sealed bunded area in accordance with the requirements of all relevant Australian Standards, and/or EPA's Storing and Handling Liquids: Environmental Protection – Participants Handbook.		During construction	EM/SM/FM	B11	Weekly Inspection Checklist
SWMP24	If any excavations are to go below a depth of 3 metres from the pre-construction ground level additional groundwater monitoring and assessment is to be undertaken.	Groundwater Level Investigation	During construction	EM/SM/FM	B11, RMMM 9.2	Site Diaries
SWMP25	In the event that groundwater is intercepted during construction works and dewatering is required, written approval and relevant licences must be obtained from the relevant authorities (such as the Water Group within the Department (i.e. DPIE) or Council's Public Domain Unit for any discharge of groundwater into Council's stormwater system).	Groundwater Level Investigation	During construction	EM/SM/FM	B11, RMMM 9.2	Licenses
SWMP26	The dewatering of the dam at the northern end of the site is to follow the Dam Dewatering Plan (Annexure D)	Dam Dewatering Plan	During construction	EM	RMMM 9.4	Dam Dewatering Notification to Water NSW
SWMP27	The discharge of surface water offsite can only occur if the water quality is within the parameters set out in section 5.2, a dewatering permit has been completed for each dewatering event and all personnel involved are appropriately trained.	Dewatering Permit & Dewatering Training	During construction	EM/FM	B11, B16	Dewatering Permit Register & Training Records
SWMP28	Working and storage areas and any proposed stockpile sites where practically possible will be located above the 100-year ARI peak flood level.	Flood Impact Assessment	During construction	SM	B16	Site Diaries

SWMP29	Hardstand areas, access tracks and other temporary works are to be designed, constructed and maintained to withstand flooding.	Flood Impact Assessment	During construction	SM	B16	Site Diaries
SWMP30	To ensure site preparedness for flooding and wet weather events, awareness training specific to the site will be included in the induction. Weather forecasts will be included in daily pre-starts/toolbox talks. A prominent site notice board will display the 1 in 1-year ARI, 1 in 5-year ARI and 1 in 100-year ARI predicted flood levels so all staff are aware of potential inundation areas.	Flood Emergency Response Plan	During construction	EM/SM/FM	B16, B23	Induction and Pre-Start/Toolbox Records
SWMP31	After any rain events >20mm in 24 hours an ESC inspection is to be undertaken to review the effectiveness of the controls and if any need to be adjusted or if the ESCP needs to be updated.	ESCP	During construction	EM	C20	ESC Inspection Checklist
SWMP32	Measures that will be undertaken to manage flood flows for small and large sized events, including, but not limited to 1 in 1-year ARI, 1 in 5-year ARI and 1 in 100-year ARI include: a) Storage of hazardous materials away from flow paths. b) Site compound and facilities layout to take into consideration of the flow paths. c) Ensure evacuation routes are kept clear during high risk periods. d) Ensure loose materials, fuel, chemicals and equipment can either be secured or removed during a flood event if required.	Flood Impact Assessment	Before and during construction	EM/SM/FM	B16, B23	ESC Weekly Checklist
SWMP33	All loads coming to or from the site are to be covered to avoid dust or other materials from escaping the vehicle.	Driver Code of Conduct	During construction	FM	C18, C19, RMMM 3.1	Weekly Inspection
SWMP34	All plant and equipment (including trucks) are to minimise the amount of idling and shall be turned off (or throttled down if appropriate) when not in use for an extended period of time.	Driver Code of Conduct	During construction	FM	Best practice	Weekly Inspection

SWMP35	A bioretention basin is to be constructed when site is stabilised to the point where a sediment basin is no longer necessary. This will be when smaller controls are able to manage stormwater in line with Blue Book requirements.	Progressive ESCP's	During construction	EM/SM/FM	RMMM 9.3	ESC Weekly Checklist
SWMP36	As part of the induction reference to the importance of harm minimisation to the remnant vegetation on site will be made clear to all staff.	Induction	During construction	EM	Best practice	Induction Records

7. Compliance Management

7.1. Roles and Responsibilities

The McMahon team's organisational structure and overall roles and responsibilities are outlined in Section 4.2 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Section 6 of this Plan.

7.2. Training

All personnel, including employees, contractors and utility staff working on site will undergo site induction training relating to soil and water management issues. The induction training will address elements related to soil and water management including:

- Existence and requirements of this Sub-plan,
- Existence and requirements of other management plans and guidelines such as the Unexpected Contaminated Lands and Asbestos Finds Procedure, Flood Emergency Response and Stormwater,
- Relevant legislation and guidelines,
- Roles and responsibilities for soil and water management,
- Incident response, management and reporting,
- Dewatering reporting requirements,
- Dust suppression requirements,
- Potential for contaminated material to be present on site and management requirements if such material is identified, and

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in erosion and sediment controls and dewatering procedures.

Further details regarding staff induction and training are outlined in Section 5.1 of the CEMP.

7.3. Monitoring and Inspections

Compliance with the requirements of this WMP, its implementation and effectiveness will be monitored through:

- Regular inspections of worksite and activities,
- McMahon Environmental Inspections which occur weekly (or more depending on works/weather conditions),

Requirements and responsibilities in relation to inspections are documented in Section 4.3 of the CEMP. Regular monitoring and inspections will be carried out during construction in accordance with Section 9 of the CEMP. Inspection and monitoring requirements relevant to soil and water management for the Project are identified in 7.

Table 7 Inspection and monitoring requirements relevant to soil and water management

Item	Frequency	Standards	Records	Responsibility
ESC survey	Weekly	Inspection to be undertaken by Environment manager or qualified environment advisor	ESC Checklist (Appendix D ESCP)	Environment Manager
Site inspections	Weekly	Implementation of this Plan	Environmental Representative Inspection Report	Environment Manager
Pre-wet weather inspections	Prior to predicted wet weather	Inspection to be undertaken by Environment manager or qualified environment advisor	Pre-wet weather checklist (Appendix D of ESCP)	Environment Manager
Post-wet weather inspections	Post-wet weather	Inspection to be undertaken by Environment manager or qualified environment advisor	ESC Checklist (Appendix D ESCP)	Environment Manager
Visual surveillance	Daily	Dust monitoring Sediment tracking Erosion and sediment controls Groundwater monitoring	Site diary and photos as relevant	Supervisor Environment Manager
Import register check	Periodically	Inspection to be undertaken by Environment manager or qualified environment advisor	Import register	Environment Manager

7.4. Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this Plan, CoC, RMMMs and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 13 of the CEMP.

7.5. Reporting

Reporting requirements are documented in Section 13.1 of the CEMP.

8. Review and Improvement

8.1. Corrective and Preventative Actions

Corrective and preventative actions that will be applied to this plan are outlined in Section 15 of the CEMP.

8.2. Review and Revision

The review and revision process for the CEMP and sub-plans (including this plan) is outlined in Section 16 of the CEMP.

Annexure A Other Conditions of Consent relevant to this Plan

Table 8 Other Conditions of Approval relevant to this Plan

<table>
<tr><th>CoC No.</th><th>Requirement</th><th>Document Reference</th></tr>
<tr><td>A1</td><td>In addition to meeting the specific performance measures and criteria in this consent, all reasonable and feasible measures must be implemented to prevent, and, if prevention is not reasonable and feasible, minimise any material harm to the environment that may result from the construction and operation of the development.</td><td>Section 6</td></tr>
<tr><td>A2</td><td>The development may only be carried out:
(a) in compliance with the conditions of this consent;
(b) in accordance with all written directions of the Planning Secretary;
(c) generally in accordance with the EIS and Response to Submissions;
(d) in accordance with the Development Layout in Appendix 1;
(e) in accordance with the revised management and mitigation measures in Appendix 3;
(f) in accordance with the approved plans in the table below:
<table><tr><th colspan="4">Architectural Drawings prepared by Kit Handley Architects Pty Ltd</th></tr><tr><td>Dwg No.</td><td>Rev</td><td>Name of Plan</td><td>Date</td></tr><tr><td>A101</td><td>1</td><td>Proposed Site & Roof Plan</td><td>17/04/20</td></tr><tr><td>A102</td><td>1</td><td>Proposed G & L1 Floor Plan</td><td>17/04/20</td></tr><tr><td>A103</td><td>1</td><td>Proposed Electrical Plan</td><td>17/04/20</td></tr><tr><td>A104</td><td>1</td><td>Proposed Elevations</td><td>17/04/20</td></tr><tr><td>A105</td><td>1</td><td>Proposed Elevation & Sections</td><td>17/04/20</td></tr><tr><td>A106</td><td>1</td><td>Proposed Group 1 Furniture Plans</td><td>17/04/20</td></tr><tr><td>A107</td><td>1</td><td>Proposed Group 2 & 3 FF&E</td><td>17/04/20</td></tr></table>(g) in accordance with modification application SSD-7308-Mod-2 and supporting documentation;
(h) in accordance with modification application SSD-7308-Mod-3 and supporting documentation;
(i) in accordance with modification application SSD-7308-Mod-4 and supporting documentation<u>; and</u>
<u>(j) in accordance with modification application SSD-7308-Mod-1 and supporting documentation.</u></td><td>Section 2.1</td></tr>
<tr><td>A9</td><td>The Applicant must comply with all relevant prescribed conditions of development consent under Part 6, Division 8A of the EP&A Regulation.</td><td>Section 3.2</td></tr>
<tr><td>A11</td><td>Where conditions of this consent require consultation with an identified party, the Applicant must:
b) consult with the relevant party prior to submitting the subject document for information or approval; and
c) provide details of the consultation undertaken including:
(i) the outcome of that consultation, matters resolved and unresolved; and
(ii) details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.</td><td>Section 3.4</td></tr>
</table>

A20	References in the conditions of this consent to any guideline, protocol, Australian Standard or policy are to such guidelines, protocols, Standards or policies in the form they are in as at the date of this consent.	Section 3.1
A21	Consistent with the conditions of this consent and without altering any limits or criteria in this consent, the Planning Secretary may, when issuing directions under this consent in respect of ongoing monitoring and management obligations, require compliance with an updated or revised version of such a guideline, protocol, Standard or policy, or a replacement of them.	Section 8.2
A22	Any condition of this consent that requires the carrying out of monitoring or an environmental audit, whether directly or by way of a plan, strategy or program, is taken to be a condition requiring monitoring or an environmental audit under Division 9.4 of Part 9 of the EP&A Act. This includes conditions in respect of incident notification, reporting and response, non-compliance notification, Site audit report and independent auditing.	Section **Error! Reference source not found.** Section **Error! Reference source not found.** Section **Error! Reference source not found.**
A24	The Applicant must ensure that all of its employees, contractors (and their sub-contractors) are made aware of, and are instructed to comply	Section 7.2

CoC No.	Requirement	Document Reference
	with, the conditions of this consent relevant to activities they carry out in respect of the development.	
B6	Prior to the commencement of earthworks, the Applicant must prepare an unexpected contamination procedure to ensure that potentially contaminated material is appropriately managed. The procedure must form part of the CEMP in accordance with condition B11 and where any material identified as contaminated is to be disposed off-site, the disposal location and results of testing submitted to the Planning Secretary prior to its removal from the site.	Construction Environmental Management Plan
B10	Management plans required under this consent must be prepared in accordance with relevant guidelines, including but not limited to the *Environmental Management Plan Guideline: Guideline for Infrastructure Projects* (DPIE, April 2020).	Section 2.1
B11	Prior to commencement of construction, the Applicant must submit a Construction Environmental Management Plan (CEMP) to the Certifier and to the Planning Secretary for approval. The CEMP must include, but not be limited to, the following: a) Details of: (i) Hours of work; (ii) 24-hour contact details of site manager (iii) Management of dust and odour to protect the amenity of the neighbourhood; (iv) Stormwater control and discharge; (v) measures to ensure that sediment and other materials are not tracked onto the roadway by vehicles leaving the site; (vi) groundwater management plan including measures to prevent groundwater contamination; (vii) external lighting in compliance with AS 4282-2019 Control of the obtrusive effects of outdoor lighting; (viii) community consultation and complaints handling; b) Construction Traffic and Pedestrian Management Sub-Plan (see condition B13); c) Construction Noise and Vibration Management Sub-Plan (see condition B14); d) Construction Waste Management Sub-Plan (see condition B15); e) Construction Soil and Water Management Sub-Plan (see condition B16); f) Biodiversity Management Sub-Plan (see condition B17); g) Flood Emergency Response Sub-Plan (see condition B18); h) an unexpected finds protocol for contamination and associated communications procedure; i) an unexpected finds protocol for Aboriginal and non-Aboriginal heritage and associated communications procedure; j) waste classification (for materials to be removed) and validation (for materials to remain) be undertaken to confirm the contamination status in these areas of the site; and k) sustainability measures and practices to be implemented during the construction process.	Construction Environmental Management Plan

CoC No.	Requirement	Document Reference
C27	All waste generated during construction must be secured and maintained within designated waste storage areas at all times and must not leave the site onto neighbouring public or private properties.	Construction Waste Management Sub-Plan, Flood Emergency Response Management Plan
C29	The Applicant must ensure that concrete waste and rinse water are not disposed of on the site and are prevented from entering any natural or artificial watercourse or Council's stormwater system.	Construction Waste Management Sub-Plan, Section 6
C31	The Applicant must ensure that the removal of hazardous materials, particularly the method of containment and control of emission of fibres to the air, and disposal at an approved waste disposal facility is in accordance with the requirements of the relevant legislation, codes, standards and guidelines.	Construction Waste Management Sub-Plan, Section 6

Annexure B Revised Environmental Management and Mitigation Measures relevant to this plan

Table 9 Revised Environmental Management and Mitigation Measures relevant to this plan

Requirement	Updated Measures	Application	Document Reference
1. General Project Commitments			
1.1 All practical and reasonable measures to prevent and/or mitigate significant adverse impacts on the environmental will be implemented.	No change.	Construction and Operation	Section 6
1.2 All practical and reasonable measures to protect human health and safety for staff, visitors, contractors, construction workers and the general public will be implemented.	No change.	Construction and Operation	Section 6
2. General Management			
2.1 Inductions of contractors and construction workers will include management and mitigation measures outlined in this Table where relevant.	No change.	Construction	Section 7.2
2.2 Management during the construction cycle will monitor potential environmental impacts (i.e. noise, dust, Aboriginal and non-Aboriginal heritage, erosion and sediment control, etc.) to ensure impacts on the environment are minimised.	No change.	Construction	Section 5, 6 & 7.3
3. Air Quality			
3.1 The following precautionary management and mitigation measures are to be implemented: • Minimise exposed surfaces, such as stockpiles and cleared areas, including partial covering of stockpiles where practicable • Implement dust suppression measures, such as watering of exposed soil surfaces, dust mesh, water trucks and sprinklers to minimise dust generation • Minimise dust generating activities and water stockpiles and exposed areas during adverse weather conditions such as high winds and dry periods • Establish hard surfaced haul routes which are regularly damped down and cleaned;	No change.	Construction	Section 5.4, 5.5, 5.6, 6 & 7.3

Requirement	Updated Measures	Application	Document Reference
• Perform regular visual inspections to identify areas that may require watering • Establish defined site entry and exit points to minimise tracking of soil on surrounding road • Ensure vehicles entering and leaving the site are covered to prevent escape of materials during transport			
3.2 Best practice management and mitigation measures are to be implemented to prevent and/or minimise airborne particulate.	No change.	Construction and Operation	Section 5.4, 5.5, 5.6, 6 & 7.3
9. Soil and Water			
9.1 A Stormwater Management Plan is to be prepared by a suitably qualified engineer prior to the commencement of construction that is generally in accordance with the report titled "St Marys Intermodal— Stormwater Management Report" dated 21 January 2019 by BG&E and is to include: • relevant standards, requirements and specifications • design plans including any water sensitive urban design measures • describe the measures to be implemented to maintain the infrastructure	No change.	Pre-construction	Stormwater Management Plan
9.2 If excavation is required at a depth below 3 metres, additional groundwater monitoring and assessment is to be undertaken at the specific location(s) where excavation is greater than 3 metres below the existing surface.	No change.	Pre-construction	Section 5.1, 6
9.3 Construction of a bioretention basin to maintain water quality to Penrith City Council Standards.	No change.	Construction	Section 5.6
9.4 Dewater existing sediment basin in accordance with the Dam Dewatering Plan.	No change.	Construction	Section 5.2, 6 Annexure D
16. Landscape and Visual Assessment			
16 During construction the following measures are to be implemented: ▪ Dust is be controlled in response to visual signs ▪ Areas of soil disturbed by the project would be rehabilitated progressively or immediately post-construction	No change	Construction	Section 5.4, 5.6 & 6

Annexure C **Erosion and Sediment Control Plan**

Primary Erosion & Sediment Control Plan

St Marys Intermodal Freight Hub

WOLFPEAK

DOCUMENT CONTROL RECORD

Job number	EE20038
Author(s)	Tim Elder
Date	08/01/2021
Revision	5

Recipients are responsible for eliminating all superseded documents in their possession.

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1 INTRODUCTION

The St Marys Intermodal Freight Hub (the project) is a new development to be constructed within the Penrith local government area by Pacific National.

The project will provide for the operation of an intermodal (road and rail) terminal and container park, with an ultimate operating capacity of 301,000 twenty-foot equivalent freight container units annual throughput (NSW DPIE 2020).

Elder Enviro Pty Ltd has been engaged to prepare a Primary Erosion and Sediment Control Plan (ESCP) for the construction stage of the project.

1.1 Objective

The Primary ESCP provides the overarching plan demonstrating general drainage, erosion and sediment control practices for the project.

The objective of the Primary ESCP is to minimise environmental harm resulting from erosion and sediment transport associated with project construction.

1.2 Scope

The Primary ESCP incorporates the following key elements:

- Prepared by a Certified Professional in Erosion and Sediment Control (CPESC)
- Includes an overarching erosion risk and hazard assessment
- Identifies management strategies and controls to be implemented to effectively manage erosion, and subsequent sediment mobilisation during the construction stage
- Provides ESC recommendations and designs consistent with project approval documentation and plans, including:
    - *Development Consent* (Minister for Planning and Public Spaces, May 2020)
    - *Modification of Development Consent* (Minister for Planning and Public Spaces)
    - *St Marys Freight Hub Environmental Impact Assessment* (SITE planning + design, 2019)
    - *St Marys Freight Hub – Stormwater Management Report* (BG&E Pty Ltd, 2019)
- Provides ESC recommendations and designs consistent with the following best practice guidelines:
    - *Managing Urban Stormwater; Soils and Construction vol. 1, 4th edition* (Landcom, 2004) - herein referred to as the 'Bluebook'.
    - *Best Practice Erosion and Sediment Control* (International Erosion Control Association (IECA), 2008).

1.3 Principles

This Primary ESCP is prepared and certified in accordance with the following principles of effective erosion and sediment control, as described in IECA 2008.

1. Appropriately integrated the development into the site
2. Integrate erosion and sediment control issues into site and construction planning
3. Develop effective and flexible ESCPs based on anticipated soil, weather, and construction conditions

4. Minimise the extent and duration of soil disturbance
5. Control water movement through site
6. Minimise soil erosion
7. Promptly stabilise disturbed areas
8. Maximise sediment retention on site
9. Maintain all ESC measures in a proper working order at all times
10. Monitor the site and adjust ESC practices to maintain the required performance standard.

2 PROJECT DESCRIPTION

2.1 Project location

The project is located on 9.6 ha of previously developed industrial land in the suburb of St Marys within the Penrith local government area. The project is bounded to the north by Little Creek (a tributary of South Creek); to the west by the Ropes Creek Railway; and to the east by existing commercial properties. Access to the site is via Forrester Road to the east and Lee Holm Road to the north (Figure 2-1).

2.2 Construction program

Construction is anticipated to commence in December 2020 with practical completion in August 2021.

Work activities include:

- Hardstand areas for container storage and laydown, rail and vehicle loading and unloading areas
- Internal access roads
- Wash bay
- Fuel storage area
- Building pads – office, container workshop and transport workshop
- Light and heavy vehicle parking bays
- Signage and landscaping
- Utility services to support the proposed development including drainage, potable water, water (for firefighting purposes), power, data, security and sewerage
- Minor clearing of areas of vegetation regrowth, remediation (if required) and minor earthworks (Site Planning + Design, 2019)

Modifications under SSD 7308 MOD 1 include:

- re-lay the existing rail sidings (x2) within the existing rail corridor
- upgrade an existing level crossing and construct a 3.5 m wide one-way access track from the terminal level crossing adjacent to siding 2, to transport locomotive drivers and undertake maintenance inspections
- construct stormwater management facilities and discharge outlets
- establish a temporary construction compound to support rail refurbishment works

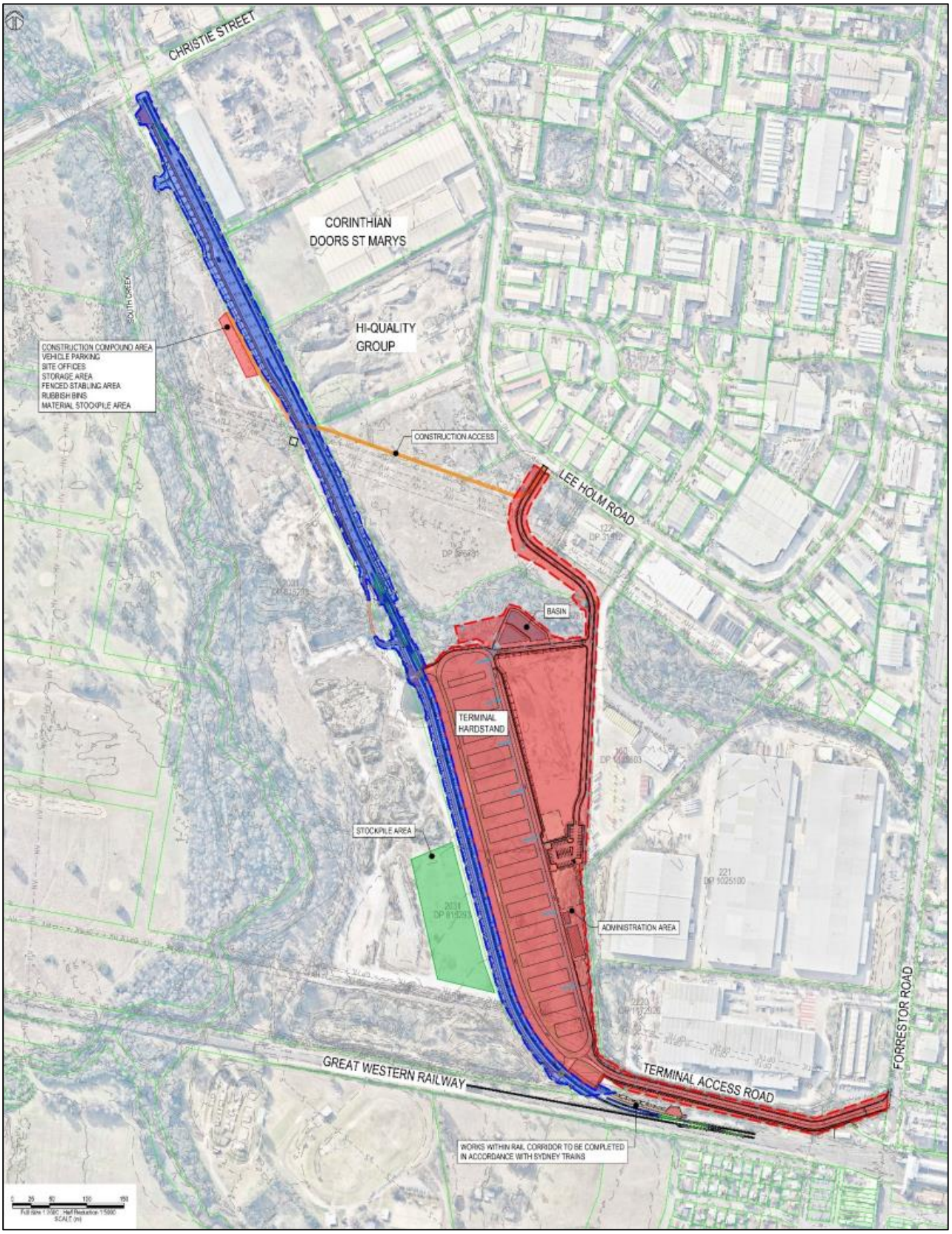

Figure 2-1. Map of project site location (from Draft Instrument of Modification)

2.3 Earthworks

Earthworks for construction of the Freight Hub project will involve:

- Stripping and stockpiling of topsoil
- Cut and fill to achieve the design subgrade levels
- Trenching for services
- Achievement of grades to ensure effective stormwater management.
- Creation of temporary and permanent stockpiles to the west of the main construction site.

Earthworks will be completed using the following equipment:

- 30t Excavator
- Semi Tippers
- Grader (GPS Controlled)
- 18t Padfoot Roller
- Tandem Truck
- Watercart
- Skid Steer Loader

Unused material will be stockpiled and remain onsite. The stockpiles will be documented and managed to required standards with a maximum height of 1.5 metres. All stockpiles will be located in a free draining area, away from tree roots, and managed to prevent runoff and dust. Earthworks will not involve any importation or export of additional spoil material (Site Planning + Design, 2019).

3 SITE CHARACTERISTICS

3.1 Climate

The Bureau of Meteorology climate statistics for the nearby Prospect Reservoir (BOM Site number 067019), located approximately 12 km to the south-east of the project site, report the following:

- Mean annual rainfall of 873 mm
- The highest mean monthly rainfall experienced between January and March
- Mean monthly rainfall for the construction period (July – December) is between 45 and 75 mm per month (BOM 2020)

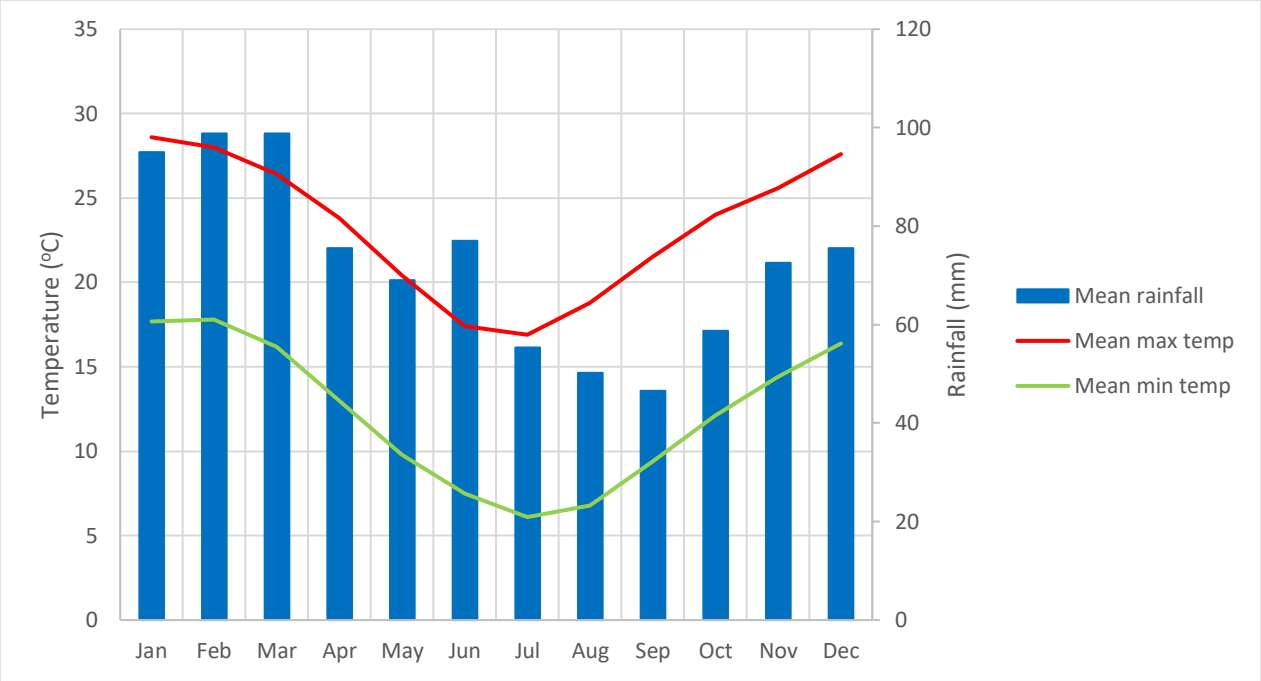

Figure 3-1. Prospect Reservoir Climate (BOM 2020)

3.2 Topography

The project site is relatively flat with an overall topographic relief of approximately 24 to 30 m AHD, descending from south to north (Douglas Partners 2019). Overall slope is approximately 1 %.

3.3 Existing drainage

Existing site drainage is described within the Stormwater Management Plan (refer Appendix B), summarised below:

- Existing site falls towards the north at approximately 1 % towards Little Creek
- Majority of site drains to an existing basin/dam via two existing 300mm culverts, which in turn discharge to Little Creek
- Runoff from upstream catchments is conveyed around and through the site by an existing pit and stormwater pipe network

3.4 Soil landscape

Soil landscape mapping prepared by the NSW Department of Infrastructure Planning and Natural Resources indicates the site occurs within Blacktown and South Creek soil landscape groups (NSW DoE 2004). Characteristics of these groups are described in Table 3-1.

Table 3-1. Soil landscape descriptions

Soil landscape	Common constraints	Soil hydrologic group [1]	K – factor [2]	Sediment Type [3]
Blacktown (bt)	Soils poorly drained with low fertility, localised subsoil, moderately expansive, highly plastic	Group C Moderate runoff potential	0.038	Type D (dispersible)
South Creek (sc)	High flooding hazard; localised permanently high watertables; low fertility; localised salinity	Group C/D Moderate to high runoff potential	0.05	Type F (fine grained)

Notes:

(1) Soil hydrologic group refers to parameters used in calculating runoff coefficients for different textural soil groups.

(2) K – factor is a measure of the susceptibility of the soil particles to detachment and transport by rainfall and runoff (refer Section 4.1.2).

(3) Sediment Type is calculated from grading and dispersion data and is used in the design of sediment basins (where required).

4 EROSION HAZARD AND RISK

4.1 Erosion hazard

Erosion hazard is assessed using the Revised Universal Soil Loss Equation – RUSLE (Landcom 2004). This is commonly used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. Adopted values are based upon a fully cleared site stripped of topsoil, representing the highest risk scenario (refer Table 4-1).

The RUSLE is represented by the equation: A = R * K * LS * P * C, where A refers to the rate of potential soil loss (t/ha/yr). Other parameters are described below.

4.1.1 Rainfall erosivity (R–factor)

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is a product of two components: total energy and maximum 30-minute intensity for each storm (Landcom 2004).

4.1.2 Erodibility (K-factor)

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008). A K-factor of 0.05 has been adopted for all work areas throughout the construction footprint (based on South Creek soil landscape, Table 3-1), representing the worst-case scenario.

4.1.3 Slope (LS–factor)

The LS-factor is calculated based on 200 m slope length and a 1 % gradient (relatively flat site) for the main terminal hardstand area. The rail siding area is calculated as 15 m slope length (easement width) with a slope of 3 %.

4.1.4 Cover and management factor (C–factor)

During the construction stage, a fully cleared project site is assumed (i.e. 0% groundcover representing a C-factor of 1). As construction progresses and soil stabilisation practices are implemented, groundcover % will progressively increase, reducing potential soil loss.

4.1.5 Erosion control practice factor (P–factor)

The P-factor measures the combined effect of all support practices and management variables. It also represents structural methods for controlling erosion (IECA 2008). The nominated P-factor for all areas without permanent stable groundcover is 1.3 (based on the default construction phase condition).

Potential soil loss calculations for the project construction stage are presented in Table 4-1.

Table 4-1. Potential soil loss calculations

Parameter	Freight Hub Area	Rail refurb (MOD 1)	Stockpile Area	
			Stockpiles	Haul roads
Catchment Area (disturbed)	9 ha	2.5 ha	1 ha	0.9 ha
RUSLE Factors				
Rainfall erosivity - R	6020	6020	6020	6020
Soil erodibility - K	0.05	0.05	0.05	0.05
Slope length - L	200	15	5	50
Slope gradient - S	1	3	50	2
Length/gradient (LS-factor)	0.25	0.26	1.88	0.34
Erosion control practice - P	1.3	1.3	1.3	1.3
Ground cover in disturbed catchment - %	0	0	0	0
Ground cover in disturbed catchment - C	1	1	1	1
Soil Loss & Erosion Hazard				
Soil loss (tonnage rate) (t/ha/yr)	96	103	736	133
Soil loss (volume rate) (m^3/ha/yr)	74	79	566	102
Soil loss class	1	1	5	1
Erosion hazard	Very Low	Very Low	High	Very Low

4.2 Erosion risk

Erosion risk refers to the evaluation of the “risk” of soil erosion when consideration is given to both the degree of erosion and the likelihood of the erosion occurring (IECA 2008). In the absence of a site-specific risk assessment procedure, erosion risk is determined from the average monthly rainfall depth for Prospect Reservoir (BOM 2020). Results are presented in Table 4-2. Erosion risk for all months is rated as moderate.

Table 4-2. Monthly erosion risk rating

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall depth (mm)	95.1	98.8	98.8	75.5	69	77	55.4	50.2	46.5	58.8	72.6	75.5
Erosion Risk Rating	Moderate											

4.3 Erosion and sediment control requirements

Recommended erosion and sediment control measures are based upon the relationship between erosion hazard (

Table 4-1) and erosion risk (Table 4-2).

Table 4-3 summarises erosion and sediment control requirements for all stages of project construction, as determined for a moderate erosion risk site.

Table 4-3. ESC requirements during construction

ESC Component	Minimum ESC Requirements
Drainage Control	• Clean water (upslope catchments) diverted around and/or through work areas without impacting water quality • Site runoff diverted to appropriate sediment control measures prior to discharge from site • Temporary drainage structures designed to 1 in 5-year ARI.
Erosion Control	• disturbed soil surfaces stabilised with minimum 70 % cover within 20 days of completion of works within any area of the work site • Unfinished earthworks stabilised where disturbance is likely to be suspended for a period exceeding 20 days. • Disturbed soil surfaces stabilised with minimum 80 % cover within 10 days of completion of works within any constructed drainage channel or waterway • Non-completed channel works stabilised if exposed, or expected to be exposed, for a period exceeding 20 days.
Sediment Control	• All reasonable measures are to be taken to trap sediment as close to sources as possible ('treatment train' approach) • Site runoff is to be directed to a Type 1 sediment control (ie. sediment basin) required throughout construction while ever calculated soil loss volume exceeds 150 m^3/yr.

Typical measures to be implemented during the project are discussed in Section 5 below, with specific design, timing and location to be provided within Progressive ESCPs.

5 EROSION AND SEDIMENT CONTROL MEASURES

5.1 Progressive ESCPs

As construction progresses, specific up-to-date details on the location and installation of ESC measures will be provided through Progressive ESCPs. Typically, this will include the following construction stages/situations:

- Where a new stage of construction works is commenced and/or controls require alteration due to change in work practices (e.g. topsoil strip, bulk earthworks, final stabilisation)
- Controls require alteration
- A change in the design occurs
- The desired outcome (e.g. protection of receiving environments) is clearly not being achieved

Where required, Progressive ESCPs will be based on specific site conditions and developed with construction personnel. All Progressive ESCP's are to be consistent with this Primary ESCP, with specific measures in accordance with the 'Bluebook', project approvals and associated documentation.

A Progressive ESCP for initial earthworks is attached as Appendix C.

5.2 Drainage control

Drainage controls include measures for the diversion of 'clean' stormwater runoff around and through the site; and the diversion of 'dirty' site stormwater runoff to enable treatment of sediment prior to release offsite, as defined below:

Clean water:

Water that either enters site from an external source and has not been further contaminated by sediment within site; or water that has originated from the site and is of such quality that it does not need to be treated in order to achieve the required water quality standard (IECA 2008). Site clean water constitutes surface runoff from areas of non-erodible cover, including vegetation, hardstand, soil binder, mats or blankets (eg. geotextile).

Dirty water:

Site derived water not defined as clean, thereby requiring treatment with appropriate controls prior to release from site (IECA 2008).

Temporary drainage controls installed as part of construction will enable management of stormwater within work areas. Drainage controls will perform the following functions:

- Enable diversion of 'clean' up-slope run-on water either around or through the site at non-scouring velocities
- Enable collection of 'dirty' runoff generated within construction areas and the delivery of this water to an appropriate sediment control measure
- Minimise the risk of soil erosion caused by site-generated flows within the project, through the use of 'intermediate' flow treatment and release points
- Control of the flow velocity, volume and location of water passing through the project at drainage line and waterway crossings.

Proposed controls include:

- Existing stormwater pipe network – diversion of upslope flows around the project site
- Catch drains – for collection and diversion of sheet flow across a slope or around soil disturbances
- Diversion channels – for diversion of large concentrated flows
- Diversion banks – cross drainage on unsealed roads
- Check dams (eg. rock, sediment bags, coir logs) – velocity control device within concentrated flow channels. Also used as sediment control
- Culverts.

Typical designs are provided within Appendix C and applicable site-specific Progressive ESCPs.

5.3 Erosion control

Prevention of erosion is the primary approach for the prevention of adverse impacts associated with sedimentation. Construction activities are to be undertaken to reduce the duration of soil exposure to erosive forces (wind and water), either by holding the soil in place or by shielding it. Measures to be used include a variety of construction practices, structural controls and vegetative measures aimed at managing runoff at a non-erosive velocity, and the protection of disturbed soil surfaces.

The specific measure(s) implemented will be based on seasonal erosion risk and construction considerations. Measures will be documented in the most current Progressive ESCP and based upon 'Bluebook' guidelines.

Proposed controls include:

- Promptly stabilising exposed areas once construction phase has been completed (permanent landscaping)
- Protection of soil surface (temporary and permanent) including placement of hardstand surfaces, use of soil binder, vegetation establishment (including landscaping), and protection with mats & blankets (eg. jute, geotextile) where practical
- Consideration of the use of ameliorants to stabilise catchment surfaces and reduce erosion (eg. spreading gypsum across disturbed areas)
- Dust suppression by wetting of exposed surfaces (water truck), application of soil binder, and/or application of soil cover.

5.4 Sediment control

Sediment control standards are based on soil loss calculations (Table 4-1), and include Types 1, 2 and 3 as described below. Typical designs are provided within Appendix D and applicable site-specific Progressive ESCPs.

5.4.1 Type 1 Sediment control standard

A Type 1 sediment control is typically the minimum requirement for the following scenario:

- Catchment area > 2,500 m^2 and soil loss > 150 m^3/yr

Based on project catchment area and calculations of potential soil loss in the fully disturbed construction site condition (refer Table 4-1), Type 1 sediment controls are required as the minimum sediment standard for both the freight hub construction site and the adjacent stockpile area.

A Type 1 sediment control standard is provided by purpose-built sediment basins, designed to collect and settle sediment-laden water. They perform two main functions:

- Rapid settlement of coarse-grained particles (e.g. sand and coarse silt) during all storm events that flow through the basin; and
- Settlement of fine-grained particles that are allowed to pass through the basin under controlled conditions.

This enables sediment basins to reduce turbidity levels of construction runoff water, thereby reducing potential for ecological harm. Design and management of project sediment basin(s) is provided in Section 6.

5.4.2 Type 2 Sediment control standard

A Type 2 sediment control is the minimum requirement where total soil loss volume < 150 m^3/yr and:

- Catchment area > 1000 m^2 and soil loss rate > 75 t/ha/yr
- Catchment area > 2,500 m^2 and soil loss rate is 75 – 150 t/ha/yr

A Type 2 sediment trap will demonstrate the following characteristics:

- Under typical flow conditions (discharge and suspended sediment concentration), is capable of capturing and holding at least 90% of material > 0.14mm.
- Sufficient sediment retention capacity to capture and hold one month's sediment loss from the catchment
- Designed to maintain its hydraulic and structural integrity under normal site conditions.

Type 2 controls include:

- Rock Filter Dam (RFD) **-** RFDs are structures formed by the incorporation of geotextile (e.g. A19 bidum®) and a coarse rock filter (40-75mm nominal diameter)
- Filter Bag/Tube - Filter tubes are geotextile bags through which site runoff is directed to enable filtering and treatment of sediment
- Coir logs - Coir logs are biodegradable tubes filled with densely packed coconut fibre wrapped in coir netting. They can be used as flow diversion berms or to provide sediment control by providing temporary ponding and filtering of site runoff.

5.4.3 Type 3 Sediment Control standard

A Type 3 sediment control is the minimum requirement where total soil loss volume < 150 m^3/yr and soil loss rate is < 75 t/ha/yr. A Type 3 sediment trap will demonstrate the following characteristics:

- Under typical flow conditions (discharge and suspended sediment concentration), is capable of capturing and holding at least 90% of material > 0.42 mm
- Sufficient sediment retention capacity to capture and hold one month's sediment loss from the catchment
- Designed to maintain its hydraulic and structural integrity under normal site conditions.

Type 3 controls include:

- Rock berms - clean rock may be placed as a perimeter berm to filter sheet flow runoff from site (typical size 75-150 mm)
- Sediment fence - sediment fence may be used in locations where placement of rock berms is not practical (due to access, materials and equipment constraints).

5.4.4 Supplementary sediment control

Supplementary sediment controls are not considered effective to meet the Type 3 classification in isolation but form an important component of the erosion and sediment control system when implemented as supplementary controls. Supplementary controls will be implemented during the construction program, and include:

- Grass filter strips
- Check dams
- Kerb inlets
- Construction exits.

In addition to adopting measures as per 'Bluebook' standard drawings, variations to these may be implemented where it can be demonstrated that they are equally as effective and meet the intent of best practice guidelines.

Typical designs are provided within Appendix D and applicable site-specific Progressive ESCPs.

5.5 Site stabilisation

Following the completion of construction activities, long-term protection of the site from erosion will be provided by the final constructed pavements, building, lined drainage and landscaping, as per applicable engineering plans.

Erosion and sediment controls are to remain in place until minimum 75 % self-sustaining groundcover (or equivalent) is achieved for disturbed areas (80% for drainage channels).

6 SEDIMENT CONTROL DESIGN

6.1 Project sediment control standard

Based upon catchment area and potential soil loss in the fully disturbed construction site condition (Table 4-1), A Type 1 sediment control (sediment basin) is identified for the main freight hub construction site and adjacent stockpile area.

The existing water storage present on site (previously a sediment basin) may be utilised as a Type 1 sediment control measure for the freight hub site, subject to project approval conditions. If increased capacity is required, a supplementary sediment storage may be constructed. An additional sediment basin is required for the adjacent stockpile area.

Specific requirements for Type 1 sediment control measures will change during the course of construction as areas are progressively stabilised. This may be assessed periodically during update of Progressive ESCPs.

6.1.1 Type 1 sediment basin design

Sediment basin sizing has been developed consistent with recommendations of the 'Bluebook'. Parameters used in calculation of sediment basin requirements are provided in Table 6-1.

A typical 'Bluebook' sediment basin design is provided in Figure 6-1 below.

Due to the proximity of the project site to Little Creek, the 5-day 85th %ile rainfall depth (Penrith) is adopted for sediment basin design. This value is 35 mm (Landcom 2004).

6.1.2 Sediment basin management

Sediment basins are to be managed as follows:

- Treatment and discharge of sediment basin to be within a maximum 5-day period from runoff-producing rainfall
- Water quality must comply with discharge parameters prior to discharge (typically pH in range of 6.5 to 8.5; Total suspended soils < 50mg/L; no visible oil & grease)
- Flocculants/coagulants to be applied to assist settlement of sediment prior to discharge (eg. gypsum applied within 24hrs of the conclusion of runoff event)
- Marker installed within basin to indicate the top of the sediment storage zone
- Desilted regularly to maintain design capacity of sediment storage zone
- Be regularly monitored to ensure structural integrity is maintained, including inlets and outlets.

6.1.3 Coagulants & Ameliorants

Flocculation of sediment basins is usually required to assist settlement of fine clays prior to discharge to the receiving environment. The application of a coagulant is to occur within 12 hrs of the receipt of runoff producing rainfall. Typically, gypsum (calcium sulfate) has been used for this purpose. This requires application across the sediment basin surface (spray or hand cast) at an approximate rate of 32 kg per 100 m^3 of water volume.

If alternative flocculants are proposed (eg. anionic polymers), chemical analysis is required prior to use to ensure they are effective and will not result in toxic impacts to the receiving environment.

Table 6-1. Sediment basin design

Parameter	Freight Hub	Stockpile Area[1]
Design inputs		
Design Rainfall	5 days	
5-day, 85th %ile rainfall event	35 mm (Penrith)	
Rainfall intensity: 2yr, 6hr storm	16.2 mm/hr	
Soil Type	Type D (dispersible)	
Rainfall erosivity (R-factor)	6020	
Soil erodibility (K-factor)	0.05	
Erosion Control Practice (P-factor)	1.3 (compacted and smooth)	
Cover factor (C-factor)	1 (recent disturbance, 0% cover)	
Soil hydrologic group	Group D	
Runoff Coefficient	0.74	
Soil loss		
Max soil loss (tonnage rate)	96 t/ha/yr	736
Soil loss (total volume)	664 m^3/yr (387 m^3 for 7-month construction)	658 m^3/yr (384 m^3 for 7-month construction)
Sediment basin design		
Total basin capacity	2444 m^3	604 m^3
Sediment storage zone	113 m^3	112 m^3
Settlement zone volume	2331 m^3	492 m^3
Settlement zone depth	0.6 m (min)	
Length: width ratio	3:1	
Embankment		
Crest width	2.5 m	
Downslope batter	3:1 (h:v)	
Primary outlet	Floating syphon or pumped outlet	
Emergency outlet		
Design storm ARI	1 in 20 year	
Freeboard	750 mm	

Note:

[1] Main stockpile area may be constructed to contain all stockpile site runoff (i.e bunded), thereby eliminating the requirement for a Type 1 sediment basin.

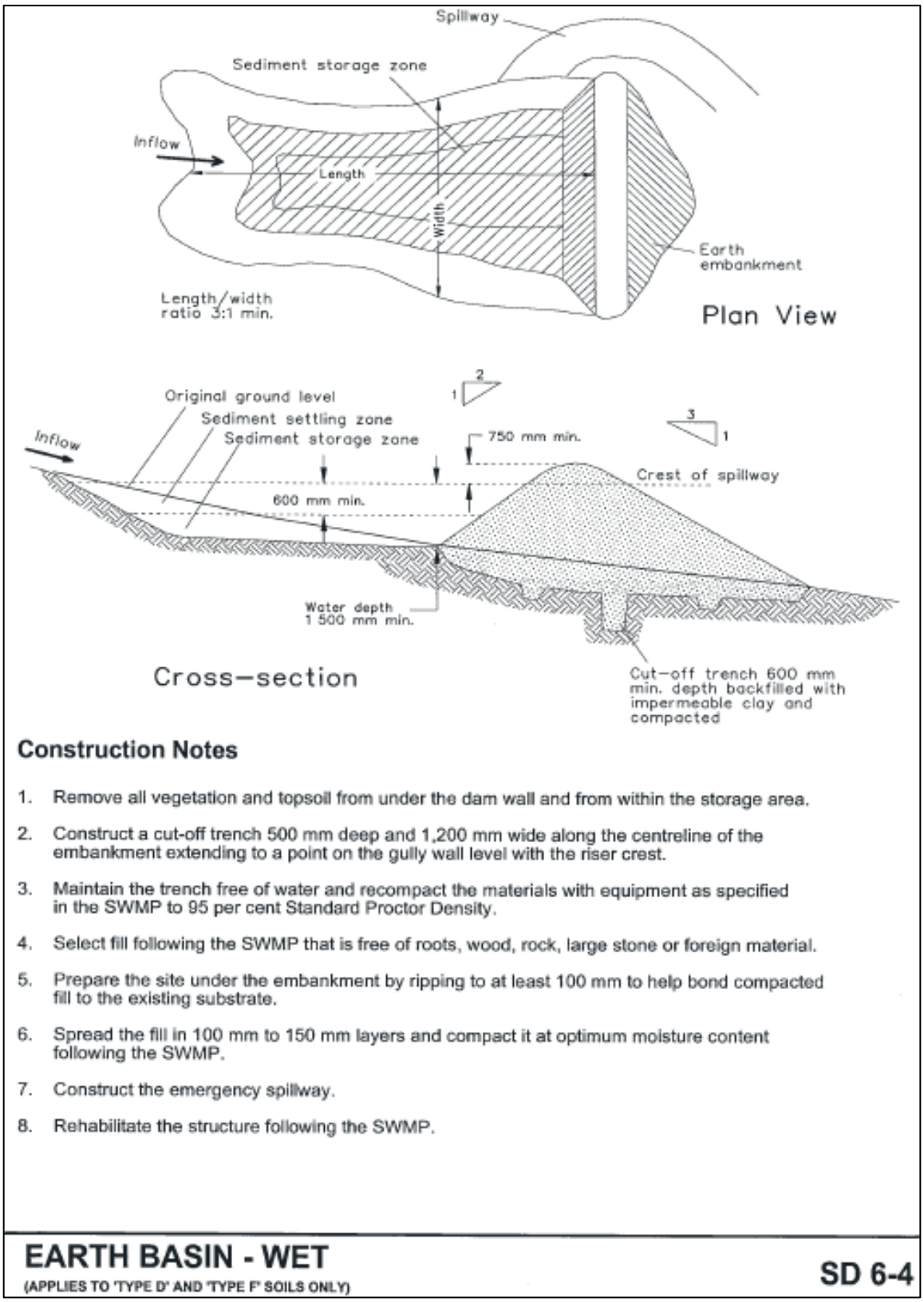

Figure 6-1. Typical sediment basin design (Landcom 2004)

7 SPECIFIC AREAS AND ACTIVITIES

7.1 Site access

Access to the construction site is to meet the following requirements:

- Minimise access road construction to ensure the least amount of site disturbance
- Main access roads to be protected with a non-erosive surface (e.g. gravel hardstand, sealed)
- Access to incorporate stabilised exit points. These are to be monitored for excessive sediment tracking onto adjacent public road
- Cut and fill batters, watercourse crossings and associated approaches are to be suitably stabilised from erosion
- Roads to be graded to a crown, or with crossfall drainage
- Runoff from roads to be directed to sediment control measures.

7.2 Vegetation clearing

Clearing activities associated with the project are to be undertaken consistent with relevant plans, approvals and the following control measures:

- Vegetation clearing shall be to the minimum amount necessary to allow access or approved works
- Previously cleared areas shall be utilised where possible for laydown and turn around points
- Areas of protected vegetation and significant areas of vegetation are to be retained and must be clearly identified prior to the commencement of clearing
- Approved areas for native vegetation clearing to be clearly marked
- Disturbance to natural watercourses and associated riparian zones must be limited to the minimum practicable.

7.3 Topsoil & spoil management

Earthworks are to incorporate the stripping and preservation of topsoil for reuse (wherever practical). The depth of topsoil stripping is dependent upon soil type, however ideally the top 50 mm is to be retained separately from other material (contains most of the biological activity and nutrients required for successful rehabilitation). Depth of topsoil stripping will be further assessed on site.

Stockpile sites are to be managed so as not to cause environmental harm as a result of sedimentation. Stockpile sites will be located and constructed consistent with the following principles:

- No temporary construction stockpiles to be located within protected areas of vegetation, driplines of trees, or within 20 m of retained trees, drainage lines, flood zones or any area otherwise likely to be inundated with water
- Avoid placement of stockpiles, where practicable, within 50 m of any drains, drainage lines or other waterways. Where not practicable, specific erosion and sedimentation controls to be implemented
- Stockpiles are not to exceed 1.5 m in height
- Stockpiles are to be protected upslope by earth diversion banks to divert run-on water

- Stockpile areas are to be protected downslope by an appropriate Type 2/3 sediment control measure (eg. sediment fence, earth berm with outlet); with resulting runoff subsequently discharged to a Type 1 sediment control (i.e sediment basin).
- Long term (> 10 days) stockpiles, batters and other erosion sensitive areas shall be adequately stabilised through velocity reduction covering, grassing, vegetation, soil binding, water diversion or other as appropriate.

7.4 Drainage crossings

Where drainage crossings are required, they are to be constructed in accordance with the following:

- Site runoff is to be prevented from directly entering the drainage channel
- Where culvert pipes are to be utilised, the following guidelines are to be considered:
    - Culverts are to have sufficient capacity to ensure minimal disturbance to channel flow for the design discharge
    - Culvert cells aligned with the channel
    - Culvert cells to extend well beyond the fill embankment
    - Rock (or geotextile) is to be used to protect fill from being swept into the channel
    - Rip rap is used at crossings and approaches.

7.5 Ancillary areas

Ancillary areas include temporary infrastructure required to support the construction program and include site compounds and lay-down areas. The erosion and sediment control principles and strategies discussed within this document will equally apply to all ancillary areas. Specific Progressive ESCP's will be developed where additional detail is required for these areas.

8 ESCP MANAGEMENT

8.1 Responsibilities

Pacific National is responsible for implementation of and adherence to this ESCP, as per Table 8-1.

Table 8-1. ESCP responsibilities

Party	Primary Responsibility
Environment Manager	• Overall implementation of the ESCP and management of environmental impacts and risks • Responsible for reporting any incidents to relevant authorities if required • Issue and distribution of ESCP • Revision of the ESCP, as required • Implementation, monitoring, reporting and corrective actions within the ESCP.
Site Manager	• Implementation of strategies, requirements, procedures and measures to ensure that appropriate environmental protection is in place • Induction, supervising and monitoring of the ESCP • Site inspections (random, daily) to ensure adherence to the ESCP.
All personnel	• Adherence to ESCP.

8.2 Training

All staff and contractors shall be required to undertake environmental awareness and training, including the following specific components for surface water and erosion and sediment control management:

- Awareness of potential impacts to surface water
- Protocols relating to stormwater and construction water, including the requirement for water quality validation prior to recycling or re-use and prior to discharge from site to the environment
- The use of erosion and sediment control devices to mitigate impacts, and ideal operation of these devices
- The requirement for erosion and sediment control devices to be implemented and maintained in accordance with Site Environmental Plans and ESCPs (if applicable).

8.3 ESC installation and maintenance

The installation and maintenance of all ESC measures is to be overseen by a suitably qualified person. Installation is to be consistent with the ESCP and associated Progressive ESCPs.

All required temporary erosion and sediment control measures must be fully operational and maintained in proper working order until permanent stabilisation is achieved, including:

- Identified soil erosion areas are to be resolved as soon as possible, with additional control measures implemented to prevent recurrence
- Settled sediment must be removed as soon as reasonable and practicable from any sediment basin if:

- It is anticipated that the next storm is likely to cause sediment to settle above the sediment basin's sediment storage zone; or
- The elevation of settled sediment is above the top of the basin's sediment storage zone.

- All sediment control devices (other than sediment basins) must be de-silted and made fully operational as soon as reasonable and practicable after runoff-producing rainfall, or if the sediment retention capacity of the device falls below 75% of the design retention capacity (IECA 2008)
- Sediment removed from areas of deposition is to be incorporated within subsoil stockpile areas and/or buried on-site.

8.4 Monitoring & reporting

ESC measures are to be inspected at least weekly during operation, within 24 hrs of expected rainfall and as soon as reasonably practical after receiving significant rainfall events (i.e. >10 mm in 24 hr period). Visual assessment will be carried out of surface water runoff structures, drainage structures and erosion control structures to ensure they are operating efficiently. An inspection checklist is provided in Appendix D.

8.5 Updates and variations

ESCPs are dynamic documents, typically requiring updating as construction stages progress and site characteristics alter. Any alterations to the implementation of erosion and sediment controls within specific areas will be recorded and outlined in updated Progressive ESCPs. This may include the following scenarios:

- Controls require alteration due to change in work practices or new stage of works is commenced
- Controls require alteration due to change in seasonal conditions
- Changes occur in slope gradients and drainage paths, with their exact form unpredictable before works start
- A change in the design occurs that materially affects the site works
- The desired outcome (e.g. protection of receiving environments) is clearly not being achieved.

The frequency of Progressive ESCP updates will be based upon currency of the existing implementation schedule and performance of controls already in place.

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APPENDIX A STORMWATER PLAN

St Marys Freight Hub

Phase 1 Rail Works Design Site Based

Stormwater Management Plan

FOR / Civil Engineering Services

CLIENT / Pacific National

DOCUMENT NO / B18028-REP-SBSMP-0001 REV / B DATE / 26/06/2020

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Appendix A Phase 1 Rail Works Hydraulic Calculations

Appendix B Stormwater Treatment System Locality & Catchment Plan

Appendix C Proposed Erosion and Sediment Control Plan & IFC St Marys Drainage Layout Plan

Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved	Signed
A	19/06/2020	Issued for Approval	John Luc	Matt Worthington-Eyre		-
B	26/06/2020	Issued for Approval	John Luc	Matt Worthington-Eyre	Matt Worthington-Eyre	-

1 INTRODUCTION

1.1 Background

BG&E Pty Ltd have been engaged by Pacific National to prepare a Site Based Stormwater Management Plan (SBSMP) in association with the drainage design to support the new Freight Hub (The Facility) at St Marys in Western Sydney, New South Wales. The report has been prepared to meet the requirements and objectives of Pacific National standards, and to also adhere to Penrith City Council's (PCC) stormwater quantity and quality requirements.

The proposed development involves the construction of a Freight Hub Facility on a staged basis to accommodate a new dedicated port shuttle service from Port Botany to St Marys.

The purpose of this SBSMP is to document the stormwater quantity and quality assessment and management plan. This document is based upon the criteria specified within the Functional Specification Report (FSR), BG&E document B18028-FSR-REP-002_B and drainage design within the IFC Design Report, BG&E document B18028-DES-REP-001_0.

1.2 Study Methodology

The design methodology adopted in conducting the investigation can be summarised generally as follows:

- Review relevant standards, codes and policies;
- Determination of the stormwater quantity and quality requirements;
- Provide a suitable and cost-effective stormwater management plan incorporating measures to accommodate stormwater quantity and quality;
- Review flooding in the area and comment on any requirement's pertaining to the proposed development; and
- Produce concept stormwater management plan and erosion and sediment control plans.

1.3 Standards & Peripherals

The following documents have been used as part of this review:

- Pacific National Infrastructure Maintenance Manual Hydraulics & Hydrology Standard 2017 (IMM 11-01_02);
- Penrith City Council Waste Water Urban Design (WSUD) Policy 2017;
- Penrith City Council WSUD Technical Guidelines 2015;
- Landcom Managing Urban Stormwater: Soils and Construction;
- Water by Design Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands Version 1.1 (2010); and
- Water By Design MUSIC Modelling Guidelines 2012.

2 SITE CHARACTERISTICS

2.1 Location

The site comprises of Lot 196 Christie Street on Deposited Plan 31912 (comprising the rail siding). It is located within a largely industrial area of St Marys, 8 km east of Penrith, NSW. Please note that the rail corridor bisects the site which in turn is bounded by Forrester Road to the east, the Great Western Railway Line to the south, and Little Creek to the North.

2.2 Topography

The broader site area comprises of approximately 12.1 hectares within 40 hectares of land area. The existing terrain can be described as being generally flat and falls downward to the north with the elevation varying from approximately RL24 - 30m AHD.

2.3 Existing Structures and Buildings

An existing dilapidated dump station structure exists along the existing railway siding and straddles the rail sidings. An existing unloading pit, which generally holds water, is located adjacent to the structure.

2.4 Existing Rail Infrastructure

The existing rail infrastructure generally includes 2 x 1200m sidings with a centrally located crossover. In general, the existing rail is 47kg with a mixture of sleeper types.

2.4.1 Great Western Railway Line

Rail access to the Facility is via an existing siding which has a connection point on the Great Western Railway between the St Marys Station and Werrington Station.

2.5 Existing Roads

The road infrastructure located adjacent the proposed Facility is as follows-

- Forrester Road – Current road access to the site is via Forrester Road to the south-east adjacent St Marys Station. It is a two-way, single lane Urban Industrial Collector Street (UICS) sign posted as 50km/hr. This road is owned by the Penrith City Council. It is proposed to be light vehicle access only via this existing access point to the new facility;
- Lee Holm Road – located adjacent to the north eastern boundary of the site. It is a two-way, single lane Urban Industrial Access Street (UIAS) sign posted as 60km/hr. This road is owned by the Penrith City Council. It is proposed to construct a new heavy vehicle access road from Lee Holm Road to the Facility adjacent Lot 122 on DP 31912; and

- Christie Street – located at the north-west end of the site near the termination of the spur line. It is a two-way, single lane Urban Collector Street (UCS) sign posted as 60km/hr. This road is owned by the Penrith City Council. It is not proposed to gain access to the site from this road, at this stage.

2.6 Existing Drainage

Along the rail alignment, the existing drainage will remain as part of the Phase 1 works. A 675mm diameter stormwater pipe runs through the terminal hardstand and crosses Siding 1B, 2B and the access track at approximately Chainage 485m. Additionally, at Chainage 820m, the existing 2.5m x 1.8m RCBC culvert will remain as part of the Phase 1 works This culvert outflows to another existing 2.1m RCP culvert crossing at the gravel access track to the west of Siding 2B.

Catch drains are proposed to the east and west of the rail sidings, primarily directing water to the north to fall with the existing terrain. These catch drains are to discharge into Little Creek or South Creek.

Refer to Figure 1.1 below for the locations of the existing drainage.

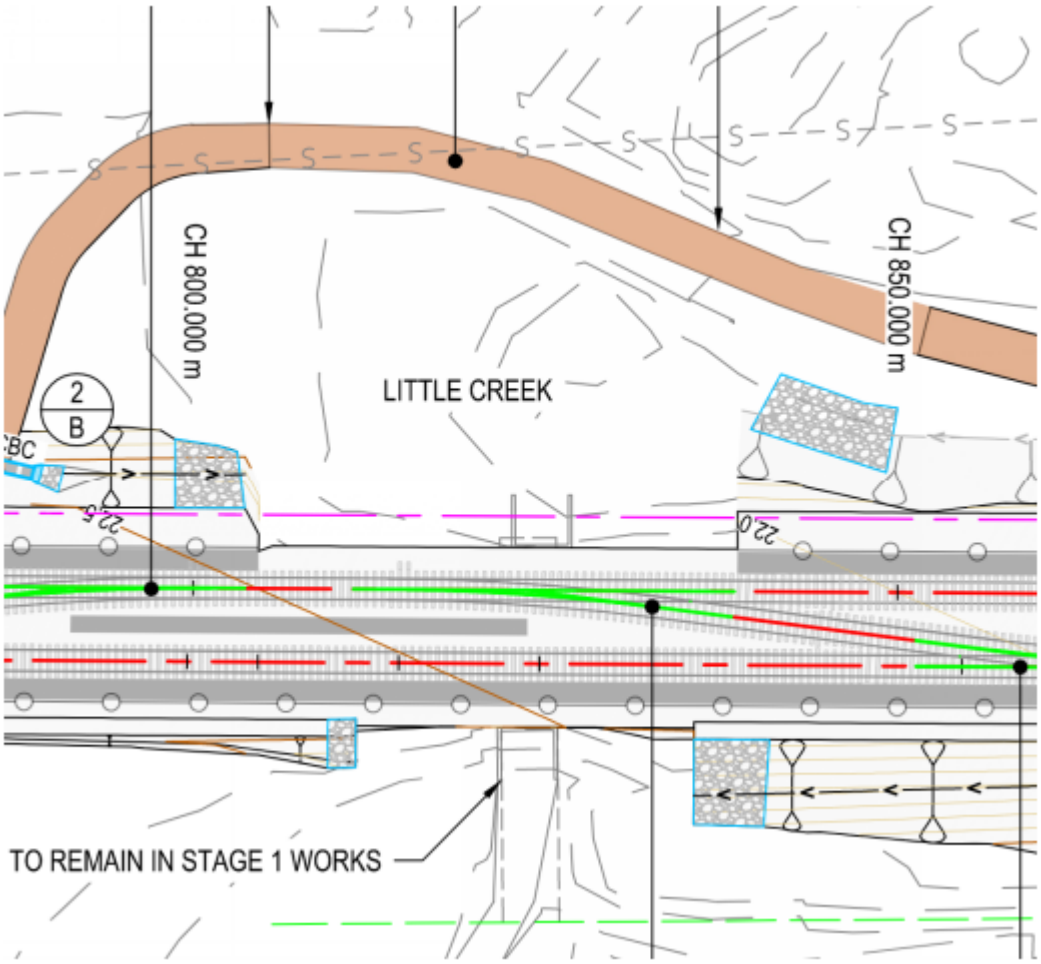


Figure 1.1: Existing Drainage Location

2.7 Existing Land Use

The existing site was initially acquired by the State Rail Authority (SRA) as a site to house its Tangara train maintenance and storage facility in 1986. It then was unused in the late 1990's. In 1999 the site was filled with material from the Northside Sewerage Tunnel Project.

The proposed land use is for a rail freight terminal and associated logistics facilities. Internal roads, services and ancillary structures are proposed as part of the overall St Marys Intermodal Terminal.

2.8 Existing Services

The following existing utilities and services located at the Facility:

- Optic Fibre cables (NBN & Optus) traverse the site from east to west in the southern portion of the site adjacent the Overhead HV electrical. These are currently only located by Dial before you Dig (DBYD). They are in excess of 3.0m below finished surface levels and are to be retained and protected during the works;
- An 11kV overhead HV electrical line traverses the southern end of the site adjacent the Great Western Railway corridor coming from St Marys station heading west entering the site through the proposed light vehicle access road corridor. This service is owned by RailCorp and is proposed to be retained and protected during construction of the light vehicle access road;
- An additional 11kV overhead HV electrical line is located at the south-eastern portion of the site entering from the Forrester Road entry location along the proposed road corridor briefly before exiting the sith south over the Great Western Railway into Camira Street. This service is owned by Endeavour Energy and is proposed to be retained and protected during construction of the light vehicle access road;
- A 66kV overhead HV electrical line also traverses the southern end of the site. This service enters the site from the access connection to Forrester Road and runs adjacent and within the common boundary to Lot 2220 on DP 1172926 and heads west through the southern portion of the site. This service is owned by Sydney Trains and a section of it will need realignment to suit the proposed facility hardstand layout. This HV relocation will be undertaken by a specialist Contractor and is outside the scope of the D&C Contractor;
- A 33kV overhead HV transmission line is located at the northern portion of the site running east to west. Two transmission towers are located within the site boundary. No alteration to this service is proposed as part of this development;
- Existing 150mm diameter reticulation sewer runs approximately along the eastern boundary of the site from south to north crossing the site boundary multiple times. It is proposed to connect into this existing pipe at two separate locations. The sewer is located by DBYD and no easement exists for this service;
- A 525mm diameter trunk sewer and branch line run from east to west across the northern portion of the site. There is a large Sewer vent on this Branch line at the intersection of the branch line, then increases to 600mm diameter west past the rail sidings. The sewer is located by DBYD and no easement exists for this service;
- A 225mm diameter sewer enters the site from Lee Holm Road and heads south to connect into the 525mm trunk sewer mention above. The sewer is located by DBYD and no easement exists for this service;

- There are two (2) Authority Water mains available for potable cold water and fire water connection. One identified in Lee Holm Road being 150mm cast iron cement lined. There is an existing 100mm fire hydrant booster at the proposed entry location of Lee Holmes Drive, which will be required to be upgraded or removed for the new works. JHA ensure this is covered in proposed works section; and
- There are two (2) Authority Water mains located in Forrester Road. One being a 600mm ductile iron cement lined trunk main which is not available for connection and the other being a 200mm cast iron cement lined reticulation main which appears to be available for connection. JHA ensure this is covered in proposed works section.

2.9 Easements

There are numerous easements traversing the site inclusive of:

- EASEMENT FOR TRANSMISSION LINE 20.115 WIDE (D431274);
- EASEMENT FOR P.M.G CABLE 12.19 WIDE (K780528);
- EASEMENT FOR P.M.G CABLE 3.05 WIDE (L686302);
- EASEMENT FOR WATER PIPELINE 3.05 WIDE (DP 876781);
- PROPOSED EASEMENT FOR TRANSMISSION LINE 18.29 WIDE (DP 876781);
- EASEMENT FOR RAILWAY TRANSMISSION LINE VARIABLE WIDTH (VIDE K403219);
- EASEMENT FOR RAILWAY LINE 20.115 WIDE (L686302);
- EASEMENT FOR CARRIAGEWAY 2 WIDE (DP 1033086);
- PROPOSED EASEMENT FOR DRAINAGE 4.0 WIDE (DP 1022441);
- EASEMENT FOR DRAINAGE 3.0 WIDE & VARIABLE (DP 1022441)(8661181);
- EASEMENT FOR DRAINAGE 9.145 WIDE (DP876781)(5102977);
- PROPOSED RIGHT OF CARRIAGEWAY 12 WIDE & VARIABLE (DP 1022441);
- EASEMENT FOR P.M.G CABLE 12.19 WIDE (VIDE L686302);
- EASEMENT FOR TRANSMISSION LINE VARIABLE WIDTH (DP 1022441);
- EASEMENT FOR RAILWAY TRANSMISSION LINE 20.115 WIDE (DP 1022441);
- EASEMENT FOR TRANSMISSION LINE 30.48 WIDE (DP 1022441)(8661181);
- EASEMENT FOR TRANSMISSION LINE 9.145 WIDE (DP 1022441);
- EASEMENT FOR TRANSMISSION LINE 20.115 WIDE (DP1022441)(8661181);
- EASEMENT FOR TRANSMISSION LINE VARIABLE WIDTH (DP1022441)(8661181);
- PROPOSED RIGHT OF CARRIAGEWAY 4 WIDE AND VARIABLE;
- EASEMENT FOR DRAINAGE 4 WIDE (DP1022441)(8661181);
- EASEMENT FOR TRANSMISSION LINE 30.48 WIDE (DP876781)(5102977);
- EASEMENT FOR TRANSMISSION LINE 30.48 WIDE (VIDE H83909);
- EASEMENT FOR ELECTRICITY SUPPLY (P423797)(9187901); and

- EASEMENT FOR ELECTRICITY SUPPLY (DP451023)(9187902).

2.10 Water Courses and Flooding

Little Creek flows centrally through the site from east to west. The access road to the bus depot at the east of the site crosses the creek at an existing box culvert. Little Creek continues through the site via a second box culvert beneath the sidings and towards South Creek.

South Creek is located approximately 200m to the west of the existing rail infrastructure within the site and flows from the south to the north and forms part of the Hawkesbury-Nepean catchment.

The site is subject to flooding from both South Creek and Little Creek. Flooding from Little Creek is the dominant flood mechanism with the exception of events of larger magnitude than the 0.2% AEP (1 in 500 ARI event) flood event when flooding from South Creek is expected to overtop the existing rail siding.

Much of the proposed development area is not affected by flooding until the Probable Maximum Flood (PMF) event. Some localised areas of flooding are shown in the flood mapping and are a result of local catchment inflows. These will need to be managed through the site drainage strategy.

A Flood Impact Assessment was undertaken by BG&E and shows that the concept proposal:

- Does not increase flood affectation to surrounding property;
- Does not adversely affect floodways through the site; and
- Can manage flood evacuation from the site in a safe manner.

Refer to the section below for a summary of the flood impact assessment.

3 FLOODING

BG&E Pty Limited (BG&E) were engaged by Pacific National to prepare a flood risk assessment for the proposed rail development at the freight hub facility at St Marys. The aim of the report was to:

- Describe the flood behaviour at the rail location, assuming that construction of the freight hub is completed;
- Understand flood risks to the rail alignment;
- Assess any flood impacts due to changes in the rail vertical alignment and embankment from the pre-development scenario; and
- Establish any flood mitigation measures required, if any, to minimise flood impacts to the development itself and the surrounding area.

In order to develop the flood model, the previously provided *Little Creek Catchment Overland Flow Flood Study* flood model was adopted and amended to suit based on the rigorous approval processes as part of the NSW Floodplain Management Program. Therefore, the flood model was utilised to provide consistency between BG&E flood risk assessment and council flood planning information.

As such, the following below summaries the findings and assumptions made during the Flood Impact Assessment:

- It was determined that any adverse increase in flood levels occurring as a result of the proposed development is within the criteria of the Penrith City Council DCP and contained within land owned by Pacific National. Flood modelling has been undertaken using Penrith City Council's adopted flood model for Little Creek catchment which was developed in accordance with the Floodplain Risk Management Manual;
- No changes have been made to the *Little Creek Overland Flow Flood Study* flood model parameters and assumptions, including blockage assumptions and catchment hydrology to remain consistent;
- Based on the Council's flood modelling, the dominant flood mechanism for flooding is flows from Little Creek (Up to the 0.2% AEP event). Foe events of larger magnitude, backwater flooding from South Creek becomes the dominant flood mechanism;
- Flood levels (outside of the development application area) are not increased by more than 0.1m by the proposed works in events up to 0.2% AEP event;
- The proposed development is not considered to expose any resident to unacceptable levels of risk or property to unreasonable damage and will not increase flood hazard or risk to other properties;
- The site not expected to be significantly at risk from a PMF event on Little Creek, however a PMF event on South Creek would inundate approximately half of the development area; and
- It is recommended that a formal evacuation management plan be prepared at later stages of the design.

Refer to B18028_RailDA_RPT_003_FIA_RevA for the complete flooding investigation and justification behind the flooding impact assessment and associated strategies.

4 STORMWATER QUANTITY ASSESSMENT

4.1 Design Criteria

The stormwater drainage system has been designed to meet the criteria specified in Pacific National's Infrastructure Maintenance Manual IMM 11-01 Railway Drainage Standard.

4.2 Catchment Representation

The proposed sub-catchments were determined based on the rail design and discharge locations. Refer to Appendix A for the hydraulic calculations table which outlines each sub catchment area and their respective parameters for the proposed rail works. The total rail catchment area is approximately 3.97ha.

4.3 Catchment Discharge

The post development catchment hydrology has been assessed using the Rational Method through the 12d program. In order to achieve the mitigation of increased flow and velocity, drainage infrastructure have been appropriately graded and sized based on existing surface levels to prevent impacts on peak flow. Based on the 12d analysis, it was determined that shallow, slow moving water passed through the open channels and culvert crossings.

The post-development catchment design replicates existing catchment design in order to prevent deviation from existing catchment parameters and outcomes. To coincide with this principal, the proposed works will

also replicate complete earthworks compaction design. Whilst maintaining discharge locations, an improved drainage scheme will be implemented to allow for efficient discharge. As part of the flooding assessment completed for the freight hub, it was determined for the drainage to release runoff quickly to prevent impact on the Little Creek peak flow. Therefore, detention is not required as part of the quantity assessment.

Refer to the St Marys Freight Hub 80% Rail Design Works Flood Assessment Report (xx.docx) completed by BG&E for details regarding flooding requirements.

4.4 Stormwater Management

4.4.1.1 Drainage Design

Drainage of the rail formation has been provided by grading the new rail capping with crossfall. This allows stormwater to run-off to the surrounding area as appropriate. Open drainage has largely been adopted, with the exception of utilising proposed culvert crossings.

The following outlines the design basis for the proposed system:

- A 1 in 20 year ARI (5% AEP) design event has been adopted for the design of the open channel drainage. This is further documented within the FSR and in line with PN IMM's;
- As no freeboard requirements are set within the PN IMM guidelines, a nominal freeboard during the 5% AEP event of 300mm has been adopted from the top of rail to the water surface;
- A Manning's roughness of 0.03 for open drainage has been used. This allows for degradation of the flow path over time;
- A fraction impervious of 100% has been applied to each catchment to replicate the compacted surface of the rail capping, for all areas where works are proposed;
- A minimum time of concentration of 5 minutes has been applied to each catchment;
- An Antecedent Moisture Condition (AMC) of 3 has been used within the model to replicate an already saturated catchment from preceding storm events. This reduces the storage and infiltration capacity of the catchment;
- Scour protection provided as per Austroads Guide to Road Design Part 5b (2013) based on 1% AEP velocities; and
- Maximise the use of open drainage and discharge the system to Little Creek or South Creek.

4.4.1.2 Cross Drainage

As part of the Phase 1 Rail Design, five culvert crossings are proposed:

- 750x375 RCBC Culvert Crossing (Ch 120 on MC01) under Siding 1A and 2A. This crossing drains the area in between the terminal access road and Great Western Railway;
- 750x375 RCBC Culvert Crossing (Ch 770 on MC01) under the access track. This crossing drains the hardstand the area between Siding 1A and 2A and outflows to Little Creek;
- 750x375 RCBC Culvert Crossing (Ch 880 on MC01) under the access track. This crossing drains a portion of the Sidings and outflows to Little Creek;
- 750x375 RCBC Culvert Crossing (Ch 1232 on MC01) under Siding 1B and 2B. This crossing drains the eastern open drainage to the western channels; and

- 750x375 RCBC Culvert Crossing (Ch 1417 on MC01) under 1B and 2B. This crossing drains the eastern open drainage to the western channel and out to South Creek.

4.5 Lawful Point of Discharge

The existing rail corridor featured a poor drainage scheme; utilising two culverts to divert flows from the terminal to Little Creek. As part of the rail works in Phase 1, open channels and cross drainage were implemented to improve the drainage design. An additional open channel is proposed at the north end of the rail works boundary to allow for water to outflow to South Creek.

5 STORMWATER QUALITY ASSESSMENT

5.1 Water Quality Objectives

This site is subject to the water quality objectives outlined in the Penrith City Council Waste Water Urban Design Policy (2017) which are:

- 85% reduction for Total Suspended Solids (TSS);
- 60% reduction for Total Phosphorous (TP);
- 45% reduction for Total Nitrogen (TN); and
- 90% reduction for Total Gross Pollutants.

5.2 Treatment Methodology

The proposed stormwater treatment system for the development utilises bioretention swales and the existing sedimentation basin located adjacent to Little Creek. The selected sizing of the bioretention swales was determined based on catchment size constraints and the requirement to achieve water quality targets. The water quality treatment train design was based on site constraints and utilising the existing drainage scheme.

Accompanying this report is a MUSIC model of the proposed treatment system.

5.3 Catchment Properties

The proposed catchment parameters are outlined in Table 5.1 below. The proposed catchment parameters have been determined based on the rail corridor and expected pollutants. Refer to Appendix B for a visual representation of the proposed catchments.

Table 5.1: Catchment Parameters

Catchment ID	Catchment Area (ha)	Fraction Impervious (%)	Surface Type	Discharge Location
Catchment 1	1.683	100	Industrial	Existing Sedimentation Basin (Little Creek)

Catchment 2	0.022	100	Industrial	Existing Sedimentation Basin (Little Creek)
Catchment 3	0.423	100	Industrial	Existing Sedimentation Basin (Little Creek)
Catchment 4	0.321	100	Industrial	Existing Sedimentation Basin (Little Creek)
Catchment 5	1.204	100	Industrial	South Creek (Existing discharge location)
Catchment 6	0.249	100	Industrial	South Creek (Existing discharge location)
Untreated Catchment	0.068	100	Industrial	Little Creek (Existing discharge location)

Industrial catchment nodes have been adopted for the MUSIC analysis as this closely replicates the expected pollutant load from the rail corridor.

A fraction impervious of 100% has been adopted to replicate the highly compacted nature of the rail corridor.

Note that the untreated catchment is not able to be treated due to the limitations of earthworks and formation over Little Creek. This scheme is in keeping with the existing rail corridor, with all other areas within the corridor being treated. This is expected to provide a vast improvement over the existing water quality.

5.4 Treatment Train

The following treatment system was adopted to achieve the required pollutant load reductions:

- **5x Vegetated Swales with Bioretention**
  - Vegetated swales are an effective stormwater conveyance and treatment device, commonly used throughout a vast range of stormwater applications. They are highly effective at sediment and suspended solids removal, which in turn removes phosphorus and nitrogen as attached nutrients to the sediment. In addition to this, they are a low-maintenance stormwater treatment method which is both natural and aesthetically pleasing. Note that the proposed vegetated swales prelude small bioretention basins for nutrient removal. The vegetated swales act as the primary treatment to filter out the majority of heavy sediments and gross pollutants.
  - Bioretention basins are an efficient stormwater treatment device, commonly used for their effective nutrient removal capabilities. Saturated basins are proposed to outlet to the existing waterways to improve the effects of nitrogen removal by allowing moisture storage in plants. Planting of the bioretention basins is to be in accordance with the Penrith City Council WSUD Technical Guidelines. The following Figure 5.1 below outlines the typical cross section of the bioretention system adopted.

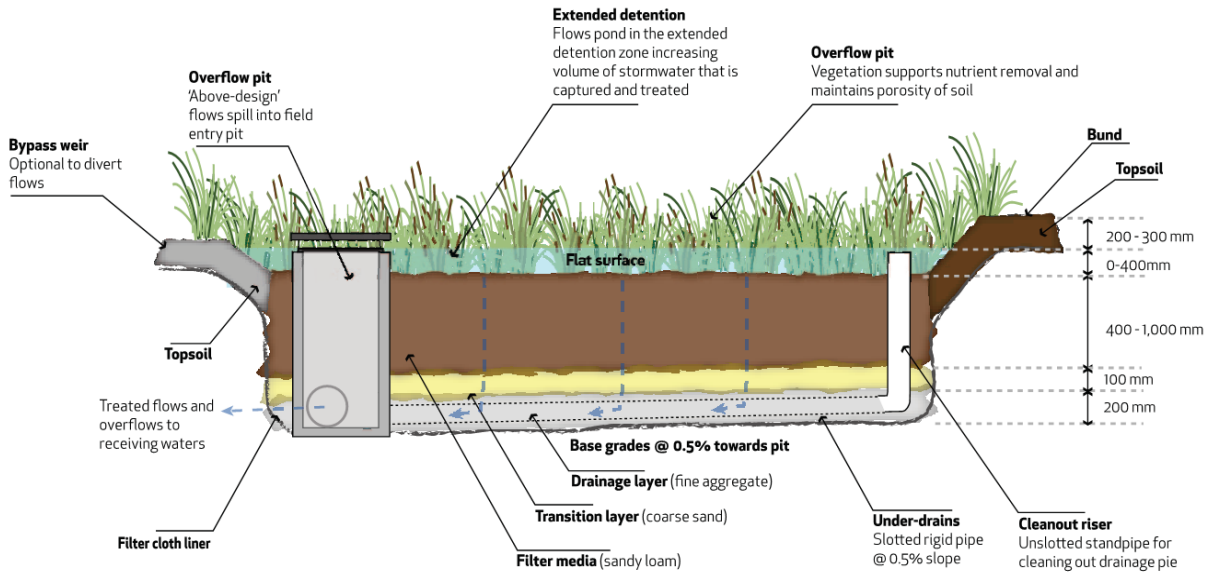


Figure 5.1: Typical Bioretention Cross Section

- **1x Existing Sedimentation Basin**
  - The existing sedimentation basin will be utilised and treated as a wet sediment basin as part of the drainage scheme. As not much information is known, it is assumed that no nutrient uptake from existing plants will be accounted for.
- **3x Spill Capture Basins**
  - The proposed spill capture is in the form of an inlet pond below the overflow weir. A baffle is proposed to prevent hydrocarbons and oil from exiting the pond. In order to model the spill capture they have been modelled as sediment basins with MUSIC. This allows a coincidental spill event to be taken into account with the rainfall event. Spill capture basins have been modelled as cascading sediment basins to simulate the settlement of particles and storage of water. In addition to this as the swales are vegetated, nutrient uptake from plants will be provided; however, this is not modelled. The following Figure 5.2-5.4 provides an illustration of a typical spill basin.

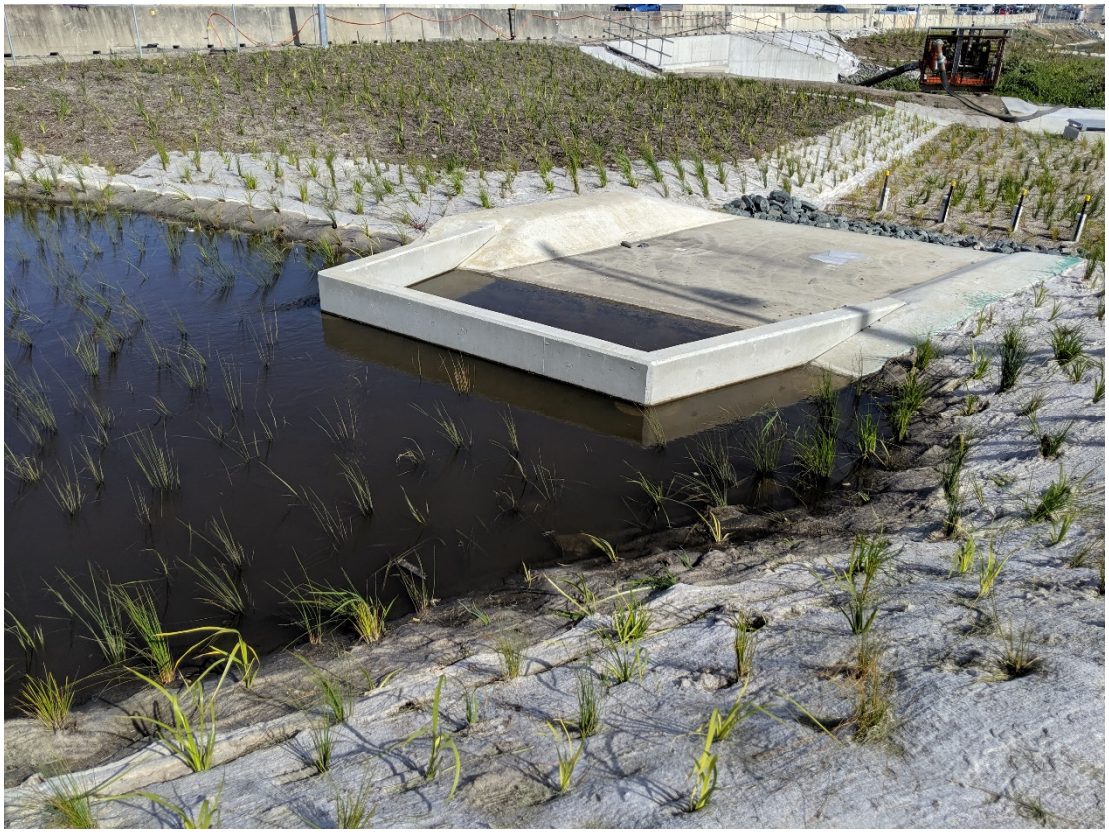


Figure 5.2: Typical Spill Capture Basin

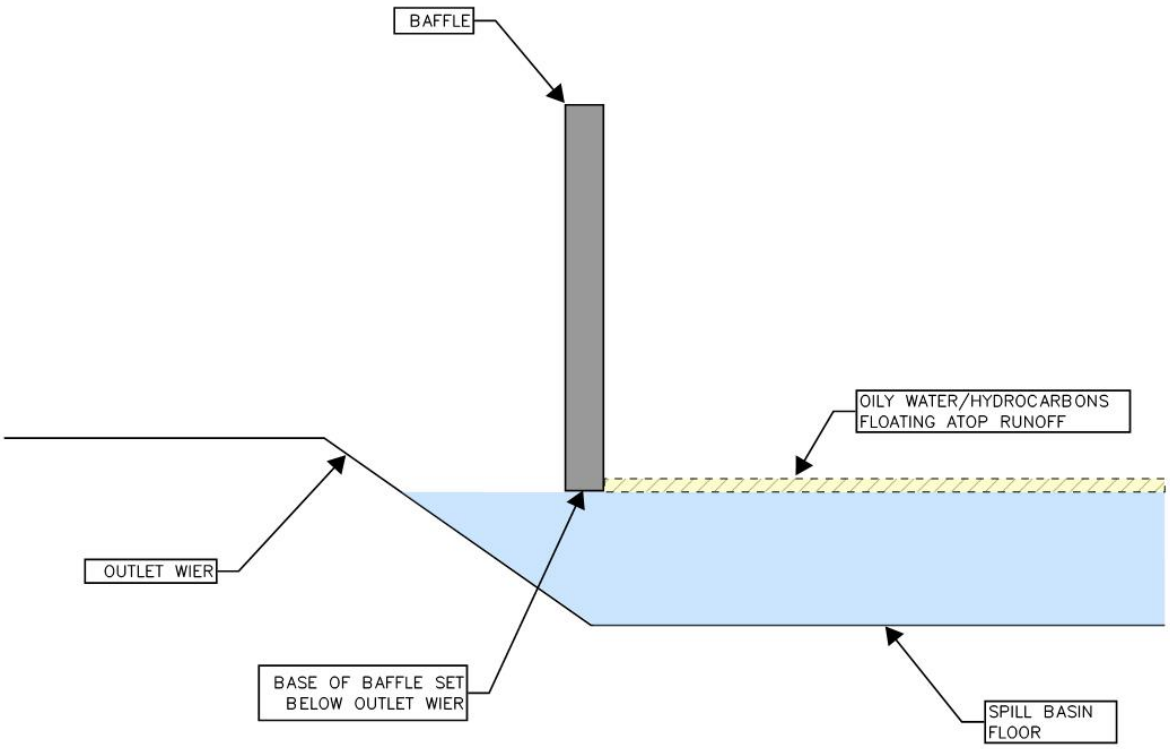


Figure 5.3: Typical Baffle Concept 1

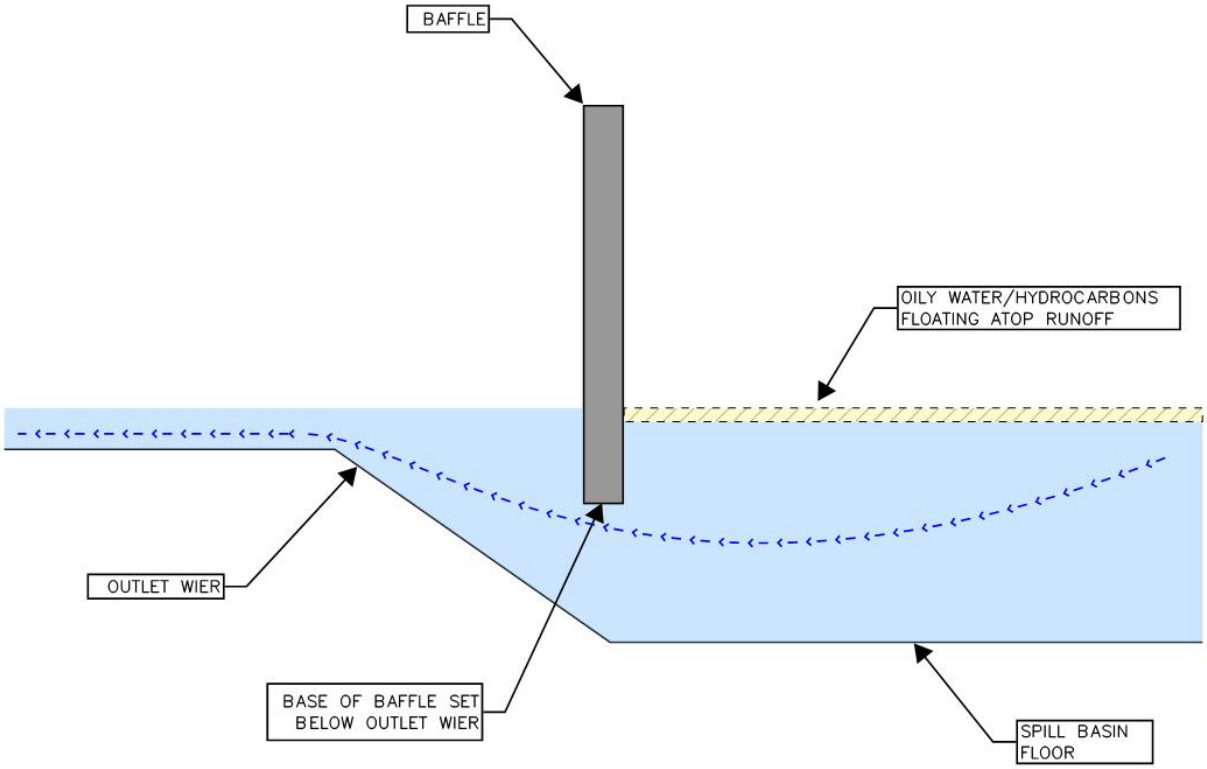


Figure 5.4: Typical Baffle Concept 2

The proposed treatment system is as shown below in Figure 5.5 and the water quality results are tabulated in Table 5.2. Due to the large existing sedimentation basin being utilised as part of the water quality treatment train, achieving water quality targets requires little additional water quality treatment infrastructure.

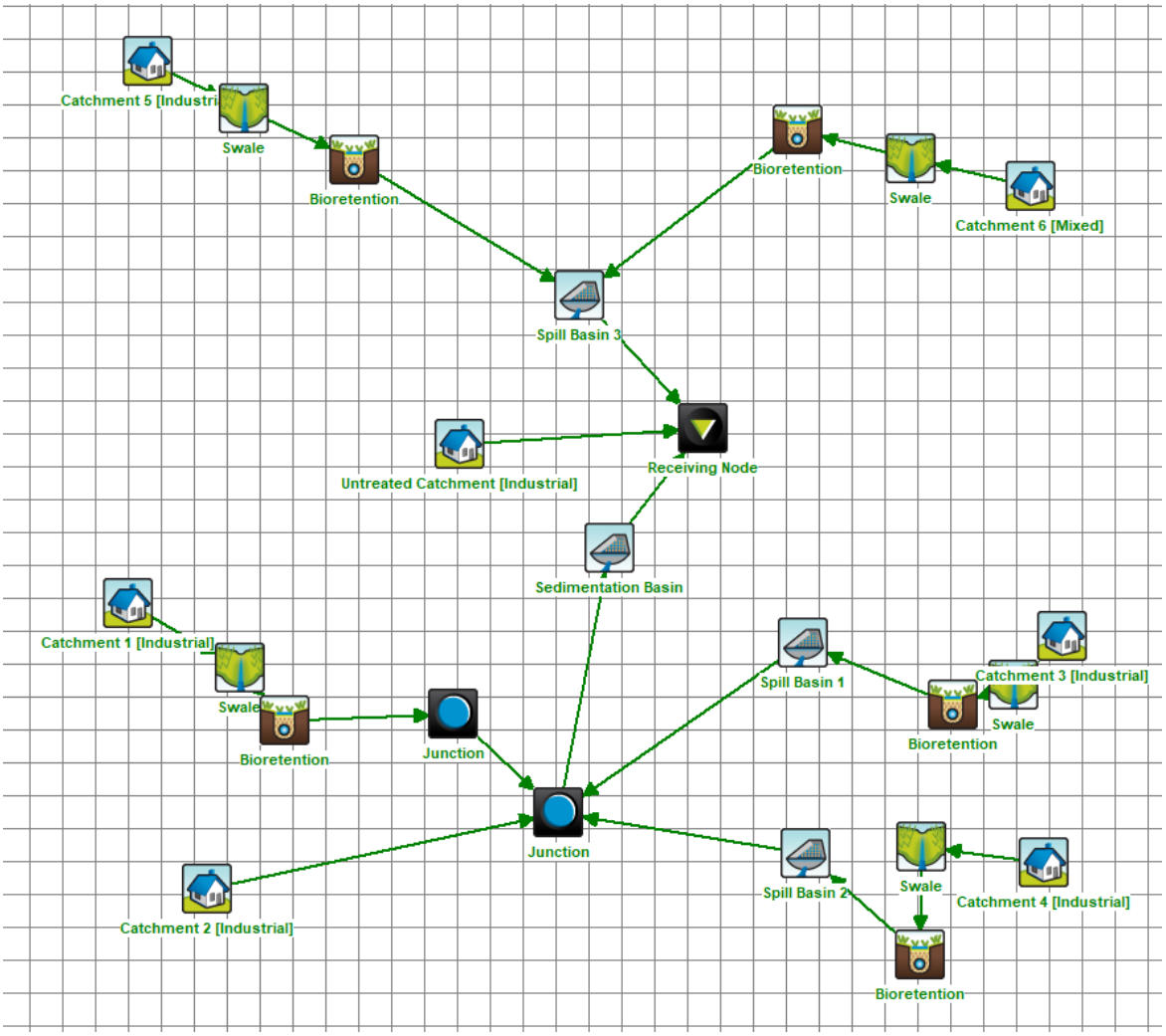


Figure 5.5: Developed Site MUSIC Model

5.5 MUSIC Results

The following Table 5.2 outlines the MUSIC modelling results achieved.

Table 5.2: MUSIC Modelling Results

	Source Load	Residual Load	Percentage Reduction (%)
Flow (ML/year)	21.9	20.2	8.1
Total Suspended Solids (kg/year)	4080	486	88.1
Total Phosphorus (kg/year)	6.62	2.46	62.8
Total Nitrogen (kg/year)	49	26.9	45
Gross Pollutants (kg/year)	619	10.7	98.3

6 STORMWATER QUALITY MANAGEMENT PLAN – CONSTRUCTION PHASE

6.1 Objectives

The objective of the Construction Phase Management Plan is to ensure compliance with the Penrith City Council requirements and the Landcom Managing Urban Stormwater: Soils and Construction. The purpose of the management plan is to prevent the discharge of polluted stormwater off the site and to ensure that the environmental values of receiving waters are maintained or enhanced.

Pollutants typically generated during the Construction Phase are outlined in Table 6.1.

Table 6.1: Typical Construction Phase Pollutant

Pollutant	Sources
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts.
Sediment	Unprotected exposed soils and stockpiles during earthworks and building.
Hydrocarbons	Fuel and oil spills, leaks from construction equipment.
Toxic materials	Cement slurry, asphalt prime, solvents, cleaning agents, wash waters (e.g. from tile works).
pH altering substances	Acid sulphate soils, cement slurry and wash waters.

The proposed stormwater treatment devices detailed within this report are to be constructed and established in accordance with the Water by Design Construction and Establishment Guidelines Version 1.1, April 2010.

Landcom's Managing Urban Stormwater: Soils and Construction – Volume 1 was utilised to determine relevant performance criteria in relations to construction site management practices. These criteria will be adhered to in order to achieve construction phase water quality management.

Table 6.2: Typical Construction Phase Criteria

Issue	Construction Phase Stormwater Design Desired Outcomes
Drainage Control	1. Manage stormwater flows around or through areas of exposed soil to avoid contamination. 2. Manage sheet flows in order to avoid or minimise the generation of rill or gully erosion. 3. Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works.

	4. Provide emergency spillways for sediment basins to achieve the construction phase stormwater management design objectives for emergency spillways on temporary sediment basins.
Erosion Control	1. Stage clearing and construction works to minimise the area of exposed soil at any one time. 2. Effectively cover or stabilise exposed soils prior to predicted rainfall. 3. Prior to completion of works for the development, and prior to removal of sediment controls, all site surfaces must be effectively stabilised using methods which will achieve effective short-term stabilisation.
Sediment Control	1. Direct runoff from exposed site soils to sediment controls that are appropriate to the extent of disturbance and level of erosion risk.
Litter, Hydrocarbons and other Contaminants	1. Remove gross pollutants and litter. 2. Avoid the release of oil or visible sheen to released waters. 3. Dispose of waste containing contaminants at authorised facilities.
Water Stability and Flood Flow Management	1. Where measures are required to meet post-construction waterway stability objectives, these are either installed prior to land disturbance and are integrated with erosion and sediment controls, or equivalent alternative measures are implemented during construction. 2. Earthworks and the implementation of erosion and sediment controls are undertaken in ways which ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 1 in 100 year ARI (1% AEP).

6.2 Management of Sedimentation & Erosion

A siltation and erosion fence are to be erected. It is expected that the siltation fence along the western perimeter of the site will eliminate almost all risk of sediment being washed off the site, as the site falls to the west. Accidental spills of soil or any other material shall be removed immediately if rainfall is likely to occur or at least upon completion of the days' work depending upon the material.

Entry and exit from the site will be restricted to a single stabilised location at Forrester Road to minimise the risk of tracking sediment over the site. It is expected that a layer of crushed rock will provide the necessary stabilisation for the access route. A specific area on the site shall be designated for washing down construction plant. The wash-down area will be contained by earth bunds. There will be no waste water discharged from the site during construction.

Conceptual details of the control measures to be implemented during construction are presented in Appendix C. The details of the erosion and sediment control devices are to be confirmed during the Operational Works phase.

6.3 Management of Contaminated Soils

As illustrated below in Figure 6.1, the proposed site location is not affected by acid sulphate soils on the New South Wales ePlanning Interactive Mapping.

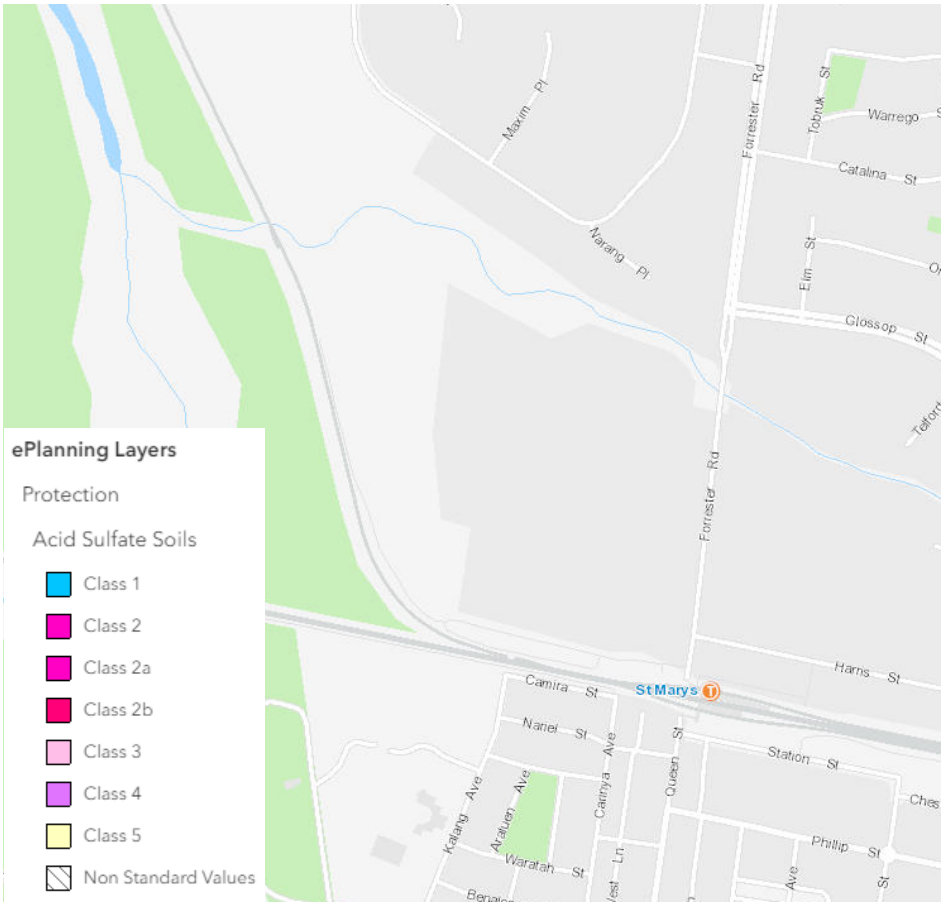


Figure 6.1: NSW Government Acid Sulphate Soil Map (Source: NSWG)

6.4 Management of Imported Materials

Any material imported onto the site (including construction materials) will be stockpiled in a location where it cannot contaminate stormwater runoff.

6.5 Monitoring & Maintenance

Silt traps, sediment fences and structural measures should be checked daily during construction by the Construction Manager. Inspections will ensure the integrity of control structures and other structural measures. Additional inspections will be required immediately following periods of heavy rain. Sediment build-up is to be removed from behind the silt fences and other barriers immediately after each major rainfall event. All noted stormwater treatment devices within this report are to be inspected, maintained, rectified and reported on in accordance with the Water by Design Maintaining Vegetated Stormwater Assets Version 1, (2012) manual.

6.6 Responsibility & Reporting

Performance monitoring of all drainage control measures along with erosion and sediment control devices will remain the responsibility of the contractor. Site inspection forms/checklists shall be reported to the Construction Manager following inspection of water quality devices/measures.

The contractor should erect signage at the entrance to the site with contact information (including after-hours contact information). The contractor shall be responsible for the appropriate handling of all complaints.

The contractor is to report on all stormwater quality treatment devices in accordance with Penrith City Council requirements.

7 EROSION AND SEDIMENT CONTROL DESIGN

7.1 Erosion and Sediment Control

- Erosion and Sediment Control
  - New South Wales Landcom Blue Book – Managing Urban Stormwater 2004; and
  - International Erosion Control Association Best Practice Erosion and Sediment Control.
- Permanent Stormwater Drainage
  - Australian Standard 3500.3 2015 – Plumbing and Stormwater Drainage;
  - Australian Standard 3725 2007 – Design for Installation of Buried Concrete Pipes:
  - Australian Rainfall and Runoff 2016;
  - Roads Maritime Services (RMS) Standard Drawings and Details (where applicable); and
  - Australian Guide to Road Design – Drainage - Part 5A and 5B (where applicable).

7.2 Pre-Construction Phase

Before construction activities commence, the following measures are to be implemented to mitigate against disturbance and adverse water quality impacts. These measures may be adopted in a staged approach and may be implemented prior to construction beginning in any one section of the project. These elements are further discussed within the Construction Environment Management Plan (CEMP), prepared by the Contractor.

- Designation of area for plant, storage of raw material, construction equipment, vehicle parking and wash down pads;
- Diversion of upstream stormwater runoff around disturbed areas of the development as required;
- Immediate stabilization of disturbed areas, where required for highly erodible soils. This can be assessed and confirmed once site soil analysis results are available;

- Monitoring of stormwater quality discharging from the site and the implementation of additional measures if quality of discharge exceeds the requirements;
- Designation and marking of transport routes across the site to minimise dust disturbance;
- Erosion management techniques and measures to be installed during construction. This is further discussed within the following sections of this report;
- Sediment control measures to be installed during construction. This is further discussed within the following sections of this report; and
- Education of site personnel for the implementation and management of sediment and erosion control measures.

7.3 Construction Phase

The following outlines the proposed erosion and sediment control measures to be adopted for construction.

7.3.1 Bulk Earthworks

Bulk earthworks are to be minimised to where necessary and to be carried out in accordance with the design package.

It is the contractor's responsibility to manage the site's erosion and sediment control measures, including staging and dust control/suppression.

For details regarding extent of earthworks, and cut and fill areas, refer to the Bulk earthworks design package.

7.3.2 Erosion Control

Erosion matter is triggered by the unintended energy mismanaged by the movement of surface runoff. The following engineering features are expected to be provided as part of the civil works package to minimise the erosion by surface runoff:

- Catch Drains (Diversion channels) with Check Dams:
  - These have been implemented where necessary to drain capping/pavement and capture runoff from surrounding areas. Rock check dams are proposed to dissipate flow energy and provide small sediment traps. Check dams can remain for the operational phase, at the discretion of the Contractor and Pacific National.
- Inlet & outlet protection:
  - Culvert inlet and outlet protection has been implemented as part of the drainage works, to prevent soil erosion caused by the flow acceleration into culverts and concentrated flow exiting culverts.
- Erosion Matting:
  - This has been used at concentrated flow locations for immediate erosion mitigation, until ground cover and or rock protection has been implemented. This is considered an interim measure;
- Geotextile:

- This has been designed and implemented, where deemed necessary, to manage the impact caused by the kinetic energy carried with the runoff, as well as in (assisting) providing efficient drainage solution where it is applicable such as acting as a separation layer between rock mattress and underlying soil.

For details refer to the erosion and sediment control plans.

7.3.3 Sediment Control

The following measures have been proposed for the project to form a holistic sediment control during the construction phase of the civil works

- Stabilised entry/exit:
  - This is to be implemented at the entry location of all working areas to minimise sediment travel onto the road network.
- Wash down area
  - A specific area on the site shall be designated for washing down construction plant. The wash down area will be contained by earth bunds. There will be no waste water discharged from the site during construction.

7.4 Operational Phase

The proposed operational drainage scheme for the rail package of works can be found within Appendix C. The scheme provides a combination of open channels and culvert crossings.

The following aspects of the works have been considered:

7.4.1 Erosion Control

The following erosion control measures are provided as part of the Erosion and Sediment Control Plan (ESCP) to minimise erosion by surface runoff:

- Vegetation/Ground Cover:
  - The primary erosion control measure across the site is established ground cover, which will largely remove the potential for erosion. Note that no immediate vegetation other than landscaping is proposed. It is expected that over time through natural measures the site will become vegetated. As the site is evenly graded and has existing ground cover there is minimal risk of flow concentrations in common rainfall events.
- Shallow Grade Open Drainage:
  - Shallow open drainage has been adopted wherever possible to allow for low flow velocities, largely mitigating the need for additional scour protection above and beyond ground cover.
- Outlet protection:
  - Culvert outlet protection has been implemented as part of the drainage works, to prevent soil erosion caused by the flow acceleration out of culverts and concentrated flow exiting culverts.
- Geotextile:

– This has been designed and implemented, where deemed necessary, to manage the impact caused by the kinetic energy carried with the runoff, as well as in (assisting) providing efficient drainage solution where it is applicable such as acting as a separation layer between rock mattress and underlying soil.

7.4.2 Sediment Control

The following measures have been proposed for the project to form a holistic sediment control during the operational phase of borrow pit:

- Vegetation/Ground Cover:
  – Aside from providing erosion protection during rainfall events, vegetation also acts to trap sediment within shallow slow-moving water. This allows soils to be retained on site, should they erode. Erosion within open drainage is not expected to occur due to the low flow velocities and rock protection provided. Note that no immediate vegetation other than landscaping is proposed. It is expected that over time through natural measures the site will become vegetated.

8 STORMWATER QUALITY MANAGEMENT PLAN – OPERATIONAL PHASE

8.1 Objectives

Water quality objectives for stormwater leaving the developed site under the operational phase are based on reductions in mean annual pollutants loads detailed in the Penrith City Council WSUD Policy (2017). Pollutant reduction values are outlined in Table 7.1 below.

Table 8.1: Operational (Permanent) Water Quality Objectives

Pollutant Indicator	Pollutant Reduction
Total Suspended Solids	85%
Total Phosphorous	60%
Total Nitrogen	45%
Gross Pollutants	90%

8.2 Performance Requirements

Performance requirements for the Management Plan are in accordance with the Penrith City Council and Landcom Managing Urban Stormwater: Soils and Construction Volume 1.

- The reduction of dust and particulate matter being washed into the stormwater drainage system; and

- The prevention of hydrocarbons, nutrients, chemicals and heavy metals washed from the stormwater drainage system to the external catchment.

8.3 Management Measures

The majority of the site will either be sealed or landscaped following development. The amount of sediment likely to be generated by a mulched and watered landscape area is considered to be minimal.

Gross pollutants such as paper and plastic waste will be prevented from entering the stormwater drainage system by the installation of filtration and regular maintenance.

Dust and particulate matter washed into the stormwater system will be reduced by regular sweeping and removal.

Dangerous goods will be stored in properly designed and constructed storage areas as required by the relevant statutory requirements.

All noted stormwater treatment devices noted within this report are to be inspected, maintained, rectified and reported on in accordance with Penrith City Council and SafeWork NSW requirements.

8.4 Monitoring & Maintenance

The monitoring and maintenance of the proposed spill basins is to be carried out in accordance with the requirements stipulated by the Water by Design Maintaining Vegetated Stormwater Assets Version 1, (2012) manual.

9 CONCLUSION

The SBSMP demonstrates that under the proposed concept plan, stormwater runoff from the development will be in compliance with the relevant design guidelines and codes as listed in Section 1.3, to provide mitigation strategies in regards to the proposed development on receiving waters. Refer to the flooding assessment report undertaken by BG&E (B18028_RailDA_RPT_003_FIA_RevA) for details regarding the flooding investigation and the associated proposed flooding mitigation strategies.

The consideration of the proposed stormwater runoff and drainage demonstrates the viability of the proposed rail works, with regards to stormwater quantity and quality. As outlined in the earlier sections, the proposed water quality treatment scheme achieved the water quality targets as outlined the Penrith City Council WSUD Policy and will be constructed based on best practice management principles.

It was identified that the volume and rate of stormwater runoff levels will remain slow and shallow, as imitating the existing catchment design parameters was the overall design outcome. Therefore, stormwater detention was not required. Erosion and sediment control measures during the construction phase will be implemented as illustrated in Appendix C.

APPENDIX A

Phase 1 Rail Works Hydraulic Calculations

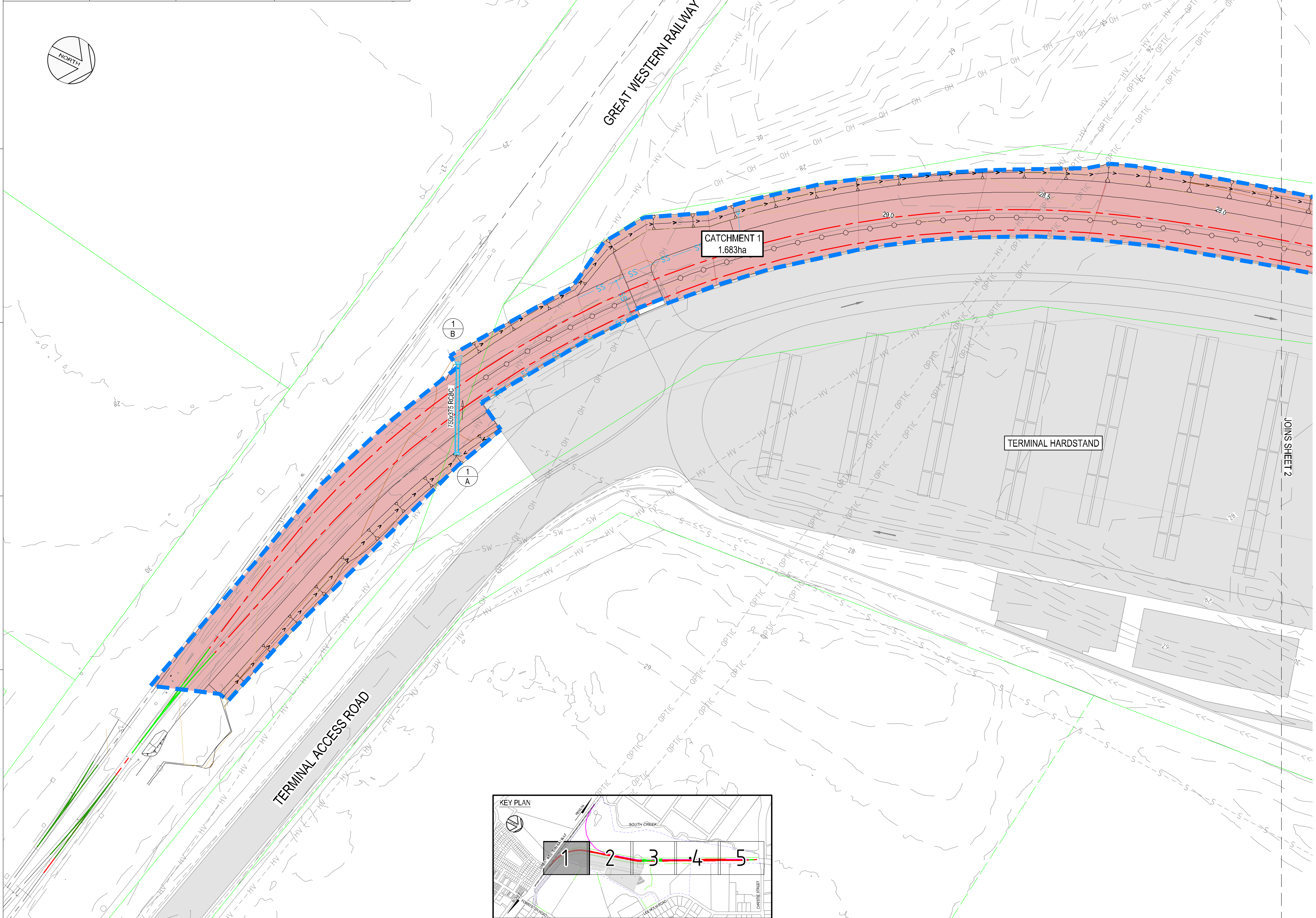
LOCATION				TIME		SUB-CATCHMENT RUNOFF						INLET DESIGN										DRAIN DESIGN												HEADLOSSES									PART FULL PIPE			DESIGN LEVELS				
				tc	I	C	C10	C10	A	C*A	Q	Qa							Qi	Qb		tv	I	A	Q			Qp	L				Vf			Ku	Kw			Hw	Sf	Hf	V2/2g	D	Vp					
DESIGN EVENT (AEP)	STRUCTURE NAME	DRAIN SECTION	SUB-CATCHMENTS CONTRIBUTING	SUB-CATCHMENT TIME OF CONC.	RAINFALL INTENSITY (mm/hr)	CO-EFFICIENT OF RUNOFF	10yr RUNOFF CO-EFFICIENT (IMPERVIOUS AREA)	10yr RUNOFF CO-EFFICIENT (PERVIOUS AREA)	SUB-CATCHMENT AREA	EQUIVALENT AREA	SUB-CATCHMENT DISCHARGE	FLOW IN K&C (INC. BYPASS)	ROAD GRADE AT INLET	MAXIMUM FLOODED WIDTH	MAXIMUM D*V PRODUCT	MINOR FLOW ROAD CAPACITY	INLET TYPE	INLET DESCRIPTION	FLOW INTO INLET	BYPASS FLOW	BYPASS STRUCTURE NAME	CRITICAL TIME OF CONC.	CRITICAL RAINFALL INTENSITY	CRITICAL EFFECTIVE AREA	MAJOR TOTAL FLOW	MAJOR SURFACE FLOW CAPACITY	MAJOR SURFACE FLOW	PIPE FLOW	REACH LENGTH	PIPE GRADE	PIPE/BOX DIMENSIONS	PIPE TYPE (CLASS)	FLOW VELOCITY FULL (PIPE GRADE CAPACITY)	STRUCTURE Ku CHART	STRUCTURE Ku METHOD	STRUCTURE Ku	STRUCTURE Kw	STRUCTURE SUBMERGENCE RATIO	STRUCTURE GRATE FLOW RATIO	STRUCTURE W.S.E LOSS	PIPE FRICTION SLOPE	PIPE FRICTION HEADLOSS (L x Sf)	PIPE VELOCITY HEAD	PART FULL FLOW DEPTH	PART FULL FLOW VELOCITY	PIPE UPSTREAM HGL	PIPE DOWNSTREAM HGL	UPSTREAM STRUCTURE HGL	STRUCTURE SETOUT LEVEL	STRUCTURE NAME
				(mins)	(mm/hr)				(ha)	(ha)	(m^3/s)	(m^3/s)	(%)	(m)	(m^2/s)	(m^3/s)			(m^3/s)	(m^3/s)		(mins)	(mm/hr)	(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m)	(%)			(m/s)							(m)	(%)	(m)	(m/s)	(m)	(m/s)	(m AHD)	(m AHD)	(m AHD)	(m AHD)	
5.0%	OC6/2	OC6/2 to D/1		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000	0.796				CHNL auto	OPEN CHANNEL	0.000	0.000		1.799	219.849	0.000			0.000	0.000	0.943	0.155	0.500	CHNL	0.000		Direct	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	21.767	21.767	21.767	21.491	OC6/2
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		1.799	295.665	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	21.797	21.797	21.797		
5.0%	D/1	D/1 to D/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					HW IN	HEADWALL	0.000	0.000		1.807	219.386	0.000			0.000	0.000	24.991	0.193	0.375	BC	0.000	Outlet Control	Ku - 201 Box Culvert Inlet - 30°	0.000	0.000	0.728		0.000	0.000	0.000	0.000	0.000	0.000	21.767	21.767	21.767	21.994	D/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		1.807	295.052	0.000	0.000			0.000					0.000	Outlet Control		0.000	0.000	0.809		0.000	0.000	0.000	0.000	0.000	0.000	21.797	21.797	21.797		
5.0%	D/2	D/2 to OC3/4		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000	3.500				HW OUT	HEADWALL	0.000	0.000	OC3/4	2.015	207.801	0.000			0.000	0.000	2.510	0.171	0.500	CHNL	0.000		Direct	2.000	2.000			0.000	0.000	0.000	0.000	0.000	0.000	21.767	21.767	21.767	21.946	D/2
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	OC3/4	2.015	279.725	0.000	0.000			0.000					0.000			2.000	2.000			0.000	0.000	0.000	0.000	0.000	0.000	21.797	21.797	21.797		
5.0%	OC7/2	OC7/2 to E/1	OC7/1 OC8/2 OC8/3 OC8/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.093	0.089	0.044	0.044	1.431				CHNL auto	OPEN CHANNEL	0.044	0.000		5.742	173.105	0.225			0.062	0.108	0.941	0.275	0.500	CHNL	0.124		Direct	0.000	0.000			0.000	1.867	0.010	0.001	0.265	0.442	21.666	21.648	21.666	21.452	OC7/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.093	0.093	0.062	0.062							0.062	0.000		5.742	232.473	0.237	0.199			0.137					0.157			0.000	0.000			0.000	1.112	0.007	0.001	0.289	0.469	21.694	21.684	21.694		
5.0%	E/1	E/1 to E/2	OC7/1 OC8/2 OC8/3 OC8/4 OC7/2	0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					HW IN	HEADWALL	0.000	0.000		5.750	173.053	0.225			0.000	0.108	22.413	2.691	0.375	BC	0.385	Inlet Control	Ku - 201 Box Culvert Inlet - 30°	16.584	16.580	0.531		0.126	1.199	0.458	0.008	0.073	1.965	21.523	21.254	21.648	21.949	E/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		5.750	232.404	0.237	0.137			0.137					0.487	Inlet Control		12.320	12.320	0.626		0.149	1.019	0.449	0.012	0.086	2.136	21.535	21.306	21.684		
5.0%	E/2	E/2 to OC3/7	OC7/1 OC8/2 OC8/3 OC8/4 OC7/2	0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					HW OUT	HEADWALL	0.000	0.000		5.936	171.821	0.225			0.000	0.108	1.806	0.504	0.500	CHNL	0.123		Direct	2.000	2.000			0.002	0.018	0.000	0.001	0.236	0.554	21.252	21.252	21.254	21.346	E/2
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		5.936	230.761	0.237	0.136			0.136					0.155			2.000	2.000			0.002	0.015	0.000	0.001	0.257	0.587	21.304	21.304	21.306		
5.0%	OC10/1	OC10/1 to OC10/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					CHNL auto	OPEN CHANNEL	0.000	0.000	OC10/2	1.000	267.000	0.000			0.000	0.000	83.684	1.166	0.700	CHNL	0.000		Direct	0.000	0.000			0.000	0.903	0.756	0.000	0.000	0.000	30.001	29.245	30.001	30.001	OC10/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	OC10/2	1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.869	0.727	0.000	0.000	0.000	30.001	29.274	30.001		
5.0%	OC10/2	OC10/2 to A/1		5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.167	0.159	0.079	0.079	1.194	0.744	0.212	4.351	CHNL auto	OPEN CHANNEL	0.079	0.000		5.000	178.000	0.159		4.351	0.111	0.079	2.230	0.500	0.700	CHNL	0.064		Direct	0.000	0.000			0.000	2.157	0.024	0.000	0.240	0.546	29.245	29.197	29.245	29.025	OC10/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.167	0.167	0.111	0.111		0.846	0.262	4.351			0.111	0.000		5.000	239.000	0.167	0.222			0.111					0.091			0.000	0.000			0.000	2.260	0.024	0.000	0.273	0.595	29.274	29.223	29.274		
5.0%	A/1	A/1 to A/2	OC10/2	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.000	0.000	0.000	0.000	0.489				HW IN	HEADWALL	0.000	0.000		5.019	177.877	0.160			0.000	0.079	21.583	0.500	0.375	BC	0.281		Direct	2.000	2.000			0.008	-0.006	0.030	0.004	0.103	1.019	29.129	29.130	29.137	29.714	A/1
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.000	0.000	0.000	0.000							0.000	0.000		5.019	238.837	0.168	0.111			0.111					0.395			2.000	2.000			0.016	-0.001	0.032	0.008	0.130	1.143	29.166	29.166	29.182		
5.0%	A/2	A/2 to OC10/3	OC10/2 A/1	0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					HW OUT	HEADWALL	0.000	0.000		5.198	176.690	0.160			0.000	0.078	1.692	0.342	0.300	CHNL	0.262		Direct	2.000	2.000			0.007	0.533	0.008	0.003	0.230	0.447	29.123	29.114	29.130	29.281	A/2
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		5.198	237.254	0.168	0.110			0.110					0.368			2.000	2.000			0.014	0.537	0.008	0.007	0.261	0.487	29.152	29.143	29.166		
5.0%	OC10/3	OC10/3 to OC10/4	OC10/2 A/1	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.000	0.000	0.000	0.000	28.988	0.046	0.005	1.850	CHNL auto	OPEN CHANNEL	0.000	0.000		5.213	176.597	0.160		1.850	0.000	0.079	34.552	0.501	0.300	CHNL	0.262		Direct	0.000	0.000			0.000	0.527	0.180	0.004	0.214	0.516	29.114	28.932	29.114	28.900	OC10/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.000	0.000	0.000	0.000		0.052	0.007	1.850			0.000	0.000		5.213	237.130	0.168	0.111			0.111					0.369			0.000	0.000			0.000	0.531	0.180	0.007	0.243	0.562	29.143	28.960	29.143		
5.0%	OC10/4	OC10/4 to OC10/5	OC10/2 A/1 OC10/3	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.050	0.047	0.023	0.023	2.184	0.538	0.087	1.010	CHNL auto	OPEN CHANNEL	0.023	0.000		5.500	174.697	0.207		1.010	0.033	0.101	13.809	1.035	0.300	CHNL	0.336		Direct	0.000	0.000			0.000	0.670	0.108	0.006	0.205	0.721	28.932	28.839	28.932	28.727	OC10/4
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.050	0.050	0.033	0.033		0.612	0.108	1.010			0.033	0.000		5.500	234.596	0.217	0.175			0.142					0.472			0.000	0.000			0.000	0.622	0.104	0.011	0.233	0.785	28.960	28.874	28.960		
5.0%	OC10/5	OC10/5 to OC10/6	OC10/2 A/1 OC10/3 OC10/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.023	0.022	0.011	0.011		0.461	0.047	10.640	CHNL auto	OPEN CHANNEL	0.011	0.000		5.616	173.937	0.229		10.640	0.015	0.111	11.421	0.717	0.500	CHNL	0.226		Direct	0.000	0.000			0.000	0.800	0.088	0.003	0.255	0.681	28.839	28.748	28.839	28.584	OC10/5
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.023	0.023	0.015	0.015		0.524	0.058	10.640			0.015	0.000		5.616	233.583	0.240	0.171			0.156					0.318			0.000	0.000			0.000	0.792	0.087	0.005	0.290	0.742	28.874	28.783	28.874		
5.0%	OC10/6	OC10/6 to OC10/7	OC10/2 A/1 OC10/3 OC10/4 OC10/5	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.015	0.015	0.007	0.007	5.453	0.417	0.035	4.564	CHNL auto	OPEN CHANNEL	0.007	0.000		5.711	173.309	0.244		4.564	0.010	0.117	15.858	0.500	0.500	CHNL	0.130		Direct	0.000	0.000			0.000	0.335	0.058	0.001	0.241	0.561	28.748	28.695	28.748	28.502	OC10/6
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.015	0.015	0.010	0.010		0.478	0.043	4.564			0.010	0.000		5.711	232.746	0.256	0.175			0.165					0.184			0.000	0.000			0.000	0.316	0.056	0.002	0.274	0.611	28.783	28.733	28.783		
5.0%	OC10/7	OC10/7 to OC10/8	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.033	0.031	0.015	0.015		0.490	0.063	4.518	CHNL auto	OPEN CHANNEL	0.015	0.000		5.843	172.437	0.275		4.518	0.022	0.132	38.937	0.500	0.500	CHNL	0.176		Direct	0.000	0.000			0.000	0.312	0.133	0.002	0.271	0.600	28.695	28.573	28.695	28.423	OC10/7
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.033	0.033	0.022	0.022		0.557	0.078	4.518			0.022	0.000		5.843	231.583	0.288	0.207			0.185					0.247			0.000	0.000			0.000	0.290	0.126	0.003	0.308	0.653	28.733	28.620	28.733		
5.0%	OC10/8	OC10/8 to OC10/9	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.069	0.066	0.033	0.033		0.675	0.097	4.085	CHNL auto	OPEN CHANNEL	0.033	0.000		6.167	170.295	0.341		4.085	0.046	0.161	32.370	0.500	0.500	CHNL	0.323		Direct	0.000	0.000			0.000	0.514	0.165	0.005	0.345	0.678	28.573	28.407	28.573	28.228	OC10/8
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.069	0.069	0.046	0.046		0.767	0.119	4.085			0.046	0.000		6.167	228.727	0.357	0.273			0.227					0.454			0.000	0.000			0.000	0.516	0.166	0.011	0.392	0.738	28.620	28.453	28.620		
5.0%	OC10/9	OC10/9 to OC/1	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.052	0.050	0.024	0.024		0.387	0.126	0.010	CHNL auto	OPEN CHANNEL	0.024	0.000		6.437	168.515	0.390		0.010	0.034	0.183	31.048	0.690	0.500	CHNL	0.366		Direct	0.000	0.000			0.000	0.886	0.237	0.007	0.340	0.789	28.407	28.132	28.407	28.066	OC10/9
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.052	0.052	0.034	0.034		0.387	0.178	0.010			0.034	0.000		6.437	226.354	0.409	0.292			0.257					0.515			0.000	0.000			0.000	0.904	0.238	0.014	0.387	0.860	28.453	28.172	28.453		
5.0%	OC/1	OC/1 to OC/2	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.053	0.050	0.025	0.025	5.416	0.636	0.078	7.032	CHNL auto	OPEN CHANNEL	0.025	0.000	OC/2	6.696	166.807	0.441		7.032	0.035	0.204	51.725	1.375	0.500	CHNL	0.233		Direct	0.000	0.000			0.000	1.327	0.701	0.003	0.248	0.947	28.100	27.414	28.100	27.852	OC/1
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.053	0.053	0.035	0.035		0.722	0.097	7.032			0.028	0.007	OC/2	6.696	224.077	0.462	0.315			0.280					0.321			0.000	0.000			0.000	1.316	0.699	0.005	0.280	1.026	28.132	27.451	28.132		
5.0%	OC/2	OC/2 to OC/3	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.097	0.093	0.046	0.046	1.199	0.791	0.116	7.615	CHNL auto	OPEN CHANNEL	0.046	0.000		7.127	163.963	0.534		7.615	0.072	0.243	120.382	1.174	0.500	CHNL	0.278		Direct	0.000	0.000			0.000	1.147	1.397	0.004	0.273	0.932	27.414	26.033	27.414	27.141	OC/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.097	0.097	0.065	0.072		0.935	0.153	7.615			0.072	0.000		7.127	220.283	0.559	0.414			0.342					0.391			0.000	0.000			0.000	1.143	1.395	0.008	0.310	1.016	27.451	26.075	27.451		
5.0%	OC/3	OC/3 to OC/4	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.228	0.218	0.108	0.108					CHNL auto	OPEN CHANNEL	0.108	0.000		8.130	157.342	0.751			0.151	0.328	133.514	1.174	0.500	CHNL	0.375		Direct	0.000	0.000			0.000	1.153	1.555	0.007	0.305	1.005	26.033	24.494	26.033	25.728	OC/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.228	0.228	0.151	0.151							0.151	0.000		8.130	211.455	0.787	0.614			0.462					0.529			0.000	0.000			0.000	1.156	1.558	0.014	0.347	1.095	26.075	24.532	26.075		
5.0%	OC/4	OC/4 to OC/5	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.254	0.242	0.120	0.120		1.132	0.212	7.019	CHNL auto	OPEN CHANNEL	0.120	0.000	OC/5	8.627	154.061	0.973		7.019	0.169	0.416	77.270	1.174	0.500	CHNL	0.476		Direct	0.000	0.000			0.000	1.160	0.903	0.012	0.334	1.067	24.494	23.598	24.494	24.160	OC/4
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.254	0.254	0.169	0.169		1.287	0.262	7.019			0.135	0.034	OC/5	8.627	207.081	1.020	0.721			0.553					0.632			0.000	0.000			0.000	1.147	0.900	0.020	0.371	1.145	24.532	23.645	24.532		
5.0%	OC/5	OC/5 to OC/6	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.148	0.141	0.070	0.070	1.397	0.924	0.151	7.467	CHNL auto	OPEN CHANNEL	0.070	0.000		9.176	150.439	1.110		7.467	0.132	0.464	42.475	1.232	0.500	CHNL	0.530		Direct	0.000	0.000			0.000	1.119	0.501	0.014	0.345	1.116	23.598	23.122	23.598	23.253	OC/5
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.148	0.148	0.098	0.132		1.174	0.225	7.467			0.132	0.000		9.176	202.252	1.163	0.785			0.653					0.747			0.000	0.000			0.000	1.105	0.500	0.028	0.392	1.216	23.645	23.175	23.645		
5.0%	OC/6	OC/6 to OC/7	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.080	0.077	0.038	0.038	2.573	0.736	0.103	2.918	CHNL auto	OPEN CHANNEL	0.038	0.000		9.398	148.975	1.180		2.918	0.053	0.488	11.162	0.654	0.500	CHNL	0.558		Direct	0.000	0.000			0.000	0.877	0.085	0.016	0.396	0.892	23.122	23.024	23.122	22.730	OC/6
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.080	0.080	0.053	0.053		0.837	0.128	2.918			0.053	0.000		9.398	200.300	1.237	0.741			0.688					0.786			0.000	0.000			0.000	0.901	0.086	0.032	0.450	0.971	23.175	23.075	23.175		
5.0%	OC/7	OC/7 to OC/8	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.026	0.025	0.012	0.012		0.375	0.065	11.219	CHNL auto	OPEN CHANNEL	0.012	0.000		9.491	148.361	1.205		11.219	0.017	0.497	9.846	1.000	0.500	CHNL	0.568		Direct	0.000	0.000			0.000	0.983	0.098	0.016	0.368	1.050	23.024	22.928	23.024	22.657	OC/7
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.026	0.026	0.017	0.017		0.421	0.081	11.219			0.017	0.000		9.491	199.482	1.263	0.717			0.700					0.800			0.000	0.000			0.000	0.981	0.098	0.033	0.418	1.144	23.075	22.978	23.075		
5.0%	OC/8	OC/8 to OC/9	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.020	0.019	0.009	0.009	4.159	0.277	0.060	9.668	CHNL auto	OPEN CHANNEL	0.009	0.000		9.573	147.820	1.224		9.668	0.013	0.503	11.493	1.000	0.500	CHNL	0.574		Direct	0.000	0.000			0.000	0.983	0.114	0.017	0.369	1.053	22.928	22.815	22.928	22.558	OC/8
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.020	0.020	0.013	0.013		0.302	0.076	9.668			0.013	0.000		9.573	198.760	1.283	0.721			0.708					0.809			0.000	0.000			0.000	0.987	0.114	0.033	0.420	1.147	22.978	22.865	22.978		
5.0%	OC/9	OC/9 to OC/10	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.024	0.023	0.011	0.011	0.375	0.480	0.047	7.603	CHNL auto	OPEN CHANNEL	0.011	0.000	OC/10	9.344	149.329	1.229		7.603	0.016	0.510	13.794	1.000	0.500	CHNL	0.583		Direct	0.000	0.000			0.000	1.007	0.138	0.017	0.371	1.057	22.815	22.676	22.815	22.443	OC/9
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.024	0.024	0.016	0.016		0.546	0.058	7.603			0.013	0.003	OC/10	9.669	197.917	1.306	0.731			0.715					0.817			0.000	0.000			0.000	1.011	0.138	0.034	0.422	1.150	22.865	22.725	22.865		
5.0%	OC/10	OC/10 to OC/11	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.032	0.030	0.015	0.015	6.008	0.494	0.061	9.898	CHNL auto	OPEN CHANNEL	0.015	0.000	OC/11	9.459	148.571	1.259		9.898	0.024	0.520	11.102	1.055	0.500	CHNL	0.594		Direct	0.000	0.000			0.000	1.333	0.123	0.018	0.370	1.083	22.676	22.528	22.676	22.305	OC/10
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.032	0.032	0.021	0.024		0.592	0.082	9.898			0.019	0.005	OC/11	9.459	199.761	1.320	0.752			0.727					0.831			0.000	0.000			0.000	1.341	0.123	0.035	0.420	1.178	22.725	22.577	22.725		
5.0%	OC/11	OC/11 to B/1	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.024	0.023	0.011	0.011	2.452				CHNL auto	OPEN CHANNEL	0.011	0.000		9.552	147.960	1.282			0.021	0.527	2.554	0.763	0.500	CHNL	0.602		Direct	0.000	0.000			0.000	0.485	0.028	0.019	0.289	1.802	22.477	22.465	22.477	22.188	OC/11
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.024	0.024	0.016	0.021							0.021	0.000		9.552	198.947	1.343	0.763			0.742					0.849			0.000	0.000			0.000	-2.043	0.055	0.037	0.329	1.963	22.517	22.569	22.517		
5.0%	B/1	B/1 to B/2	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.006	0.006	0.003	0.003	1.515	0.830	0.007	0.064	HW IN	HEADWALL	0.003	0.000		9.573	147.820	1.288		0.064	0.004	0.529	10.402	1.000	0.375	BC	0.663		Direct	2.000	2.000			0.045	-0.203	0.037	0.022	0.190	1.925	22.420	22.441	22.465	22.169	B/1
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.006	0.006	0.004	0.004		0.943	0.009	0.064			0.004	0.000		9.573	198.759	1.349	0.749			0.745					0.935			2.000	2.000			0.089	-0.120	0.025	0.045	0.224	2.111	22.480	22.493	22.569		
5.0%	B/2	B/2 to OC/12	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.021	0.020	0.010	0.010	3.387	0.748	0.027	10.728	HW OUT	HEADWALL	0.010	0.000	OC/12	9.659	147.247	1.308		10.728	0.014	0.535	2.083	1.052	0.500	CHNL	0.611		Direct	0.000	0.000			0.000	0.918	0.021	0.019	0.374	1.090	22.441	22.422	22.441	22.065	B/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.021	0.021	0.014	0.014		0.850	0.033	10.728			0.011	0.003	OC/12	9.659	197.997	1.370	0.765			0.751					0.858			0.000	0.000			0.000	0.900	0.021	0.038	0.425	1.186	22.493	22.474	22.493		
5.0%	OC/12	OC/12 to OC/13	OC10/2 A/1 OC10/3 OC10/4 OC10/5 OC10/6 OC10/7 OC10/8	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.005	0.005	0.003	0.003	1.000				CHNL auto	OPEN CHANNEL	0.003	0.000	LOST	9.677	147.133	1.313			0.006	0.537	12.908	0.992	0.500	CHNL	0.613		Direct	0.000	0.000			0.000	1.266	0.136	0.019	0.379	1.067	22.422	22.259	22.422	22.043	OC/12
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.005	0.005	0.004	0.006							0.005	0.001	LOST	9.677	197.844	1.376	0.761			0.755					0.863			0.000	0.000			0.000	1.277	0.135	0.038	0.431	1.162	22.474	22.309	22.474		

LOCATION				TIME		SUB-CATCHMENT RUNOFF							INLET DESIGN									DRAIN DESIGN												HEADLOSSES									PART FULL PIPE			DESIGN LEVELS				
				tc	I	C	C10	C10	A	C*A	Q	Qa							Qi	Qb		tv	I	A	Q			Qp	L				Vf			Ku	Kw			Hw	Sf	Hf	V2/2g	D	Vp					
DESIGN EVENT (AEP)	STRUCTURE NAME	DRAIN SECTION	SUB-CATCHMENTS CONTRIBUTING	SUB-CATCHMENT TIME OF CONC.	RAINFALL INTENSITY (mm/hr)	CO-EFFICIENT OF RUNOFF	10yr RUNOFF CO-EFFICIENT (IMPERVIOUS AREA)	10yr RUNOFF CO-EFFICIENT (PERVIOUS AREA)	SUB-CATCHMENT AREA	EQUIVALENT AREA	SUB-CATCHMENT DISCHARGE	FLOW IN K&C (INC. BYPASS)	ROAD GRADE AT INLET	MAXIMUM FLOODED WIDTH	MAXIMUM D*V PRODUCT	MINOR FLOW ROAD CAPACITY	INLET TYPE	INLET DESCRIPTION	FLOW INTO INLET	BYPASS FLOW	BYPASS STRUCTURE NAME	CRITICAL TIME OF CONC.	CRITICAL RAINFALL INTENSITY	CRITICAL EFFECTIVE AREA	MAJOR TOTAL FLOW	MAJOR SURFACE FLOW CAPACITY	MAJOR SURFACE FLOW	PIPE FLOW	REACH LENGTH	PIPE GRADE	PIPE/BOX DIMENSIONS	PIPE TYPE (CLASS)	FLOW VELOCITY FULL (PIPE GRADE CAPACITY)	STRUCTURE Ku CHART	STRUCTURE Ku METHOD	STRUCTURE Ku	STRUCTURE Kw	STRUCTURE SUBMERGENCE RATIO	STRUCTURE GRATE FLOW RATIO	STRUCTURE W.S.E LOSS	PIPE FRICTION SLOPE	PIPE FRICTION HEADLOSS (L x Sf)	PIPE VELOCITY HEAD	PART FULL FLOW DEPTH	PART FULL FLOW VELOCITY	PIPE UPSTREAM HGL	PIPE DOWNSTREAM HGL	UPSTREAM STRUCTURE HGL	STRUCTURE SETOUT LEVEL	STRUCTURE NAME
				(mins)	(mm/hr)				(ha)	(ha)	(m^3/s)	(m^3/s)	(%)	(m)	(m^2/s)	(m^3/s)			(m^3/s)	(m^3/s)		(mins)	(mm/hr)	(ha)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m)	(%)			(m/s)							(m)	(%)	(m)	(m/s)	(m)	(m/s)	(m AHD)	(m AHD)	(m AHD)	(m AHD)	
5.0%	OC11/1	OC11/1 to OC11/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					CHNL auto	OPEN CHANNEL	0.000	0.000	OC11/2	1.000	267.000	0.000			0.000	0.000	8.949	1.036	0.500	CHNL	0.000		Direct	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	21.832	21.832	21.832	21.650	OC11/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	OC11/2	1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	21.883	21.883	21.883		
5.0%	OC11/2	OC11/2 to OC11/3		5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.012	0.011	0.006	0.006	13.991	0.391	0.029	3.552	CHNL auto	OPEN CHANNEL	0.006	0.000		5.000	178.000	0.011		3.552	0.008	0.006	12.399	0.911	0.500	CHNL	0.015		Direct	0.000	0.000			0.000	0.001	0.000	0.000	0.099	0.380	21.832	21.832	21.832	21.557	OC11/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.012	0.012	0.008	0.008		0.444	0.035	3.552			0.008	0.000		5.000	239.000	0.012	0.016			0.008					0.021			0.000	0.000			0.000	0.001	0.000	0.000	0.113	0.414	21.883	21.883	21.883		
5.0%	OC11/3	OC11/3 to OC11/4	OC11/2	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.011	0.010	0.005	0.005	2.905	0.393	0.026	5.244	CHNL auto	OPEN CHANNEL	0.005	0.000		5.103	177.318	0.022		5.244	0.007	0.011	13.607	0.451	0.500	CHNL	0.012		Direct	0.000	0.000			0.000	0.000	0.000	0.000	0.101	0.299	21.832	21.832	21.832	21.444	OC11/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.011	0.011	0.007	0.007		0.447	0.033	5.244			0.007	0.000		5.103	238.091	0.023	0.022			0.015					0.017			0.000	0.000			0.000	-0.003	0.000	0.000	0.115	0.325	21.883	21.883	21.883		
5.0%	OC11/4	OC11/4 to OC11/5	OC11/2 OC11/3	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.032	0.031	0.015	0.015	2.018	0.646	0.047	1.968	CHNL auto	OPEN CHANNEL	0.015	0.000		5.217	176.570	0.052		1.968	0.021	0.026	10.395	0.592	0.100	CHNL	0.514		Direct	0.000	0.000			0.000	3.301	0.343	0.014	0.100	0.514	21.832	21.489	21.832	21.383	OC11/4
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.032	0.032	0.021	0.021		0.735	0.058	1.968			0.021	0.000		5.217	237.093	0.055	0.058			0.036					0.724			0.000	0.000			0.000	3.594	0.374	0.015	0.100	0.724	21.883	21.509	21.883		
5.0%	OC11/5	OC11/5 to OC3/8	OC11/2 OC11/3 OC11/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.009	0.009	0.004	0.004	2.868	0.292	0.030	19.568	CHNL auto	OPEN CHANNEL	0.004	0.000	LOST	5.200	176.680	0.061		19.568	0.006	0.030	76.383	0.824	1.000	CHNL	0.048		Direct	0.000	0.000			0.000	0.532	0.421	0.000	0.167	0.537	21.489	21.082	21.489	21.322	OC11/5
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.009	0.009	0.006	0.006		0.331	0.038	19.568			0.005	0.001	LOST	5.303	236.331	0.064	0.047			0.041					0.065			0.000	0.000			0.000	0.496	0.395	0.000	0.188	0.581	21.509	21.131	21.509		
5.0%	OC2/1	OC2/1 to OC2/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000	5.138				CHNL auto	OPEN CHANNEL	0.000	0.000	OC2/2	1.000	267.000	0.000			0.000	0.000	56.091	0.584	0.500	CHNL	0.000		Direct	0.000	0.000			0.000	0.278	0.156	0.000	0.000	0.000	21.949	21.793	21.949	21.949	OC2/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	OC2/2	1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.264	0.148	0.000	0.000	0.000	21.949	21.801	21.949		
5.0%	OC2/2	OC2/2 to OC2/3		5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.084	0.081	0.040	0.040	0.272	0.897	0.089	1.681	CHNL auto	OPEN CHANNEL	0.040	0.000	OC2/3	5.000	178.000	0.081		1.681	0.056	0.040	67.187	0.510	0.500	CHNL	0.046		Direct	0.000	0.000			0.000	0.427	0.292	0.000	0.172	0.387	21.793	21.506	21.793	21.621	OC2/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.084	0.084	0.056	0.056		1.019	0.110	1.681			0.045	0.011	OC2/3	5.000	239.000	0.084	0.101			0.045					0.051			0.000	0.000			0.000	0.393	0.270	0.000	0.179	0.398	21.801	21.537	21.801		
5.0%	OC2/3	OC2/3 to OC2/4	OC2/2	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.105	0.100	0.049	0.049	0.575	0.728	0.136	4.561	CHNL auto	OPEN CHANNEL	0.049	0.000		5.560	174.305	0.180		4.561	0.081	0.087	65.915	0.551	0.500	CHNL	0.100		Direct	0.000	0.000			0.000	0.479	0.322	0.001	0.227	0.484	21.506	21.190	21.506	21.279	OC2/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.105	0.105	0.070	0.081		0.876	0.184	4.561			0.081	0.000		5.560	234.073	0.189	0.204			0.123					0.141			0.000	0.000			0.000	0.487	0.328	0.001	0.258	0.528	21.537	21.215	21.537		
5.0%	OC2/4	OC2/4 to C/1	OC2/2 OC2/3	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.136	0.130	0.064	0.064	1.409	1.996	0.065	7.425	CHNL auto	OPEN CHANNEL	0.064	0.000	C/1	6.109	170.679	0.310		7.425	0.090	0.147	6.797	0.151	0.500	CHNL	0.168		Direct	0.000	0.000			0.000	1.182	0.045	0.001	0.332	0.381	21.190	21.110	21.190	20.915	OC2/4
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.136	0.136	0.090	0.090		2.270	0.080	7.425			0.072	0.018	C/1	6.109	229.239	0.325	0.279			0.189					0.216			0.000	0.000			0.000	1.235	0.046	0.002	0.365	0.406	21.215	21.131	21.215		
5.0%	C/1	C/1 to C/2	OC2/2 OC2/3 OC2/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.015	0.015	0.007	0.007	14.180	2.105	0.005	0.263	HW IN	HEADWALL	0.007	0.000	C/2	6.166	170.306	0.325		0.263	0.028	0.154	13.027	0.679	0.375	BC	0.193		Direct	0.000	0.000			0.000	0.239	0.062	0.002	0.112	1.187	21.036	21.004	21.036	20.905	C/1
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.015	0.015	0.010	0.028		2.958	0.015	0.263			0.023	0.006	C/2	6.166	228.741	0.340	0.239			0.211					0.264			0.000	0.000			0.000	0.231	0.063	0.004	0.132	1.298	21.060	21.030	21.060		
5.0%	C/2	C/2 to OC2/5	OC2/2 OC2/3 OC2/4 C/1	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.032	0.031	0.015	0.015	1.712				HW OUT	HEADWALL	0.015	0.000		6.274	169.589	0.355			0.027	0.167	8.599	0.581	0.500	CHNL	0.168		Direct	0.000	0.000			0.000	0.490	0.053	0.001	0.188	1.187	21.004	20.962	21.004	20.817	C/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.032	0.032	0.021	0.027							0.027	0.000		6.274	227.785	0.373	0.263			0.236					0.236			0.000	0.000			0.000	0.476	0.054	0.003	0.213	1.293	21.030	20.989	21.030		
5.0%	OC2/5	OC2/5 to OC2/6	OC2/2 OC2/3 OC2/4 C/1 C/2	10.0	145.000	0.938	0.900,0.900	0.750,0.750	0.073	0.069	0.033	0.033					CHNL auto	OPEN CHANNEL	0.033	0.000		6.346	169.116	0.422			0.046	0.198	19.103	0.654	0.500	CHNL	0.198		Direct	0.000	0.000			0.000	0.654	0.125	0.002	0.196	1.295	20.962	20.837	20.962	20.767	OC2/5
1.0%				10.0	195.000	0.990	0.900,0.900	0.750,0.750	0.073	0.073	0.046	0.046							0.046	0.000		6.346	227.155	0.443	0.325			0.279					0.279			0.000	0.000			0.000	0.654	0.125	0.004	0.223	1.411	20.989	20.864	20.989		
5.0%	OC3/1	OC3/1 to OC3/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					CHNL auto	OPEN CHANNEL	0.000	0.000		1.000	267.000	0.000			0.000	0.000	50.146	0.500	0.500	CHNL	0.000		Direct	0.000	0.000			0.000	0.161	0.081	0.000	0.000	0.000	22.027	21.946	22.027	22.027	OC3/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.114	0.057	0.000	0.000	0.000	22.027	21.970	22.027		
5.0%	OC3/2	OC3/2 to OC3/3		5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.075	0.072	0.036	0.036	1.330	0.910	0.078	1.494	CHNL auto	OPEN CHANNEL	0.036	0.000		5.000	178.000	0.072		1.494	0.050	0.036	49.082	0.315	0.500	CHNL	0.041		Direct	0.000	0.000			0.000	0.208	0.106	0.000	0.170	0.352	21.946	21.844	21.946	21.776	OC3/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.075	0.075	0.050	0.050		1.035	0.097	1.494			0.050	0.000		5.000	239.000	0.075	0.100			0.050					0.057			0.000	0.000			0.000	0.211	0.108	0.000	0.193	0.384	21.970	21.866	21.970		
5.0%	OC3/3	OC3/3 to OC3/4	OC3/2	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.094	0.089	0.044	0.044	1.402	1.622	0.055	5.356	CHNL auto	OPEN CHANNEL	0.044	0.000	OC3/4	5.409	175.301	0.161		5.356	0.062	0.078	52.056	0.346	0.600	CHNL	0.058		Direct	0.000	0.000			0.000	0.149	0.084	0.000	0.219	0.438	21.844	21.767	21.844	21.621	OC3/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.094	0.094	0.062	0.062		1.848	0.068	5.356			0.050	0.012	OC3/4	5.409	235.401	0.169	0.160			0.098					0.073			0.000	0.000			0.000	0.133	0.077	0.000	0.238	0.463	21.866	21.797	21.866		
5.0%	OC3/4	OC3/4 to OC3/5	OC3/2 OC3/3	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.117	0.111	0.055	0.055	0.320	5.194	0.021	1.339	CHNL auto	OPEN CHANNEL	0.055	0.000	OC3/5	5.843	172.437	0.272		1.339	0.090	0.131	110.611	0.221	1.000	CHNL	0.187		Direct	0.000	0.000			0.000	0.233	0.256	0.002	0.325	0.448	21.767	21.509	21.767	21.441	OC3/4
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.117	0.117	0.077	0.090		6.242	0.029	1.339			0.072	0.018	OC3/5	5.843	231.583	0.286	0.256			0.166					0.237			0.000	0.000			0.000	0.222	0.245	0.003	0.356	0.476	21.797	21.552	21.797		
5.0%	OC3/5	OC3/5 to OC3/6	OC3/2 OC3/3 OC3/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.272	0.260	0.129	0.129	0.254	1.478	0.174	11.554	CHNL auto	OPEN CHANNEL	0.129	0.000		6.356	169.053	0.527		11.554	0.199	0.247	15.431	0.522	1.000	CHNL	0.118		Direct	0.000	0.000			0.000	0.486	0.077	0.001	0.311	0.681	21.509	21.434	21.509	21.197	OC3/5
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.272	0.272	0.181	0.199		1.741	0.228	11.554			0.199	0.000		6.356	227.071	0.552	0.547			0.348					0.166			0.000	0.000			0.000	0.479	0.076	0.001	0.354	0.742	21.552	21.478	21.552		
5.0%	OC3/6	OC3/6 to OC3/7	OC3/2 OC3/3 OC3/4 OC3/5	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.035	0.034	0.017	0.017	4.425	0.698	0.048	15.133	CHNL auto	OPEN CHANNEL	0.017	0.000		6.484	168.205	0.560		15.133	0.023	0.262	59.653	0.471	1.000	CHNL	0.095		Direct	0.000	0.000			0.000	0.305	0.196	0.000	0.316	0.655	21.434	21.252	21.434	21.117	OC3/6
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.035	0.035	0.023	0.023		0.794	0.059	15.133			0.023	0.000		6.484	225.939	0.587	0.392			0.369					0.134			0.000	0.000			0.000	0.292	0.191	0.001	0.359	0.713	21.478	21.304	21.478		
5.0%	OC3/7	OC3/7 to OC3/8	OC7/1 OC8/2 OC8/3 OC8/4 OC7/2 OC3/2 OC3/3 OC3/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.128	0.123	0.061	0.061					CHNL auto	OPEN CHANNEL	0.061	0.000		6.547	167.787	0.895			0.085	0.417	39.953	0.362	0.500	CHNL	0.477		Direct	0.000	0.000			0.000	0.426	0.163	0.012	0.417	0.687	21.252	21.082	21.252	20.837	OC3/7
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.128	0.128	0.085	0.085							0.085	0.000		6.547	225.382	0.939	0.657			0.572					0.654			0.000	0.000			0.000	0.433	0.165	0.022	0.500	0.654	21.304	21.131	21.304		
5.0%	OC3/8	OC3/8 to OC3/9	OC11/2 OC11/3 OC11/4 OC11/5 OC7/1 OC8/2 OC8/3 OC8/4	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.088	0.084	0.041	0.041	2.801				CHNL auto	OPEN CHANNEL	0.041	0.000		6.880	165.589	1.040			0.058	0.479	24.862	0.500	0.500	CHNL	0.479		Direct	0.000	0.000			0.000	0.816	0.157	0.012	0.392	0.779	21.082	20.879	21.082	20.692	OC3/8
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.088	0.088	0.058	0.058							0.058	0.000		6.880	222.452	1.091	0.715			0.657					0.657			0.000	0.000			0.000	0.842	0.158	0.022	0.441	0.843	21.131	20.921	21.131		
5.0%	OC4/1	OC4/1 to OC4/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000	7.117				CHNL auto	OPEN CHANNEL	0.000	0.000	LOST	1.000	267.000	0.000			0.000	0.000	29.068	1.011	0.500	CHNL	0.000		Direct	0.000	0.000			0.000	1.011	0.294	0.000	0.000	0.000	22.898	22.604	22.898	22.898	OC4/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	LOST	1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	1.011	0.294	0.000	0.000	0.000	22.898	22.604	22.898		
5.0%	OC5/1	OC5/1 to OC6/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000	5.451				CHNL auto	OPEN CHANNEL	0.000	0.000	OC9/1	1.000	267.000	0.000			0.000	0.000	94.142	0.520	0.600	CHNL	0.000		Direct	0.000	0.000			0.000	0.227	0.214	0.000	0.000	0.000	21.981	21.767	21.981	21.981	OC5/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	OC9/1	1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.195	0.184	0.000	0.000	0.000	21.981	21.797	21.981		
5.0%	OC6/1	OC6/1 to OC6/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					CHNL auto	OPEN CHANNEL	0.000	0.000		1.000	267.000	0.000			0.000	0.000	95.899	0.377	0.700	CHNL	0.000		Direct	0.000	0.000			0.000	0.089	0.086	0.000	0.000	0.000	21.852	21.767	21.852	21.852	OC6/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000		1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.057	0.055	0.000	0.000	0.000	21.852	21.797	21.852		
5.0%	OC7/1	OC7/1 to OC7/2		10.0	145.000	0.938	0.900,0.900	0.750,0.750	0.101	0.095	0.045	0.045	8.140	1.582	0.058	26.809	CHNL auto	OPEN CHANNEL	0.045	0.000	LOST	5.000	178.000	0.091		26.809	0.064	0.045	89.000	0.431	0.700	CHNL	0.037		Direct	0.000	0.000			0.000	0.415	0.372	0.000	0.200	0.449	22.035	21.666	22.035	21.835	OC7/1
1.0%				10.0	195.000	0.990	0.900,0.900	0.750,0.750	0.101	0.100	0.064	0.064		1.802	0.071	26.809			0.051	0.013	LOST	5.000	239.000	0.096	0.114			0.051					0.041			0.000	0.000			0.000	0.394	0.355	0.000	0.210	0.463	22.044	21.694	22.044		
5.0%	OC8/1	OC8/1 to OC8/2		0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000					CHNL auto	OPEN CHANNEL	0.000	0.000	OC8/2	1.000	267.000	0.000			0.000	0.000	9.999	0.500	0.500	CHNL	0.000		Direct	0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	22.108	22.108	22.108	22.079	OC8/1
1.0%				0.0	0.000		0.900,0.900	0.750,0.750		0.000	0.000	0.000							0.000	0.000	OC8/2	1.000	358.000	0.000	0.000			0.000					0.000			0.000	0.000			0.000	0.000	0.000	0.000	0.000	0.000	22.111	22.111	22.111		
5.0%	OC8/2	OC8/2 to OC8/3		5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.004	0.004	0.002	0.002	0.945	0.408	0.009	7.288	CHNL auto	OPEN CHANNEL	0.002	0.000	OC8/3	5.000	178.000	0.004		7.288	0.002	0.002	38.461	0.314	0.500	CHNL	0.005		Direct	0.000	0.000			0.000	0.212	0.083	0.000	0.078	0.190	22.108	22.026	22.108	22.029	OC8/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.004	0.004	0.002	0.002		0.464	0.011	7.288			0.002	0.000	OC8/3	5.000	239.000	0.004	0.004			0.002					0.005			0.000	0.000			0.000	0.172	0.068	0.000	0.082	0.196	22.111	22.045	22.111		
5.0%	OC8/3	OC8/3 to OC8/4	OC8/2	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.016	0.015	0.008	0.008	0.562	0.361	0.042	0.018	CHNL auto	OPEN CHANNEL	0.008	0.000	LOST	5.321	175.885	0.019		0.018	0.015	0.009	50.827	0.515	0.500	CHNL	0.018		Direct	0.000	0.000			0.000	0.476	0.245	0.000	0.117	0.335	22.026	21.784	22.026	21.909	OC8/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.016	0.016	0.011	0.015		0.466	0.064	0.018			0.012	0.003	LOST	5.321	236.180	0.020	0.029			0.014					0.027			0.000	0.000			0.000	0.488	0.250	0.000	0.136	0.370	22.045	21.797	22.045		
5.0%	OC8/4	OC8/4 to OC7/2	OC8/2 OC8/3	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.028	0.027	0.013	0.013					CHNL auto	OPEN CHANNEL	0.013	0.000	OC8/3	5.424	175.205	0.046			0.019	0.022	50.409	0.388	0.500	CHNL	0.025		Direct	0.000	0.000			0.000	0.235	0.123	0.000	0.137	0.338	21.784	21.666	21.784	21.647	OC8/4
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.028	0.028	0.019	0.019							0.015	0.004	OC8/3	5.424	235.273	0.048	0.047			0.028					0.032			0.000	0.000			0.000	0.204	0.108	0.000	0.150	0.359	21.797	21.694	21.797		
5.0%	OC9/1	OC9/1 to OC9/2		5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.101	0.096	0.048	0.048	49.998				CHNL auto	OPEN CHANNEL	0.048	0.000	OC9/2	5.000	178.000	0.096			0.067	0.048	135.255	0.500	0.600	CHNL	0.053		Direct	0.000	0.000			0.000	0.403	0.553	0.000	0.211	0.429	22.223	21.678	22.223	22.012	OC9/1
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.101	0.101	0.067	0.067							0.054	0.013	OC9/2	5.000	239.000	0.101	0.121			0.054					0.060			0.000	0.000			0.000	0.392	0.538	0.000	0.220	0.442	22.233	21.703	22.233		
5.0%	OC9/2	OC9/2 to OC9/3	OC9/1	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.156	0.148	0.073	0.073	0.374	2.510	0.058	1.666	CHNL auto	OPEN CHANNEL	0.073	0.000	OC9/3	6.127	170.561	0.245		1.666	0.117	0.116	81.310	0.500	1.000	CHNL	0.066		Direct	0.000	0.000			0.000	0.395	0.331	0.000	0.342	0.566	21.678	21.357	21.678	21.336	OC9/2
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.156	0.156	0.103	0.117		2.968	0.077	1.666			0.093	0.023	OC9/3	6.127	229.081	0.256	0.256			0.140					0.080			0.000	0.000			0.000	0.354	0.300	0.000	0.367	0.594	21.703	21.416	21.703		
5.0%	OC9/3	OC9/3 to OC9/4	OC9/1 OC9/2	5.0	178.000	0.954	0.900,0.900	0.750,0.750	0.092	0.088	0.044	0.044	0.582	0.634	0.137	6.832	CHNL auto	OPEN CHANNEL	0.044	0.000		6.805	166.089	0.333		6.832	0.085	0.153	91.274	0.500	1.300	CHNL	0.067		Direct	0.000	0.000			0.000	0.634	0.522	0.000	0.427	0.624	21.357	20.778	21.357	20.930	OC9/3
1.0%				5.0	239.000	1.000	0.900,0.900	0.750,0.750	0.092	0.092	0.061	0.085		0.813	0.208	6.832			0.085	0.000		6.805	223.119	0.349	0.301			0.216					0.095			0.000	0.000			0.000	0.649	0.528	0.000	0.486	0.679	21.416	20.823	21.416		

APPENDIX B

Stormwater Treatment System Locality & Catchment Plan

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



LEGEND

- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL

CATCHMENTS

- CATCHMENT BOUNDARY
- CATCHMENT AREA 1
- CATCHMENT AREA 2
- CATCHMENT AREA 3
- CATCHMENT AREA 4
- CATCHMENT AREA 5
- UNTREATED CATCHMENT
- VEGETATED SWALE
- BIO-RETENTION SWALE

SERVICES

- HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
- OH — EXISTING OVERHEAD POWER
- OPTIC — EXISTING FIBRE OPTIC
- W — EXISTING WATER
- S — EXISTING SEWER
- SW — EXISTING STORMWATER

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

FOR REVIEW

Used on / Next higher assembly:

Filename: B18028-SKC-1080 - SKC-1084.dwg

Alternate DMS number:

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
A	18.06.20	ISSUED FOR INFORMATION	JL	MWE			

Designing Company: Brisbane Office
BG&E DOC No: B18028
Designed R.Robertson 22.04.2020
Checked M.Worthington-Eyre 22.04.2020
Ind.Rev. Company | Ind.Rev. Name
Ind.Review Signature

pacific national
Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

SK-C-1080 | Rev A
Sheet No. 1 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
STORMWATER CATCHMENT
PLAN - SHEET 1

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE

NORTH

CATCHMENT 1
1.683ha

TERMINAL HARDSTAND

JOINS SHEET 1

JOINS SHEET 3

LEGEND

- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL

CATCHMENTS

- CATCHMENT BOUNDARY
- CATCHMENT AREA 1
- CATCHMENT AREA 2
- CATCHMENT AREA 3
- CATCHMENT AREA 4
- CATCHMENT AREA 5
- UNTREATED CATCHMENT
- VEGETATED SWALE
- BIO-RETENTION SWALE

SERVICES

- HV HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
- OH OH — EXISTING OVERHEAD POWER
- OPTIC — EXISTING FIBRE OPTIC
- W W — EXISTING WATER
- S S — EXISTING SEWER
- SW SW — EXISTING STORMWATER

KEY PLAN

SOUTH CREEK

1 2 3 4 5

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

FOR REVIEW

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
A	18.06.20	ISSUED FOR INFORMATION	JL	MWE			

Used on / Next higher assembly:

Filename: B18028-SKC-1080 - SKC-1084.dwg

Alternate DMS number:

Designing Company: Brisbane Office
BG&E DOC No: B18028

Designed R.Robertson 22.04.2020
Checked M.Worthington-Eyre 22.04.2020
Ind.Rev. Company | Ind.Rev. Name
Ind.Review Signature

Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

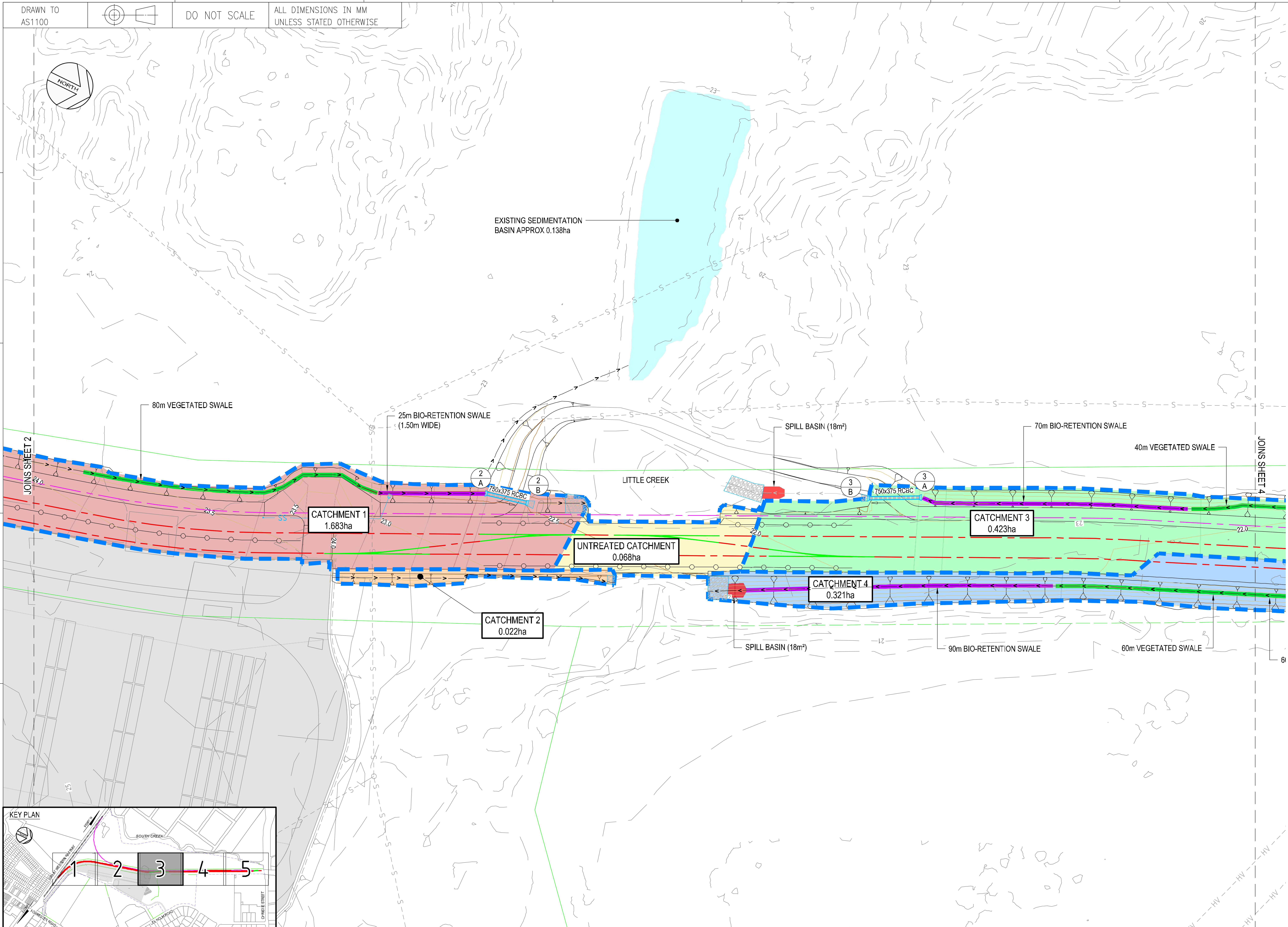
A

SK-C-1081

Sheet No. 2 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
STORMWATER CATCHMENT PLAN - SHEET 2

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE



LEGEND

- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL

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- CATCHMENT AREA 3
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- SW — EXISTING STORMWATER

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

FOR REVIEW

Used on / Next higher assembly:

Filename: B18028-SKC-1080 - SKC-1084.dwg

Alternate DMS number:

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
A	18.06.20	ISSUED FOR INFORMATION	JL	MWE			

Designing Company: BG&E Brisbane Office

BG&E DOC No: B18028

Designed R.Robertson 22.04.2020

Checked M.Worthington-Eyre 22.04.2020

Ind.Rev. Company | Ind.Rev. Name

Ind.Review Signature

pacific national

Approved By | Accepted By

Signed: | Signed:

Approval Date | Acceptance Date

SK-C-1082

Sheet No. 3 of 5

Scale: 1:500

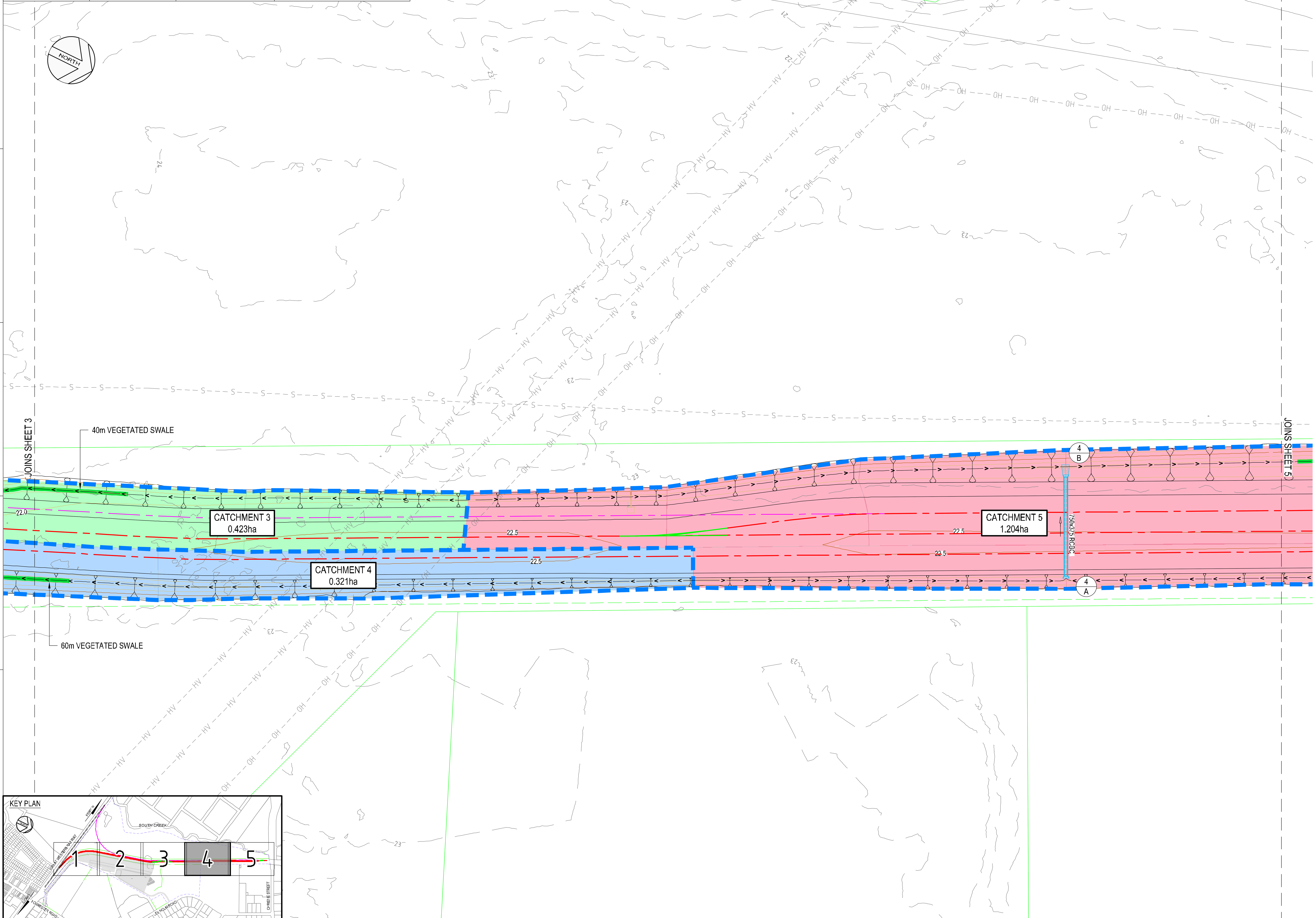
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS

STORMWATER CATCHMENT

PLAN - SHEET 3

DRAWN TO AS1100		DO NOT SCALE	ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



LEGEND

- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL

CATCHMENTS

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- CATCHMENT AREA 5
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- S — EXISTING SEWER
- SW — EXISTING STORMWATER

Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

FOR REVIEW

Used on / Next higher assembly:

Filename: B18028-SKC-1080 - SKC-1084.dwg

Alternate DMS number:

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
A	18.06.20	ISSUED FOR INFORMATION	JL	MWE			

Designing Company: BG&E Brisbane Office
BG&E DOC No: B18028

Designed R.Robertson 22.04.2020
Checked M.Worthington-Eyre 22.04.2020
Ind.Rev. Company | Ind.Rev. Name
Ind.Review Signature

pacific national
Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

SK-C-1083

Sheet No. 4 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
STORMWATER CATCHMENT
PLAN - SHEET 4

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE

FOR REVIEW

Used on / Next higher assembly:

Filename: B18028-SKC-1080 - SKC-1084.dwg

Alternate DMS number:

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
A	18.06.20	ISSUED FOR INFORMATION	JL	MWE			

Designing Company: Brisbane Office
BG&E DOC No: B18028

Designed R.Robertson 22.04.2020
Checked M.Worthington-Eyre 22.04.2020
Ind.Rev. Company | Ind.Rev. Name
Ind.Review Signature

pacific national

Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

SK-C-1084 (Rev A)

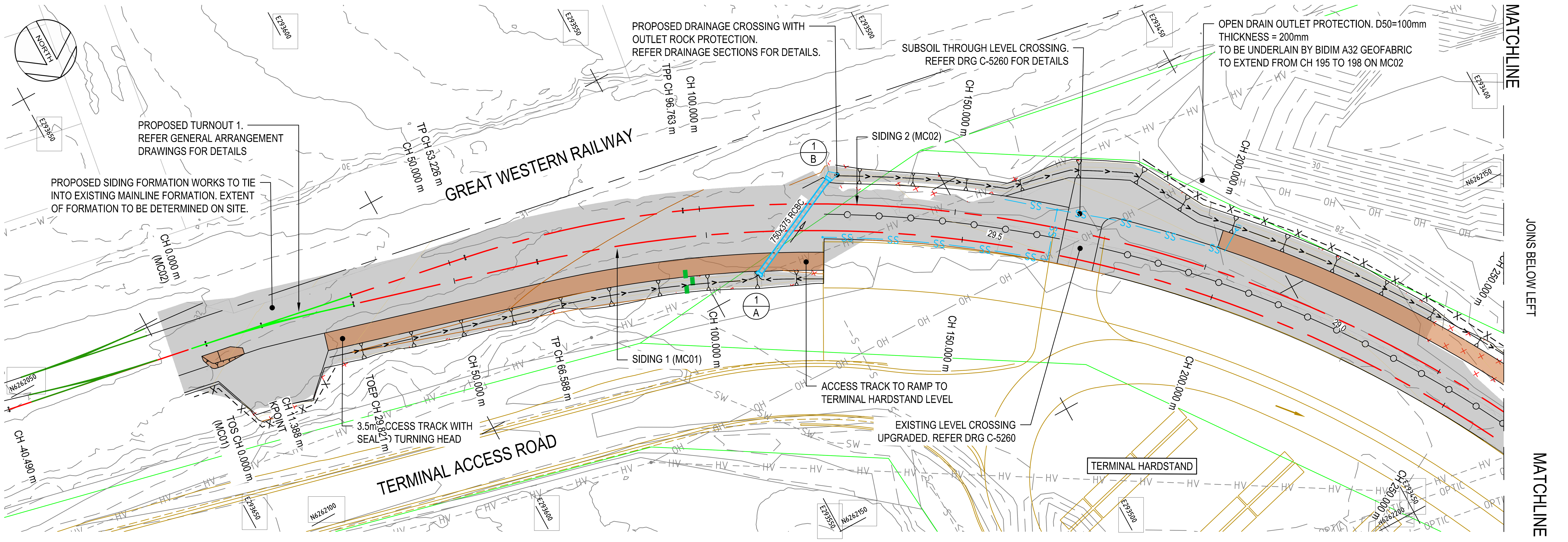
Sheet No. 5 of 5
Scale: 1:500
SHEET SIZE A1

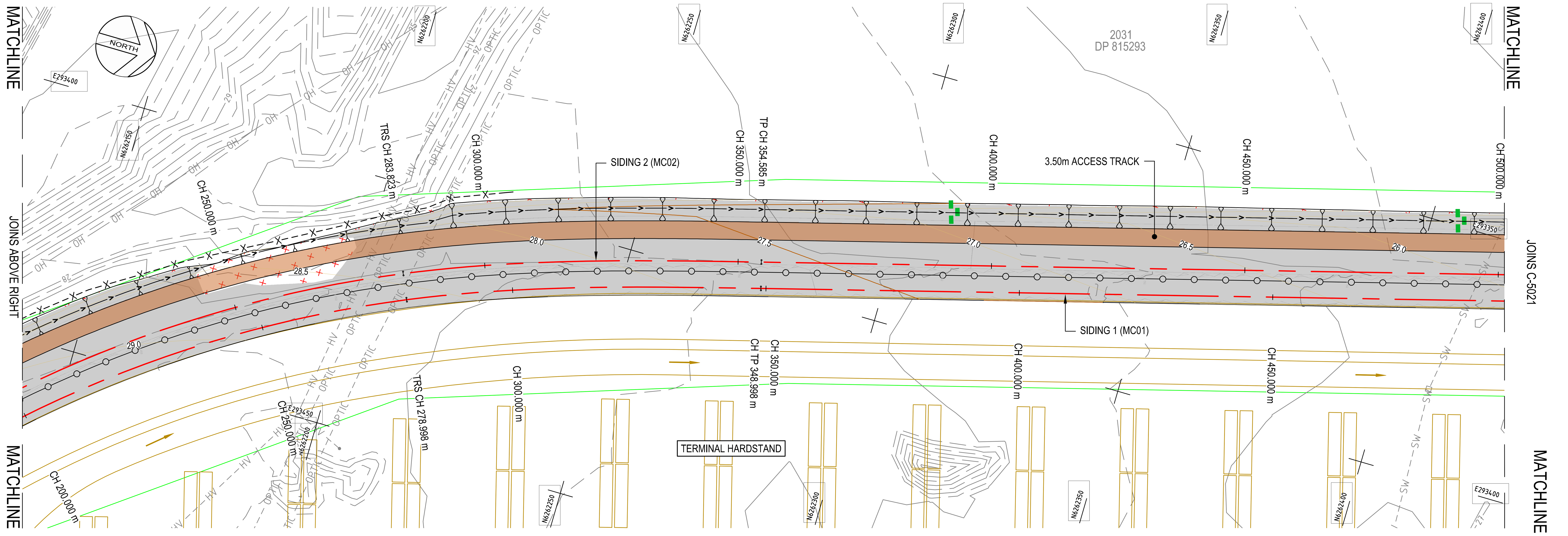
ST MARYS FREIGHT HUB - RAIL WORKS
STORMWATER CATCHMENT PLAN - SHEET 5

APPENDIX D

Proposed Erosion and Sediment Control Plan & IFC St Marys Drainage Layout Plan

DRAWN TO AS1100		DO NOT SCALE	ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE





0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

NOTES

1. REFER TO DRG No. C-5001 FOR DRAWING LIST.
2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
4. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

EARTHWORKS LEGEND

- PROPOSED CONTOURS - MAJOR
- PROPOSED CONTOURS - MINOR
- EXISTING CONTOURS
- EXISTING TREES
- ROCK CHECK DAM
- PROPOSED SILT FENCE

CUT FILL HATCHING SHOWN ILLUSTRATES THE DIFFERENCE BETWEEN THE STRIP SURFACE AND SUB GRADE.

- CUT
- FILL
- PROPOSED DRAINAGE
- PROPOSED CULVERT
- EXISTING CULVERT

CONSTRUCTION

Used on / Next higher assembly:

Filename: B18028-DRG-C-5020 - C-5022.dwg

Alternate DMS number:

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
A	22.04.20	ISSUED FOR 80%	RR	MWE			

Designing Company: Brisbane Office
BG&E DOC No: B18028

Designed	R.Robertson	22.04.2020
Checked	M.Worthington-Eyre	22.04.2020
Ind.Rev. Company	Ind.Rev. Name	
Ind.Review Signature		

pacific national

Approved By	Accepted By
Signed:	Signed:
Approval Date	Acceptance Date

BG&E

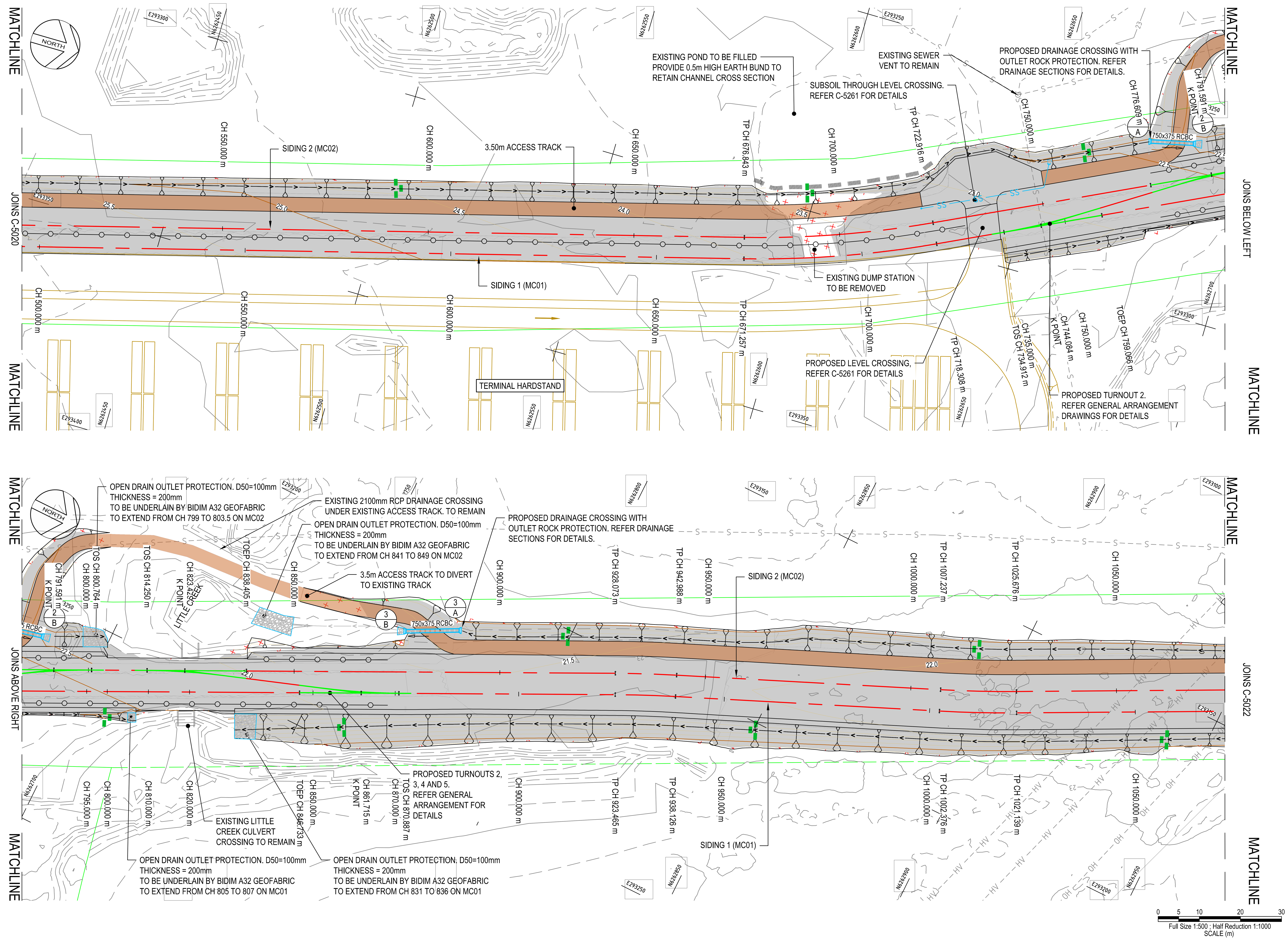
A

C-5020

Sheet No. 1 of 3
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
BULK EARTHWORKS
CUT / FILL & EROSION / SEDIMENT CONTROL - SHEET 1

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



NOTES

1. REFER TO DRG No. C-5001 FOR DRAWING LIST.
2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
4. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

EARTHWORKS LEGEND

- PROPOSED CONTOURS - MAJOR
- PROPOSED CONTOURS - MINOR
- EXISTING CONTOURS
- EXISTING TREES
- ROCK CHECK DAM
- PROPOSED SILT FENCE

CUT FILL HATCHING SHOWN ILLUSTRATES THE DIFFERENCE BETWEEN THE STRIP SURFACE AND SUB GRADE.

- CUT
- FILL
- PROPOSED DRAINAGE
- PROPOSED CULVERT
- EXISTING CULVERT

CONSTRUCTION

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
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Alternate DMS number:

Designing Company: BG&E Brisbane Office

BG&E DOC No: B18028

Designed: R.Robertson 22.04.2020

Checked: M.Worthington-Eyre 22.04.2020

Ind.Rev. Company | Ind.Rev. Name | Ind.Review Signature

pacific national

Approved By | Accepted By | Signed: | Signed: | Approval Date | Acceptance Date

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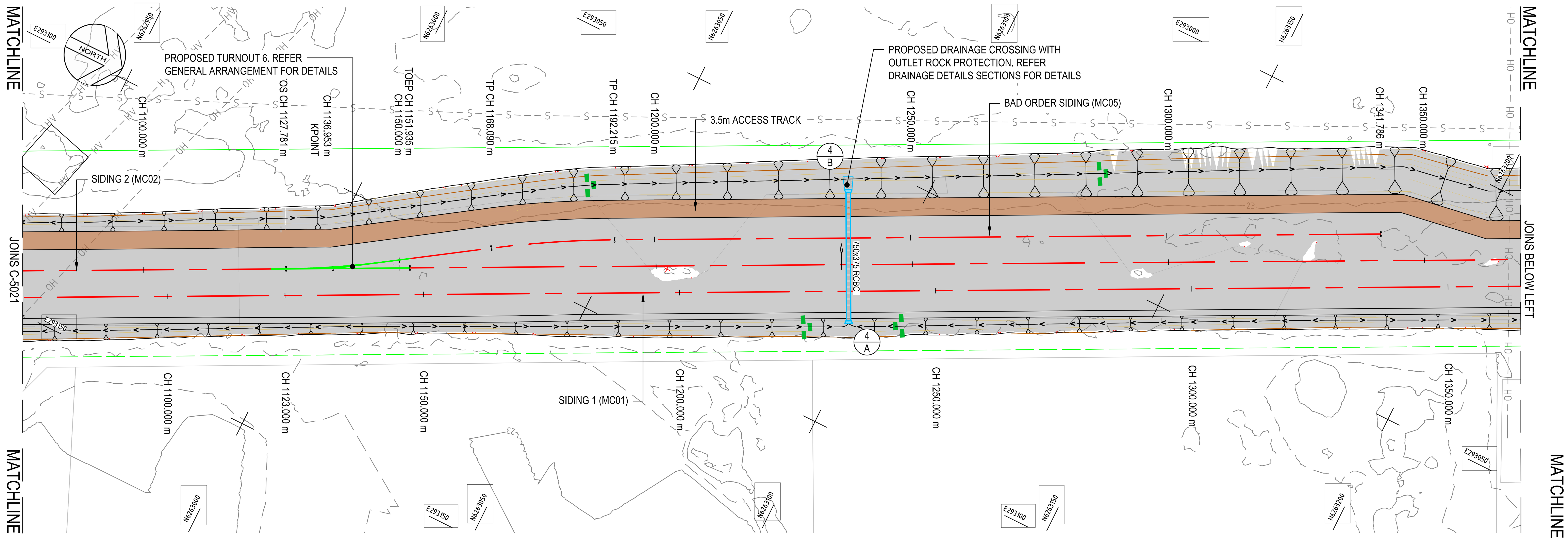
A | C-5021 | Sheet No. 2 of 3 | Scale: 1:500 | SHEET SIZE A1

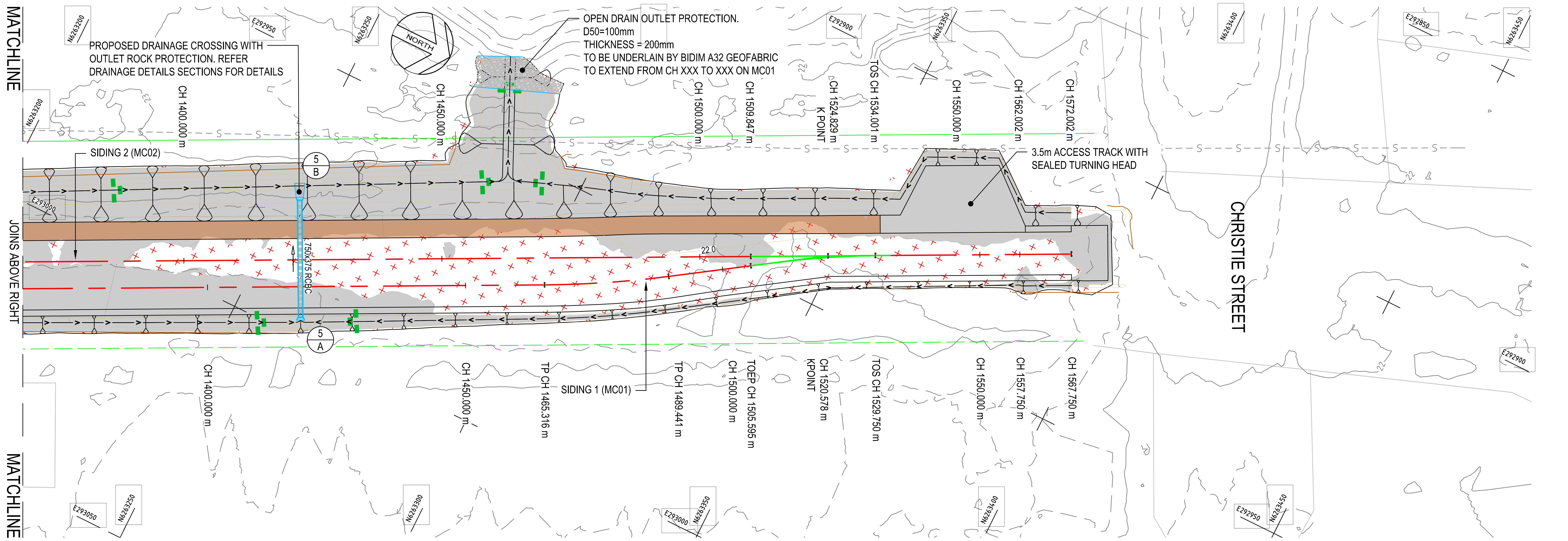
ST MARYS FREIGHT HUB - RAIL WORKS

BULK EARTHWORKS

CUT / FILL & EROSION / SEDIMENT CONTROL - SHEET 2

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE





NOTES

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2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
4. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

EARTHWORKS LEGEND

- PROPOSED CONTOURS - MAJOR
- PROPOSED CONTOURS - MINOR
- EXISTING CONTOURS
- EXISTING TREES
- ROCK CHECK DAM
- PROPOSED SILT FENCE

CUT FILL HATCHING SHOWN ILLUSTRATES THE DIFFERENCE BETWEEN THE STRIP SURFACE AND SUB GRADE.

- CUT
- FILL

- PROPOSED DRAINAGE
- PROPOSED CULVERT
- EXISTING CULVERT

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

CONSTRUCTION

Used on / Next higher assembly:

Filename: B18028-DRG-C-5020 - C-5022.dwg

Alternate DMS number:

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Designing Company: Brisbane Office, 70-72 Bowen St, Spring Hill QLD 4000, P / +61 7 3167 3300, E / info@bgeeng.com, bgeeng.com
BG&E DOC No: B18028

Designed	R.Robertson	22.04.2020
Checked	M.Worthington-Eyre	22.04.2020
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Ind.Review Signature		

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Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

A | C-5022

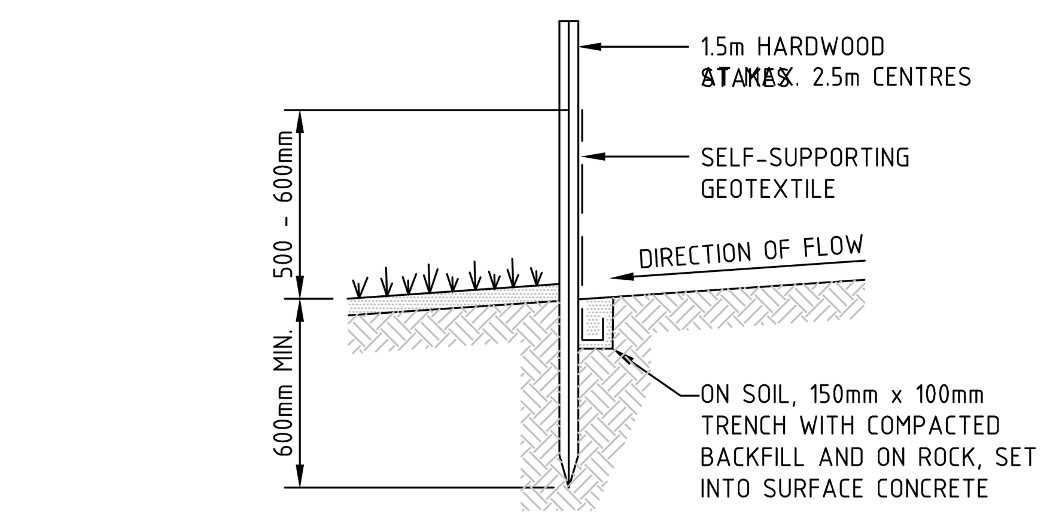
Sheet No. 3 of 3
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS

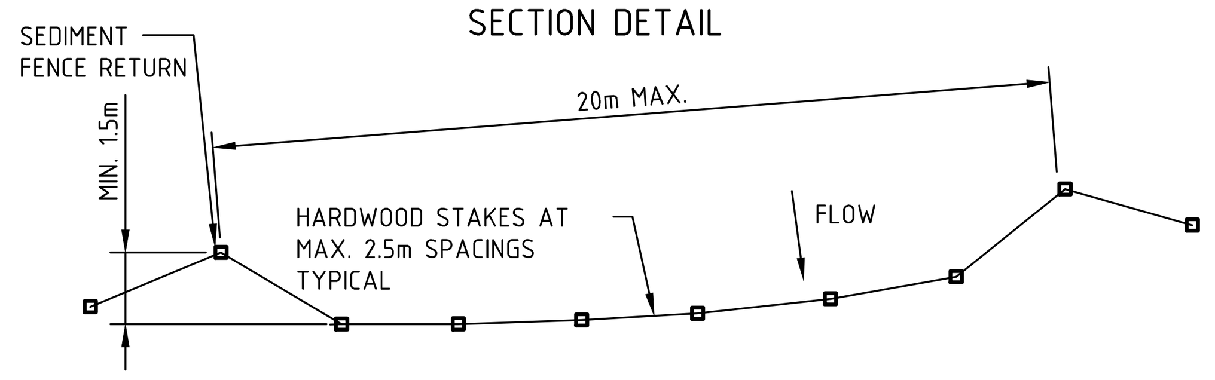
BULK EARTHWORKS

CUT / FILL & EROSION / SEDIMENT CONTROL - SHEET 3

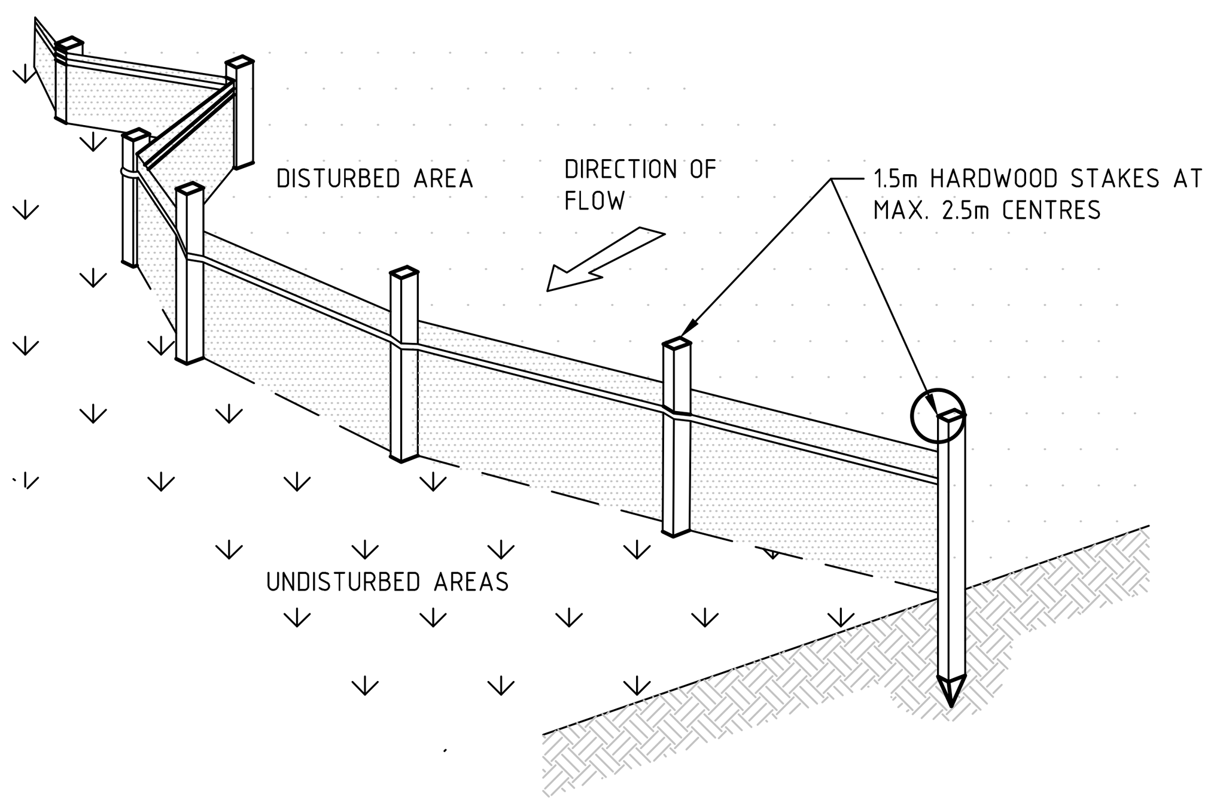
DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



SECTION DETAIL



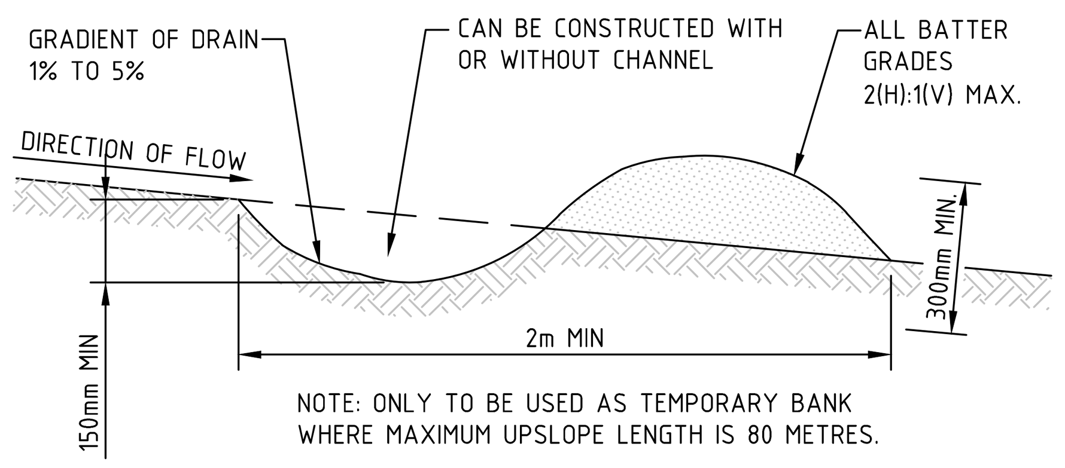
PLAN



SEDIMENT FENCE CONSTRUCTION NOTES:

1. CONSTRUCT SEDIMENT FENCES AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DRAWING TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHOULD BE SMALL ENOUGH TO LIMIT WATER FLOW IF CONCENTRATED AT ONE POINT TO 50 LITRES PER SECOND IN THE DESIGN STORM EVENT, USUALLY THE 10-YEAR EVENT.
2. CUT A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
3. DRIVE 1.5m LONG HARDWOOD STAKES INTO GROUND AT 2.5m INTERVALS (MAX.) AT THE DOWNSLOPE EDGE OF THE TRENCH. ENSURE ANY STAKES ARE FITTED WITH SAFETY CAPS.
4. FIX SELF-SUPPORTING GEOTEXTILE TO THE UPSLOPE SIDE OF THE POSTS ENSURING IT GOES TO THE BASE OF THE TRENCH. FIX THE GEOTEXTILE WITH WIRE TIES OR AS RECOMMENDED BY THE MANUFACTURER. ONLY USE GEOTEXTILE SPECIFICALLY PRODUCED FOR SEDIMENT FENCING. THE USE OF SHADE CLOTH FOR THIS PURPOSE IS NOT SATISFACTORY.
5. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
6. BACKFILL THE TRENCH OVER THE BASE OF THE FABRIC AND COMPACT IT THOROUGHLY OVER THE GEOTEXTILE.

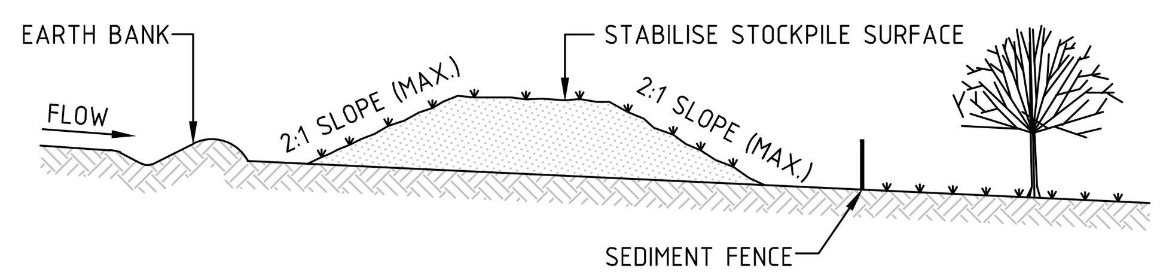
SEDIMENT FENCE
SCALE N.T.S



TEMPORARY CUT OFF DRAIN CONSTRUCTION NOTES:

1. BUILD WITH GRADIENTS BETWEEN 1% AND 5%.
2. AVOID REMOVING TREES AND SHRUBS IF POSSIBLE - WORK AROUND THEM.
3. ENSURE THE STRUCTURES ARE FREE OF PROJECTIONS OR OTHER IRREGULARITIES THAT COULD IMPEDE WATER FLOW.
4. BUILD THE DRAINS WITH CIRCULAR, PARABOLIC OR TRAPEZOIDAL CROSS-SECTIONS, NOT "V" SHAPED.
5. ENSURE BANKS ARE PROPERLY COMPACTED TO PREVENT FAILURE.
6. COMPLETE PERMANENT OR TEMPORARY STABILISATION WITHIN 10 DAYS OF CONSTRUCTION.

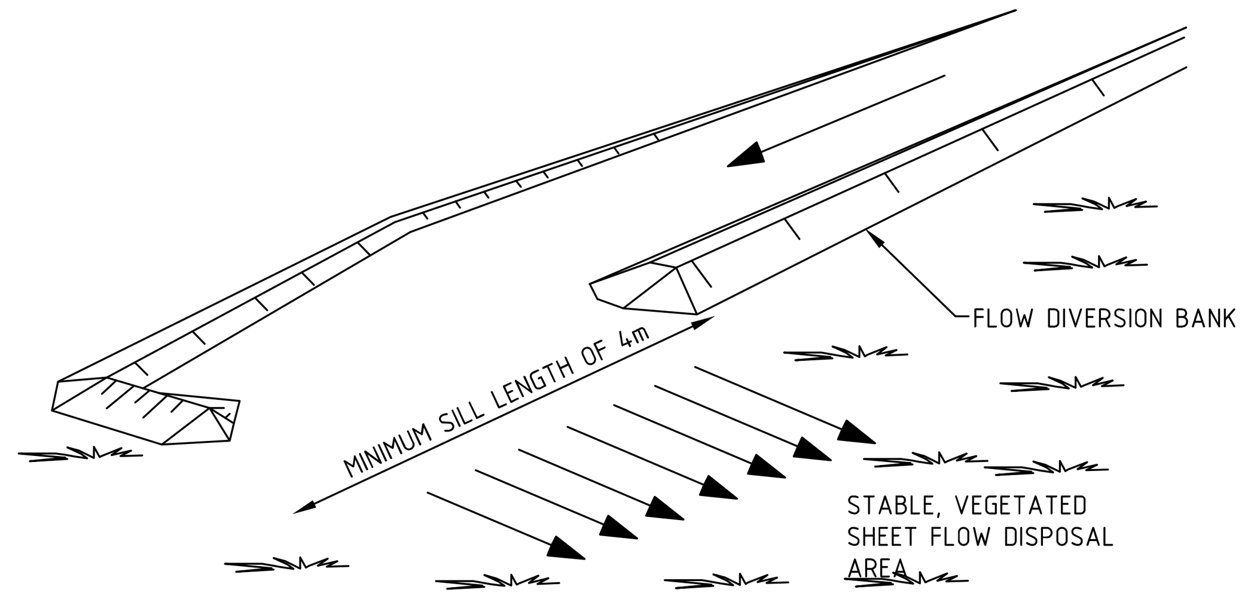
TEMPORARY CATCH DRAIN
SCALE N.T.S



STOCKPILE CONSTRUCTION NOTES:

1. PLACE STOCKPILES MORE THAN 2 (PREFERABLY 5) METRES FROM EXISTING VEGETATION, CONCENTRATED WATER FLOW, ROADS AND HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS LOW, FLAT, ELONGATED MOUNDS.
3. WHERE THERE IS SUFFICIENT AREA, TOPSOIL STOCKPILES SHALL BE LESS THAN 2 METRES IN HEIGHT.
4. WHERE THEY ARE TO BE PLACE FOR MORE THAN 10 DAYS, STABILISE FOLLOWING THE APPROVED ESCP OR SWMP TO REDUCE THE C-FACTOR TO LESS THAN 0.10.
5. CONSTRUCT EARTH BANKS ON THE UPSLOPE SIDE TO DIVERT WATER AROUND STOCKPILES AND SEDIMENT FENCES 1 TO 2 METRES DOWNSLOPE.

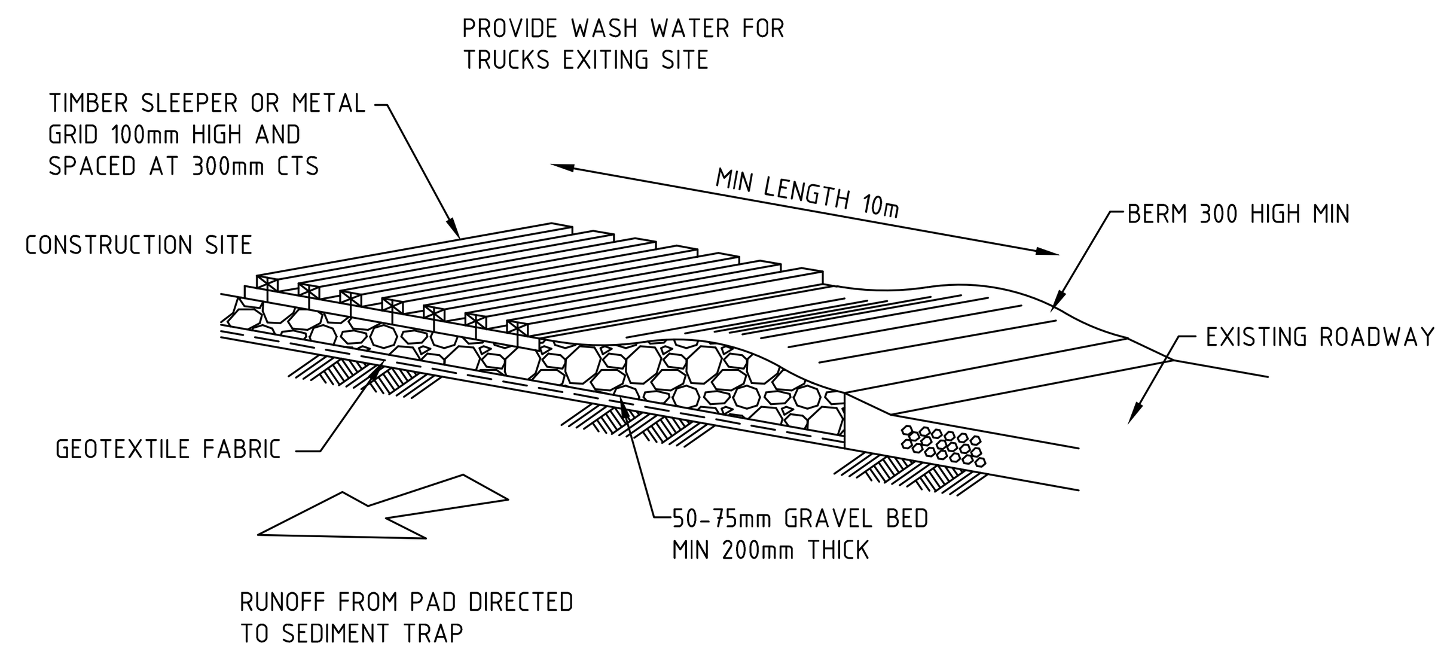
STOCKPILES
SCALE N.T.S



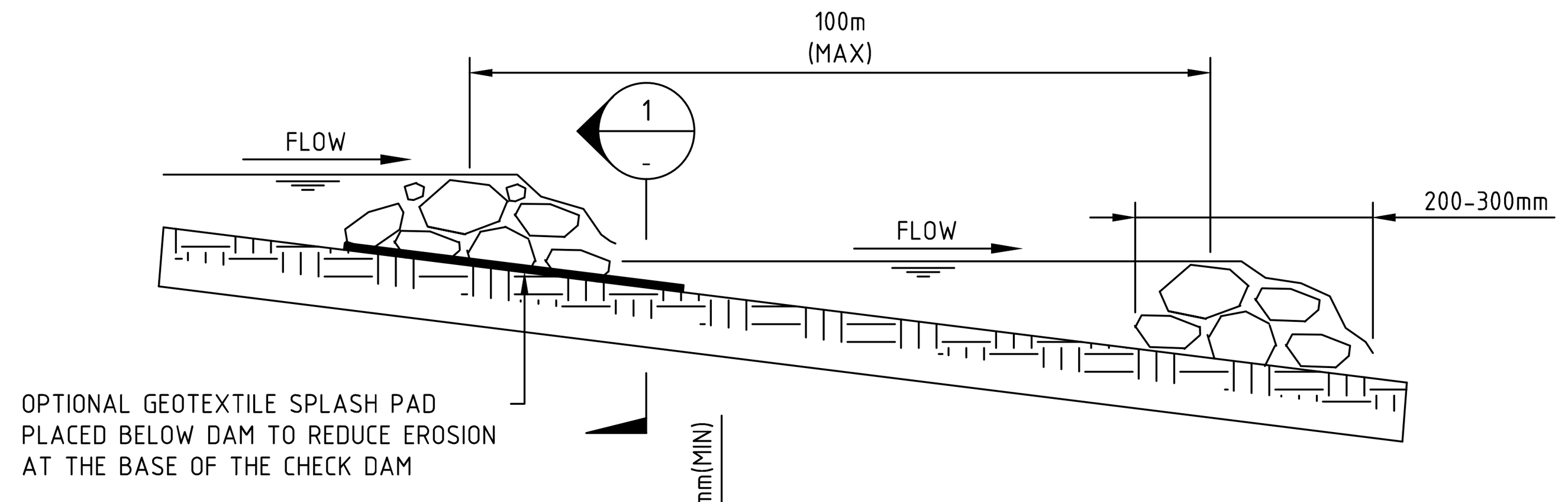
LEVEL SPREADER
NTS

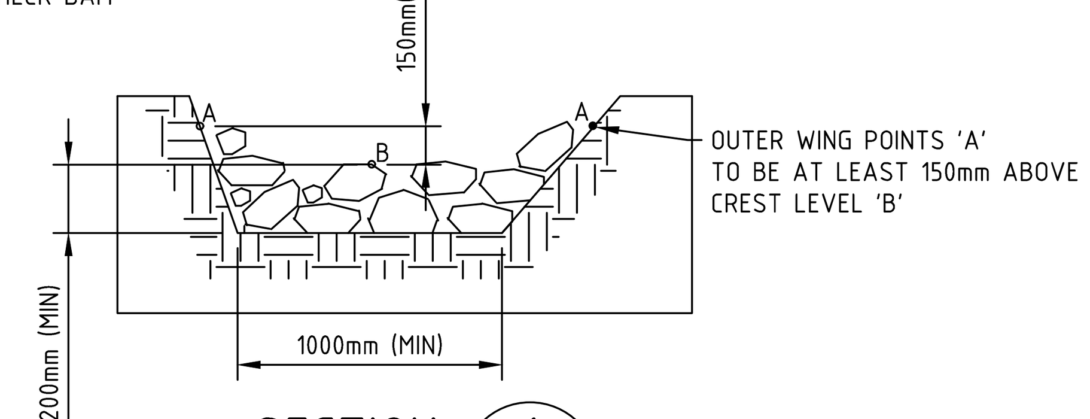
LEVEL SPREADER CONSTRUCTION NOTES:

1. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS AND CONSTRUCTION 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.
2. WHEREVER PRACTICAL, LOCATE THE LEVEL SPREADER ON UNDISTURBED, STABLE SOIL.
3. ENSURE FLOW DISCHARGING FROM THE LEVEL SPREADER WILL DISPERSE ACROSS A PROPERLY STABILISED SLOPE NOT EXCEEDING 10:1 (H:V) AND SUFFICIENTLY EVEN IN GRADE ACROSS THE SLOPE TO AVOID CONCENTRATING THE OUTFLOW.
4. THE OUTLET SILL OF THE SPREADER SHOULD BE PROTECTED WITH EROSION CONTROL MATTING TO PREVENT EROSION DURING THE ESTABLISHMENT OF VEGETATION. THE MATTING SHOULD BE A MINIMUM OF 1200MM WIDE EXTENDING AT LEAST 300MM UPSTREAM OF THE EDGE OF THE OUTLET CREST AND BURIED AT LEAST 150MM IN A VERTICAL TRENCH. THE DOWNSTREAM EDGE SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED HEAVY-DUTY WIRE STAPLES AT LEAST 150MM LONG.
5. ENSURE THAT THE OUTLET SILL (CREST) IS LEVEL FOR THE SPECIFIED LENGTH.
6. IMMEDIATELY AFTER CONSTRUCTION, TURF, OR SEED AND MULCH WHERE APPROPRIATE, THE LEVEL SPREADER.



TEMPORARY CONSTRUCTION VEHICLE EXIT
NTS





SECTION 1
SCALE NTS

ROCK CHECK DAM
SCALE N.T.S

MATERIALS

ROCK : 150 TO 300mm NOMINAL DIAMETER, HARD, EROSION RESISTANT ROCK. SMALLER ROCK MAY BE USED IF SUITABLE LARGE ROCK IS NOT AVAILABLE.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. PRIOR TO THE PLACEMENT OF THE CHECK DAMS, ENSURE THE TYPE AND SIZE OF EACH CHECK DAMS WILL NOT CAUSE A SAFETY HAZARD OR CAUSE WATER TO SPILL OUT OF THE DRAIN.
3. LOCATE THE FIRST CHECK DAM AT THE DOWNSTREAM END OF THE SECTION OF CHANNEL BEING PROTECTED. LOCATE EACH SUCCESSIVE CHECK DAM SUCH THAT THE CREST OF THE IMMEDIATE DOWNSTREAM DAM IS LEVEL WITH THE TOE OF THE CHECK DAM BEING INSTALLED.
4. ENSURE THE CHANNEL SLOPE I NO STEEPER THAN 10:1 (H:V). OTHERWISE CONSIDER THE USE OF A SUITABLE CHANNEL LINER INSTEAD OF THE CHECK DAMS.
5. CONSTRUCT THE CHECK DAM TO THE DIMENSION AND PROFILE SHOWN WITHIN THE APPROVED PLAN.
6. WHERE SPECIFIED, THE CHECK DAMS SHALL BE CONSTRUCTED ON A SHEET OF GEOTEXTILE FABRIC USED AS A DOWNSTREAM SPLASH PAD.
7. EACH CHECK DAM SHALL BE EXTENDED UP THE CHANNEL BANK (WHERE PRACTICABLE) TO AN ELEVATION AT LEAST 150mm ABOVE THE CREST LEVEL OF THE DAM.

CONSTRUCTION

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
0	01.05.20	ISSUED FOR CONSTRUCTION	RR	MWE			

Used on / Next higher assembly:

Filename: B18028-DRG-C-5020 - C-5023.dwg

Alternate DMS number:

Designing Company: BG&E Brisbane Office — BG&E DOC No: B18028

Designed: R.Robertson 22.04.2020

Checked: M.Worthington-Eyre 22.04.2020

Ind.Rev. Company | Ind.Rev. Name | Ind.Review Signature

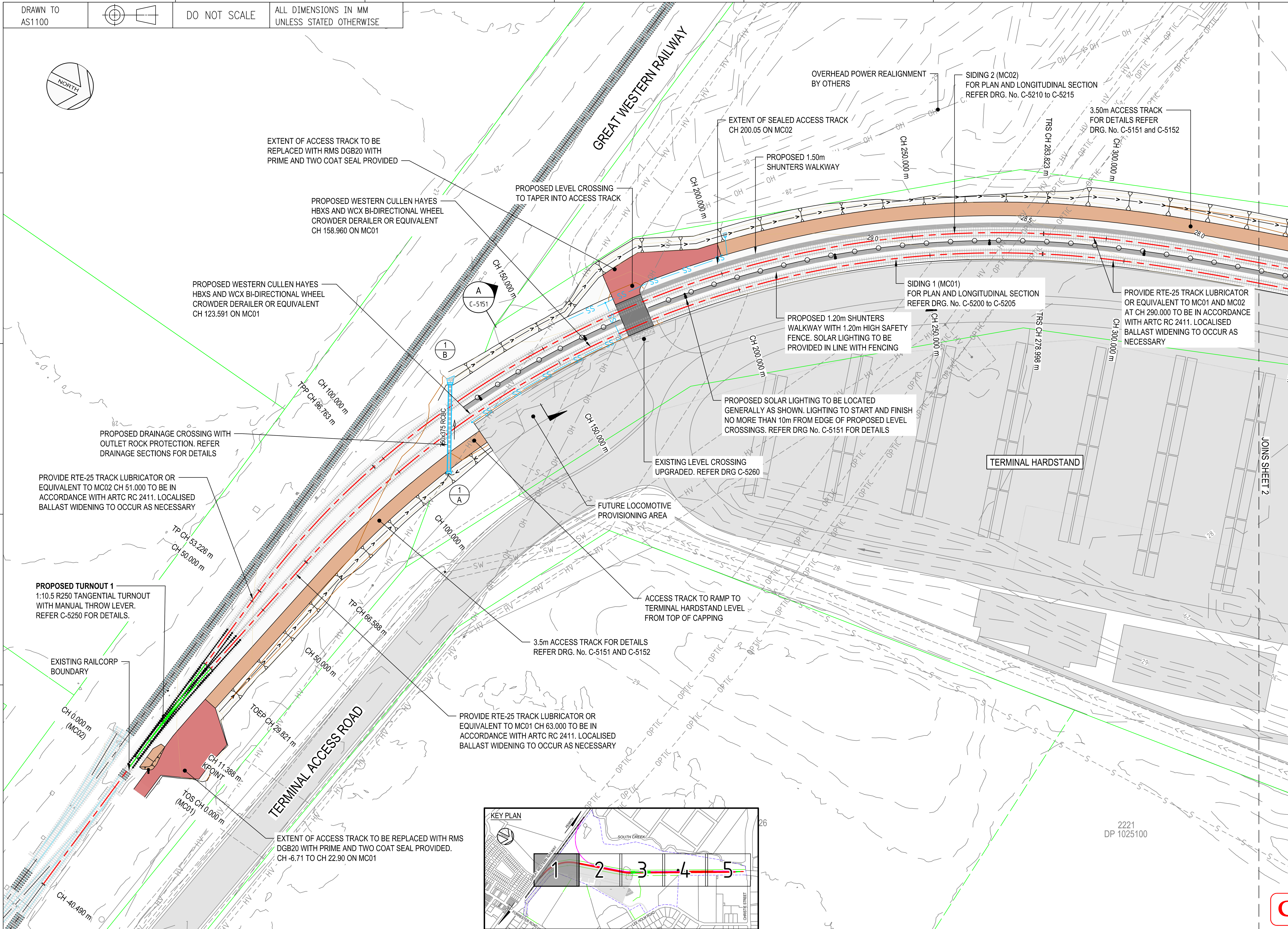
Approved By | Accepted By | Signed: | Signed: | Approval Date | Acceptance Date

pacific national

Drawing No. C-5023 — Rev 0 — Sheet No. 1 of 1 — Scale: AS SHOWN — SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
EROSION AND SEDIMENT CONTROL DETAILS

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



NORTH
GREAT WESTERN RAILWAY
TERMINAL ACCESS ROAD
TERMINAL HARDSTAND
JOINS SHEET 2
EXTENT OF ACCESS TRACK TO BE REPLACED WITH RMS DGB20 WITH PRIME AND TWO COAT SEAL PROVIDED
PROPOSED WESTERN CULLEN HAYES HBXS AND WCX BI-DIRECTIONAL WHEEL CROWDER DERAILER OR EQUIVALENT CH 158.960 ON MC01
PROPOSED WESTERN CULLEN HAYES HBXS AND WCX BI-DIRECTIONAL WHEEL CROWDER DERAILER OR EQUIVALENT CH 123.591 ON MC01
PROPOSED LEVEL CROSSING TO TAPER INTO ACCESS TRACK
EXTENT OF SEALED ACCESS TRACK CH 200.05 ON MC02
PROPOSED 1.50m SHUNTERS WALKWAY
OVERHEAD POWER REALIGNMENT BY OTHERS
SIDING 2 (MC02) FOR PLAN AND LONGITUDINAL SECTION REFER DRG. No. C-5210 to C-5215
3.50m ACCESS TRACK FOR DETAILS REFER DRG. No. C-5151 and C-5152
SIDING 1 (MC01) FOR PLAN AND LONGITUDINAL SECTION REFER DRG. No. C-5200 to C-5205
PROPOSED 1.20m SHUNTERS WALKWAY WITH 1.20m HIGH SAFETY FENCE. SOLAR LIGHTING TO BE PROVIDED IN LINE WITH FENCING
PROVIDE RTE-25 TRACK LUBRICATOR OR EQUIVALENT TO MC01 AND MC02 AT CH 290.000 TO BE IN ACCORDANCE WITH ARTC RC 2411. LOCALISED BALLAST WIDENING TO OCCUR AS NECESSARY
PROPOSED SOLAR LIGHTING TO BE LOCATED GENERALLY AS SHOWN. LIGHTING TO START AND FINISH NO MORE THAN 10m FROM EDGE OF PROPOSED LEVEL CROSSINGS. REFER DRG No. C-5151 FOR DETAILS
PROPOSED DRAINAGE CROSSING WITH OUTLET ROCK PROTECTION. REFER DRAINAGE SECTIONS FOR DETAILS
EXISTING LEVEL CROSSING UPGRADED. REFER DRG C-5260
PROVIDE RTE-25 TRACK LUBRICATOR OR EQUIVALENT TO MC02 CH 51.000 TO BE IN ACCORDANCE WITH ARTC RC 2411. LOCALISED BALLAST WIDENING TO OCCUR AS NECESSARY
FUTURE LOCOMOTIVE PROVISIONING AREA
PROPOSED TURNOUT 1
1:10.5 R250 TANGENTIAL TURNOUT WITH MANUAL THROW LEVER. REFER C-5250 FOR DETAILS.
ACCESS TRACK TO RAMP TO TERMINAL HARDSTAND LEVEL FROM TOP OF CAPPING
3.5m ACCESS TRACK FOR DETAILS REFER DRG. No. C-5151 AND C-5152
EXISTING RAILCORP BOUNDARY
PROVIDE RTE-25 TRACK LUBRICATOR OR EQUIVALENT TO MC01 CH 63.000 TO BE IN ACCORDANCE WITH ARTC RC 2411. LOCALISED BALLAST WIDENING TO OCCUR AS NECESSARY
EXTENT OF ACCESS TRACK TO BE REPLACED WITH RMS DGB20 WITH PRIME AND TWO COAT SEAL PROVIDED. CH -6.71 TO CH 22.90 ON MC01
CH 0.000 m (MC02)
CH -40.490 m
TOS CH 0.000 m (MC01)
CH 11.388 m RPOINT
TOEP CH 29.821 m
CH 50.000 m
TP CH 66.588 m
CH 100.000 m
TP CH 53.226 m
TPP CH 96.763 m
CH 150.000 m
CH 200.000 m
CH 250.000 m
TRS CH 283.823 m
CH 300.000 m
TRS CH 278.998 m
2221
DP 1025100
KEY PLAN
1 2 3 4 5

NOTES

1. REFER TO DRG No. C-5001 FOR DRAWING LIST.
2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
4. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

LEGEND

- SITE BOUNDARY
- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED EARTHWORKS BUND

PAVEMENTS

- SHUNTERS WALKWAY
- ACCESS TRACK
- SEALED ACCESS TRACK
- LEVEL CROSSING

SERVICES

- HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
- OH — EXISTING OVERHEAD POWER
- OPTIC — EXISTING FIBRE OPTIC
- W — EXISTING WATER
- S — EXISTING SEWER
- SW — EXISTING STORMWATER

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

CONSTRUCTION

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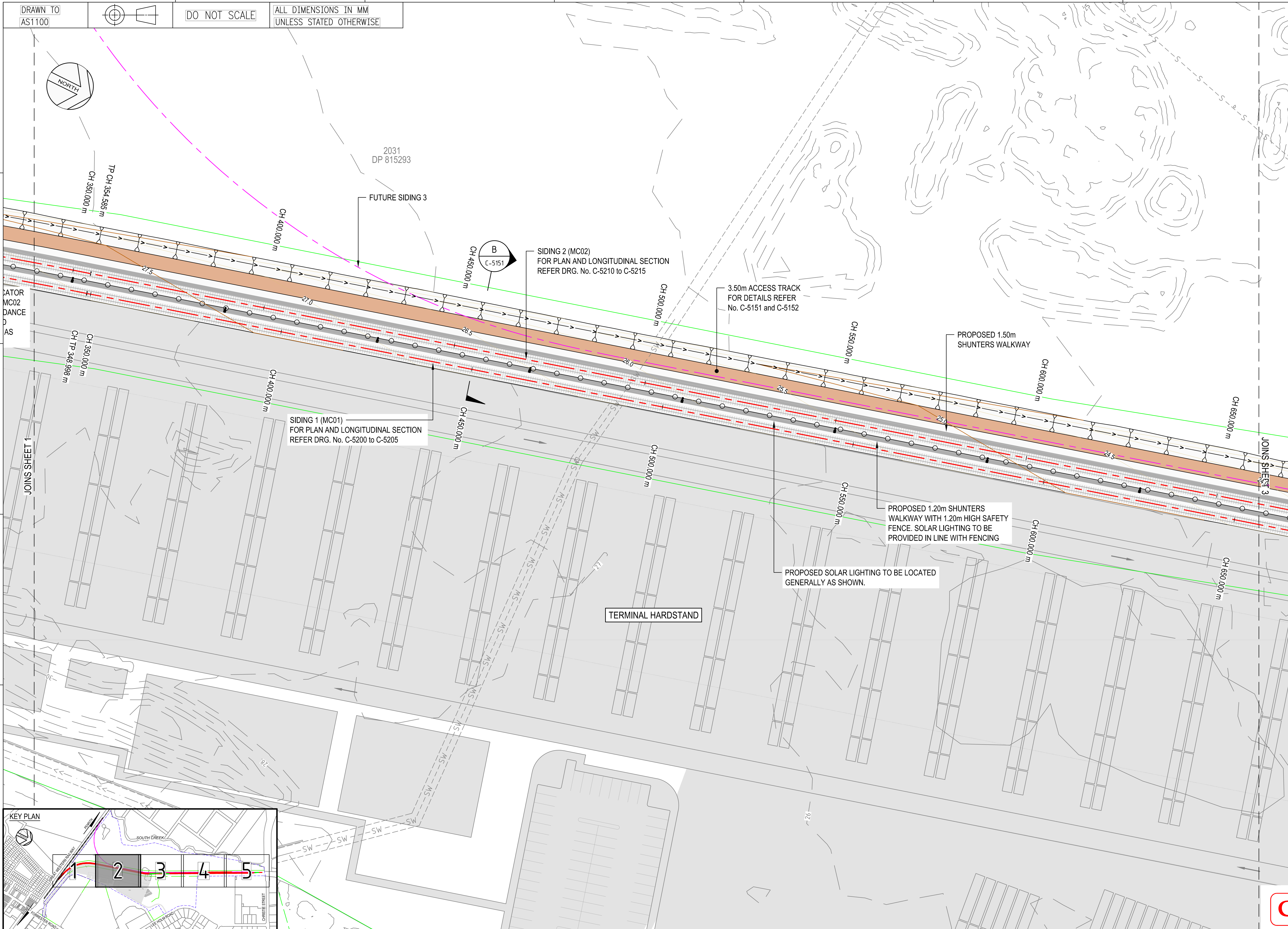
Ind.Review Signature

pacific national
Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E
C-5100
Sheet No. 1 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
GENERAL ARRANGEMENT
PLAN - SHEET 1

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



NOTES

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2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
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LEGEND

- SITE BOUNDARY
- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED EARTHWORKS BUND

PAVEMENTS

- SHUNTERS WALKWAY
- ACCESS TRACK
- SEALED ACCESS TRACK
- LEVEL CROSSING

SERVICES

- — HV — HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
- — OH — OH — EXISTING OVERHEAD POWER
- — OPTIC — EXISTING FIBRE OPTIC
- — W — W — EXISTING WATER
- — S — S — EXISTING SEWER
- — SW — SW — EXISTING STORMWATER

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

CONSTRUCTION

Used on / Next higher assembly:

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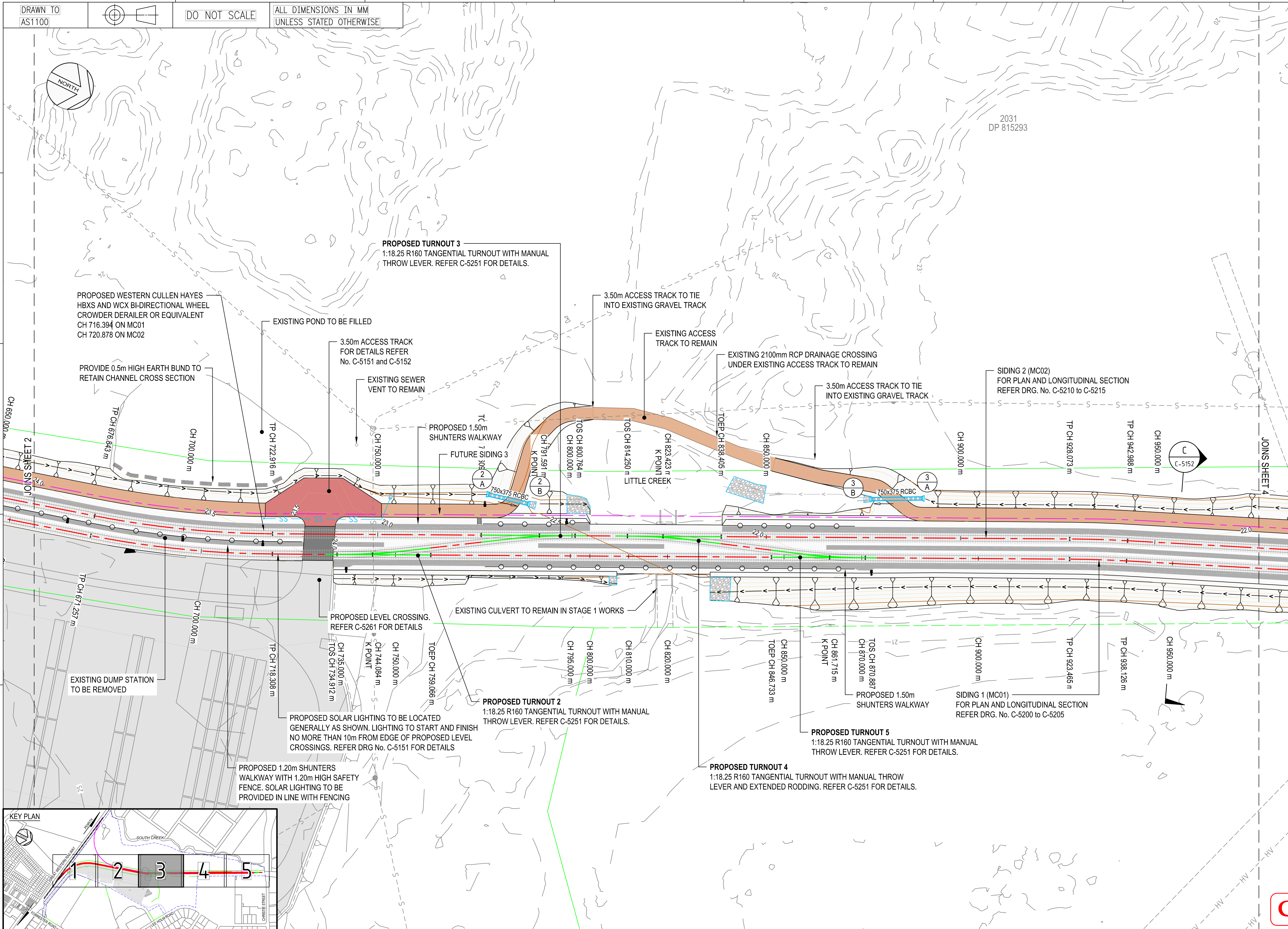
Ind.Review Signature

Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

C-5101 Rev 0
Sheet No. 2 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
GENERAL ARRANGEMENT
PLAN - SHEET 2

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



NORTH
PROPOSED TURNOUT 3
1:18.25 R160 TANGENTIAL TURNOUT WITH MANUAL THROW LEVER. REFER C-5251 FOR DETAILS.
PROPOSED WESTERN CULLEN HAYES HBXS AND WCX BI-DIRECTIONAL WHEEL CROWDER DERAILER OR EQUIVALENT CH 716.394 ON MC01 CH 720.878 ON MC02
EXISTING POND TO BE FILLED
3.50m ACCESS TRACK FOR DETAILS REFER No. C-5151 and C-5152
PROVIDE 0.5m HIGH EARTH BUND TO RETAIN CHANNEL CROSS SECTION
EXISTING SEWER VENT TO REMAIN
3.50m ACCESS TRACK TO TIE INTO EXISTING GRAVEL TRACK
EXISTING ACCESS TRACK TO REMAIN
EXISTING 2100mm RCP DRAINAGE CROSSING UNDER EXISTING ACCESS TRACK TO REMAIN
3.50m ACCESS TRACK TO TIE INTO EXISTING GRAVEL TRACK
SIDING 2 (MC02) FOR PLAN AND LONGITUDINAL SECTION REFER DRG. No. C-5210 to C-5215
2031 DP 815293
PROPOSED 1.50m SHUNTERS WALKWAY
FUTURE SIDING 3
750x375 RCBC
LITTLE CREEK
JOINS SHEET 2
JOINS SHEET 4
CH 650.000 m
TP CH 676.843 m
CH 700.000 m
TP CH 722.916 m
CH 750.000 m
CH 791.591 m K POINT
TOS CH 800.764 m
CH 800.000 m
TOS CH 814.250 m
CH 823.423 m K POINT
TOEP CH 838.405 m
CH 850.000 m
CH 900.000 m
TP CH 928.073 m
TP CH 942.988 m
CH 950.000 m
C-5152
PROPOSED LEVEL CROSSING. REFER C-5261 FOR DETAILS
EXISTING CULVERT TO REMAIN IN STAGE 1 WORKS
TP CH 671.257 m
CH 700.000 m
TP CH 718.308 m
TOS CH 734.912 m
CH 735.000 m
CH 744.084 m K POINT
CH 750.000 m
TOEP CH 759.066 m
CH 795.000 m
CH 800.000 m
CH 810.000 m
CH 820.000 m
TOEP CH 846.733 m
CH 850.000 m
CH 861.715 m K POINT
CH 870.000 m
TOS CH 870.887 m
CH 900.000 m
TP CH 923.465 m
TP CH 938.126 m
CH 950.000 m
EXISTING DUMP STATION TO BE REMOVED
PROPOSED SOLAR LIGHTING TO BE LOCATED GENERALLY AS SHOWN. LIGHTING TO START AND FINISH NO MORE THAN 10m FROM EDGE OF PROPOSED LEVEL CROSSINGS. REFER DRG No. C-5151 FOR DETAILS
PROPOSED TURNOUT 2
1:18.25 R160 TANGENTIAL TURNOUT WITH MANUAL THROW LEVER. REFER C-5251 FOR DETAILS.
PROPOSED 1.50m SHUNTERS WALKWAY
SIDING 1 (MC01) FOR PLAN AND LONGITUDINAL SECTION REFER DRG. No. C-5200 to C-5205
PROPOSED TURNOUT 5
1:18.25 R160 TANGENTIAL TURNOUT WITH MANUAL THROW LEVER. REFER C-5251 FOR DETAILS.
PROPOSED TURNOUT 4
1:18.25 R160 TANGENTIAL TURNOUT WITH MANUAL THROW LEVER AND EXTENDED RODDING. REFER C-5251 FOR DETAILS.
PROPOSED 1.20m SHUNTERS WALKWAY WITH 1.20m HIGH SAFETY FENCE. SOLAR LIGHTING TO BE PROVIDED IN LINE WITH FENCING
KEY PLAN
SOUTH CREEK
1 2 3 4 5

NOTES

1. REFER TO DRG No. C-5001 FOR DRAWING LIST.
2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
4. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

LEGEND

- SITE BOUNDARY
- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED EARTHWORKS BUND

PAVEMENTS

- SHUNTERS WALKWAY
- ACCESS TRACK
- SEALED ACCESS TRACK
- LEVEL CROSSING

SERVICES

- HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
- OH — EXISTING OVERHEAD POWER
- OPTIC — EXISTING FIBRE OPTIC
- W — EXISTING WATER
- S — EXISTING SEWER
- SW — EXISTING STORMWATER

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

CONSTRUCTION

Used on / Next higher assembly:

Filename: B18028-DRG-C-5100 - C-5104.dwg

Alternate DMS number:

Rev	Date	Revision Description	Designed	Checked	Ind. Rev.	Approved	Accepted
0	01.05.20	ISSUED FOR CONSTRUCTION	RR	MWE			
A	22.04.20	ISSUED FOR 80%	RR	MWE			

Designing Company: Brisbane Office
BG&E DOC No: B18028
Designed R.Robertson 22.04.2020
Checked M.Worthington-Eyre 22.04.2020
Ind.Rev. Company | Ind.Rev. Name
Ind.Review Signature

pacific national
Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

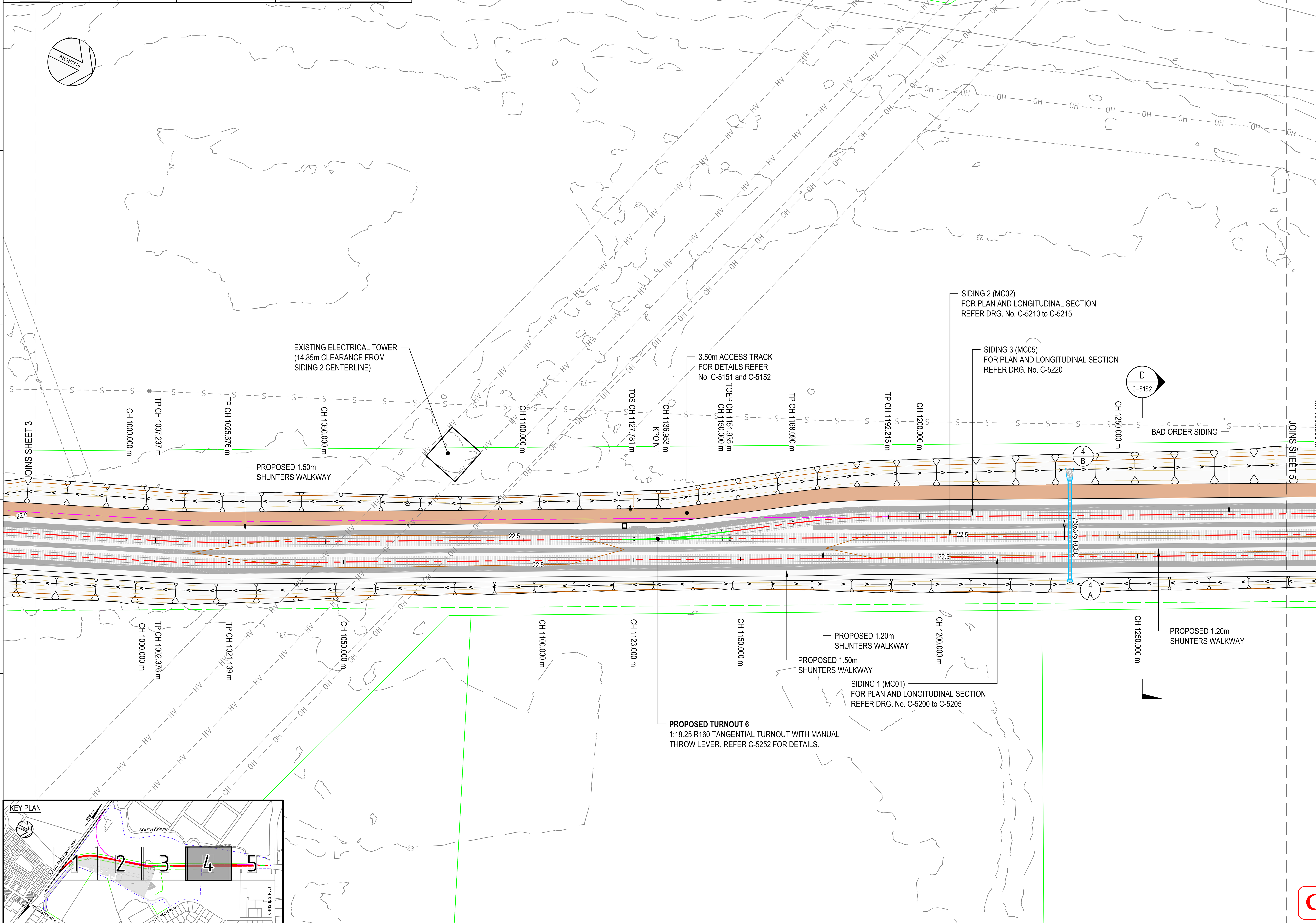
A | 0

C-5102

Sheet No. 3 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
GENERAL ARRANGEMENT
PLAN - SHEET 3

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



NOTES

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2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
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LEGEND

- SITE BOUNDARY
- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED EARTHWORKS BUND

PAVEMENTS

- SHUNTERS WALKWAY
- ACCESS TRACK
- SEALED ACCESS TRACK
- LEVEL CROSSING

SERVICES

- HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
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0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

CONSTRUCTION

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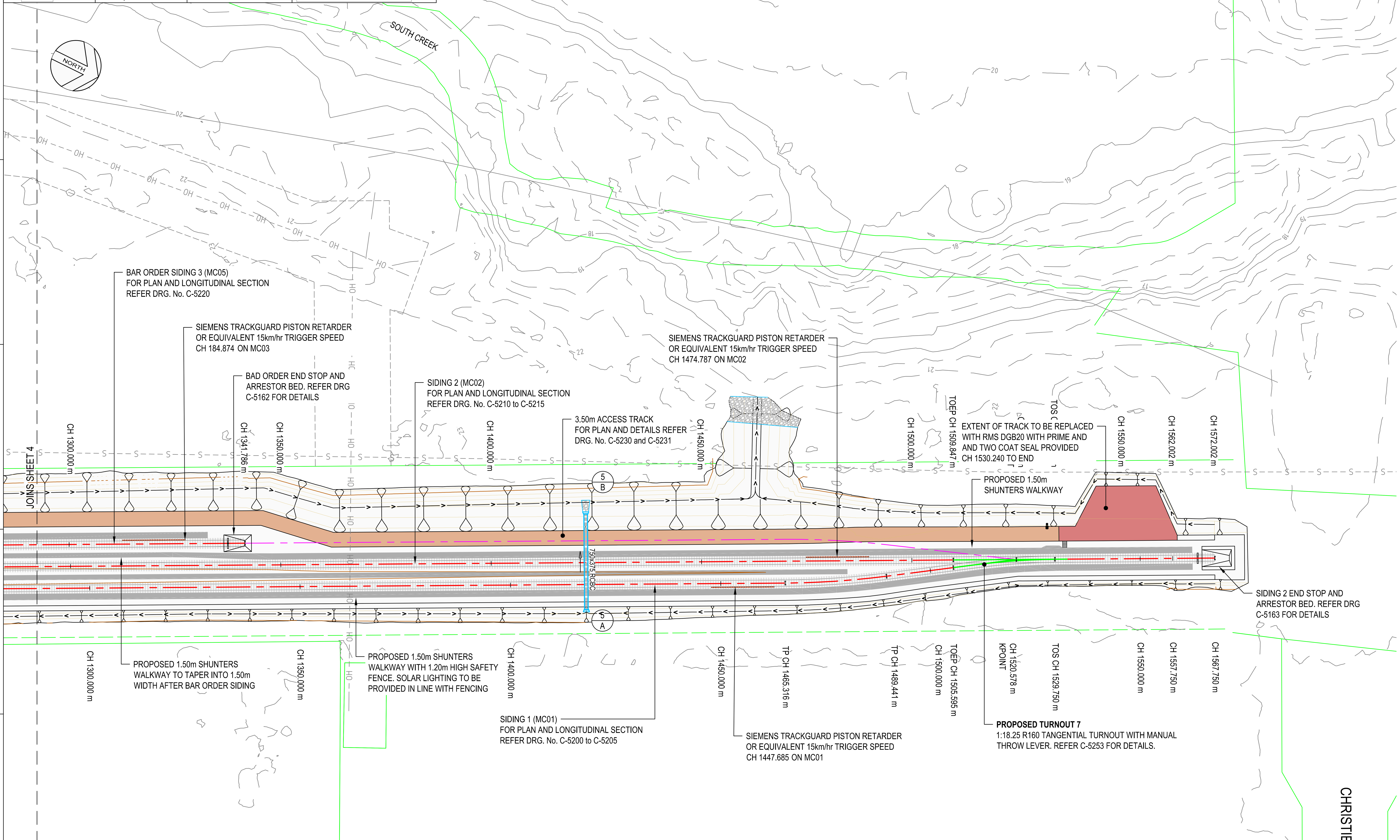
Ind.Rev. Company | Ind.Rev. Name
Ind.Review Signature

pacific national
Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E
A 0
C-5103
Sheet No. 4 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
GENERAL ARRANGEMENT
PLAN - SHEET 4

DRAWN TO AS1100 | DO NOT SCALE | ALL DIMENSIONS IN MM UNLESS STATED OTHERWISE



NOTES

1. REFER TO DRG No. C-5001 FOR DRAWING LIST.
2. REFER TO DRG. No. C-5150 FOR TRACK STRUCTURE DETAILS.
3. REFER TO DRG. No. C-5151 - C-5152 FOR TYPICAL SECTIONS.
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LEGEND

- SITE BOUNDARY
- PROPOSED TRACK
- EXISTING MAINLINE TRACK
- FUTURE TRACK
- PROPOSED TURNOUT
- PROPOSED 1.2m HIGH SAFETY FENCE
- EXISTING PROPERTY BOUNDARY
- PROPOSED DRAINAGE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED EARTHWORKS BUND

PAVEMENTS

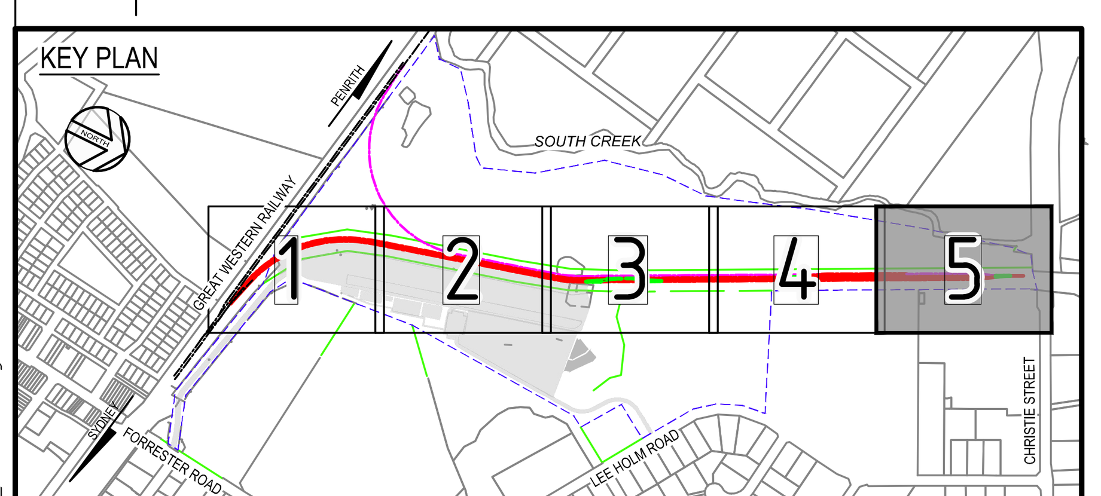
- SHUNTERS WALKWAY
- ACCESS TRACK
- SEALED ACCESS TRACK
- LEVEL CROSSING

SERVICES

- HV — EXISTING OVERHEAD HIGH VOLTAGE POWER
- OH — EXISTING OVERHEAD POWER
- OPTIC — EXISTING FIBRE OPTIC
- W — EXISTING WATER
- S — EXISTING SEWER
- SW — EXISTING STORMWATER

0 5 10 20 30
Full Size 1:500 ; Half Reduction 1:1000
SCALE (m)

KEY PLAN



CONSTRUCTION

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pacific national
Approved By | Accepted By
Signed: | Signed:
Approval Date | Acceptance Date

BG&E

A0 C-5104
Sheet No. 5 of 5
Scale: 1:500
SHEET SIZE A1

ST MARYS FREIGHT HUB - RAIL WORKS
GENERAL ARRANGEMENT
PLAN - SHEET 5

APPENDIX B PESCP – INITIAL EARTHWORKS

CONSTRUCTION NOTES:

1. THIS PROGRESSIVE EROSION AND SEDIMENT CONTROL PLAN (PESCP) APPLIES TO BULK EARTHWORK ACTIVITIES.
2. RESPONSIBILITIES AND TIMING OF EROSION AND SEDIMENT CONTROL MANAGEMENT ARE AS PER THE PROJECT CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP).
3. THIS PESCP IS TO BE READ IN CONJUNCTION WITH THE CEMP, PRIMARY EROSION & SEDIMENT CONTROL PLAN (ESCP) AND ASSOCIATED ENVIRONMENTAL DOCUMENTATION.
4. CONSTRUCTION PERSONNEL TO BE ADEQUATELY TRAINED (TOOLBOX/INDUCTION) IN EROSION AND SEDIMENT CONTROL.
5. EROSION AND SEDIMENT CONTROLS TO BE IMPLEMENTED AS PER SITE LAYOUT PLANS AND TYPICAL DESIGNS SPECIFIED WITHIN THIS ESCP (AND ASSOCIATED PLANS). THE PROVIDED DRAWINGS ARE INDICATIVE OF APPROPRIATE CONTROLS AND PRACTICES TO BE IMPLEMENTED ONSITE. EXACT LOCATION AND TYPE ARE TO BE DETERMINED ON SITE.
6. WEATHER CONDITIONS ARE TO BE MONITORED DURING THE PROPOSED PERIOD OF CONSTRUCTION ACTIVITIES. MAJOR CONSTRUCTION ACTIVITIES ARE TO BE SCHEDULED TO AVOID SIGNIFICANT RAIN EVENTS AS FAR AS PRACTICABLE.
7. CLEARING ZONES AND NO-GO AREAS TO BE CLEARLY DELINEATED PRIOR TO COMMENCEMENT OF ACTIVITIES.
8. GROUNDCOVER DISTURBANCE TO BE TO THE MINIMUM EXTENT NECESSARY FOR SITE ACCESS AND ASSOCIATED CONSTRUCTION.
9. NO CLEANING OF TOOLS OR EQUIPMENT IS TO OCCUR WITHIN 50 M OF ANY WATERCOURSE.
10. ‘CLEAN WATER’ FLOW IS TO BE MAINTAINED THROUGH THE SITE WITH SEPARATION BETWEEN CONSTRUCTION OR ‘DIRTY’ WATERS. CLEAN RUNOFF WATER FROM AREAS SURROUNDING THE PROJECT AREA ARE TO BE DIVERTED AROUND WORK AREAS WHEREVER POSSIBLE.
11. ‘DIRTY WATER’ FLOW TO SEDIMENT BASINS/TRAPS IS TO BE MAXIMISED THROUGH THE USE OF DIVERSION BANKS, CHANNEL AND CUT-OFF DRAINS.
12. SEDIMENT BASINS ARE TO BE MANAGED IN ACCORDANCE WITH THE ESCP.
13. ‘DIRTY WATER’ THAT CANNOT BE DIRECTED TO SEDIMENT BASINS MUST HAVE LOCAL CONTROLS APPLIED (E.G. TYPE 2 & 3 CONTROLS).
14. DEWATERING IS TO BE EXECUTED IN ACCORDANCE WITH THE CEMP AND ESCP.
15. SITE ACCESS IS TO BE STABILISED TO REDUCE LIKELIHOOD OF SEDIMENT TRACKING.
16. THE DEPOSITION OF SEDIMENT ON PUBLIC ROADS (TRACKING) IS TO BE MONITORED AND CONTROLLED WITH DEPOSITED SEDIMENT REMOVED IMMEDIATELY OR AS SOON AS IT IS SAFE TO DO SO.
17. DUST TO BE MINIMISED WITH WATER CARTS, PROGRESSIVE REHABILITATION, APPLICATION OF SOIL BINDING POLYMERS, WHEEL WASHES AND LIMITING VEHICLE SPEEDS.
18. SPOIL MATERIAL EXCAVATED FROM SITE IS TO BE STOCKPILED IN ACCORDANCE WITH THE CEMP & ESCP.
19. CONTROLS ARE TO BE INSPECTED AT LEAST WEEKLY AND AFTER RUNOFF PRODUCING RAINFALL EVENTS (> 10 MM IN 24 HR PERIOD) WITH MAINTAINANCE IMPLEMENTED WHEN REQUIRED.
20. ADDITIONAL CONTROLS ARE TO BE INSTALLED WHERE PERFORMANCE OF EXISTING CONTROLS ARE INADEQUATE.
21. IF CONTROLS ARE DISTURBED OR REMOVED DUE TO SITE WORK, THEY MUST BE REINSTATED PRIOR TO RAINFALL EVENTS.
22. SEDIMENT CONTROL MEASURES ARE TO BE MAINTAINED SUCH THAT THEIR CAPACITY DOES NOT FALL BELOW 70%.
23. DISTURBED AREAS ARE TO BE PROGRESSIVELY STABILISED IN ACCORDANCE WITH PERMANENT DESIGN
24. TEMPORARY ESCS ARE TO REMAIN IN PLACE UNTIL SITE IS STABILISED (> 70 % COVER).
25. FOR EXTREME WEATHER PREPAREDNESS, OR FOR SITE SHUTDOWNS, REFER TO THE CEMP

LEGEND	
ESCP boundary	
Clean water flow	
Clean water culvert	
Site water flow	
Type 1 control (eg. sediment basin)	
Lined chute	
Creek crossing	
Stabilised earth berm	
Catch drain / diversion	
Type 2 control (eg. rock filter dam)	
Rumble grid exit point	
Check dam	
Type 3 control (eg. sediment fence)	

Revision	Date	Drawn	Description
2	29/06/20	TE	Issued to client
3	10/07/20	TE	Issued to client
4	01/12/20	TE	Updated for works
5	08/01/21	TE	Updated for modification approval

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL CPESC®

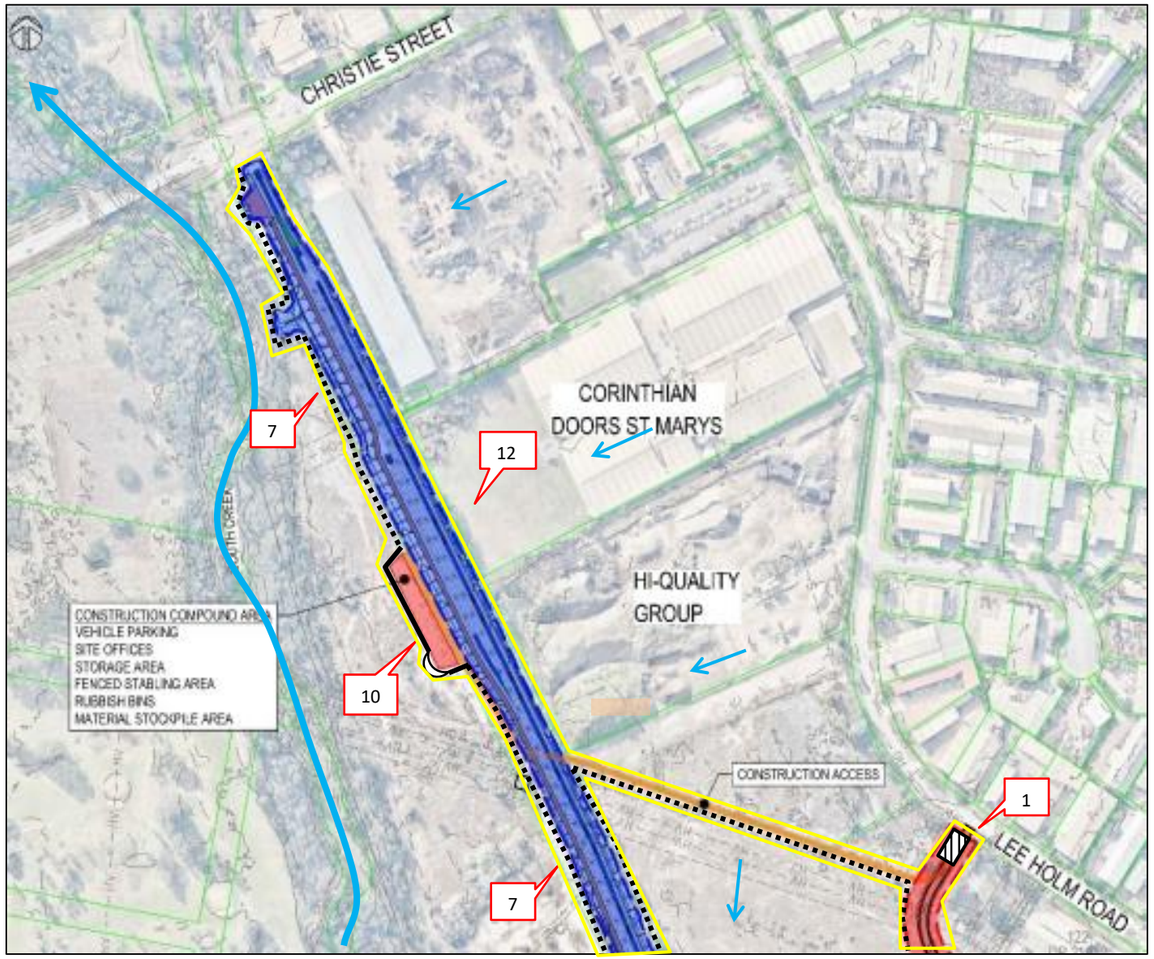
Tim Elder #4399

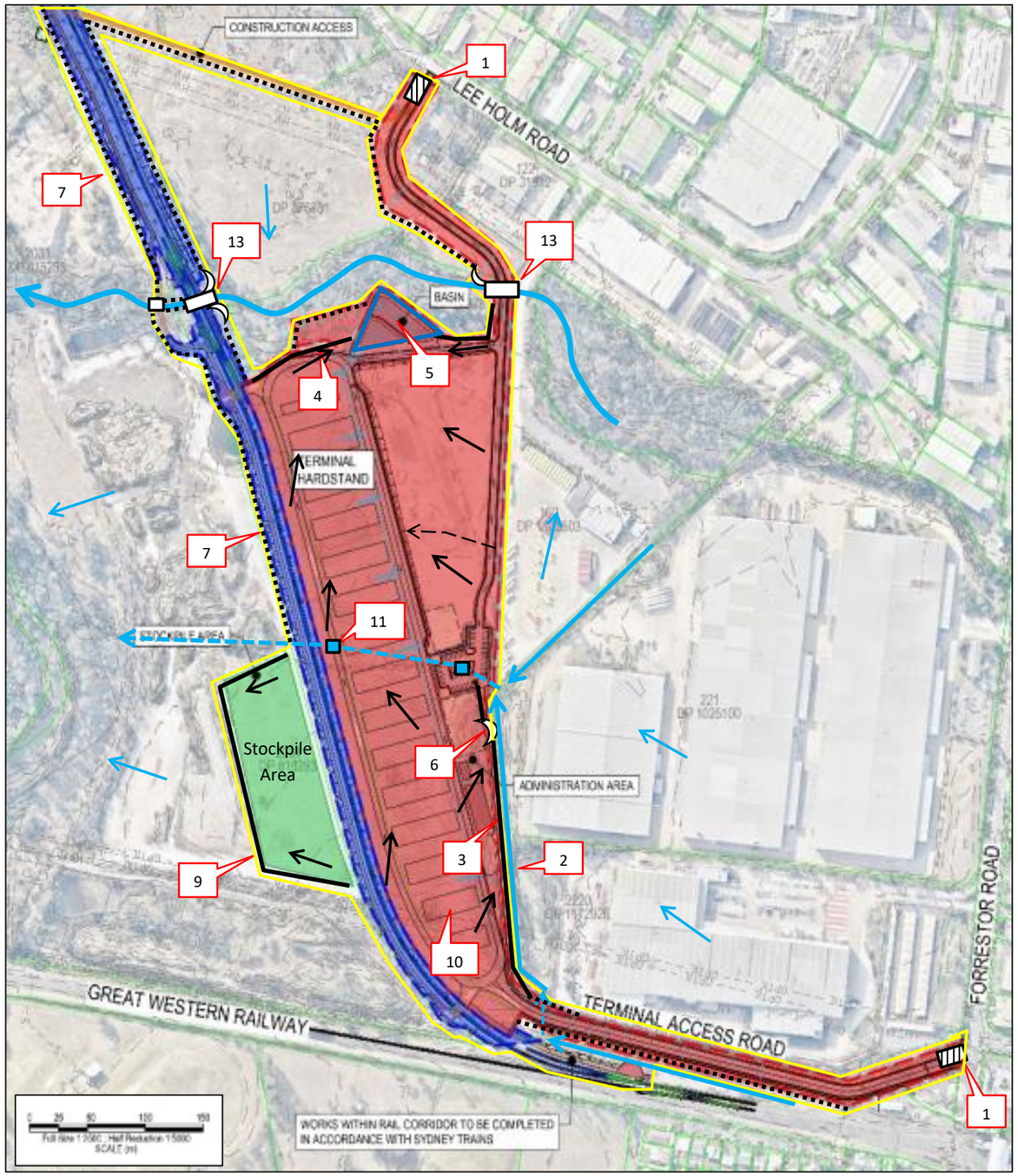
elder enviro

St Marys Intermodal Freight Hub

Progressive Erosion & Sediment Control Plan – Bulk Earthworks

NOT TO SCALE	EE20038 – PESCP001	REVISION: 5





Notes:

1. Stabilised access to be constructed at site entry/exits
2. Maintain existing grass swale drain for clean water
3. Perimeter berm to be constructed to divert clean water around site and direct all site runoff to sediment controls. Perimeter berm to be stabilised (eg. vegetation cover, soil binder or geotextile). Minimum 0.4 m height.
4. Catch drain / diversion berm(s) to be installed to direct site runoff to sediment basin.
5. Sediment basin to provide > 2,450 m3 of storage and include lined inlet chute(s), lined emergency spillway.
6. Type 2 sediment trap (e.g. rock filter dam, coir logs, straw bale filter) to be installed at discharge area along western perimeter of terminal hardstand.
7. Type 3 sediment control (e.g. sediment fence) to be installed along perimeter.
8. Check dams to be placed at approx. 50m intervals within flow paths (locations to be determined on-site).
9. Perimeter berm to be installed around stockpile area. Berm to be sized to enable 100% runoff containment within main stockpile area.
10. Perimeter berm to be installed around construction compound area. Surface runoff to be directed to Type 2 sediment control (e.g rock filter dam, coir logs).
11. Existing stormwater pits to be protected with lids to prevent contamination by site water.
12. On ground ESC measures to include provision for clean water bypass through railway easement (locations to be determined on-site).
13. Refer to App D Typical Designs for temporary watercourse crossing layout. Specific ESCPs to be developed for each location.

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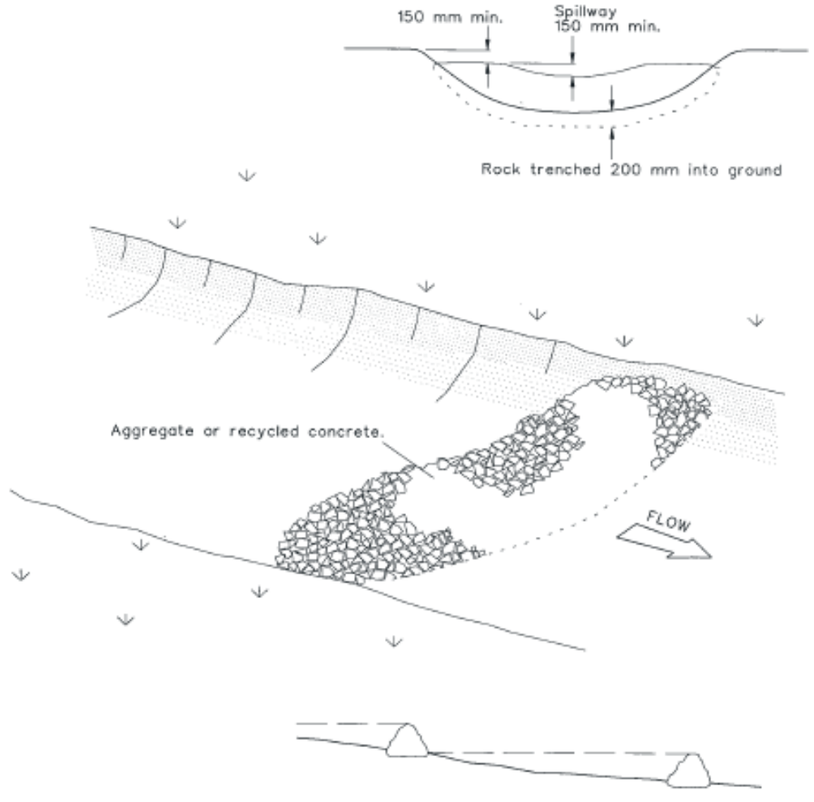
Progressive Erosion & Sediment Control Plan – Bulk Earthworks

NOT TO SCALE	EE20038 – PESCP001	REVISION: 5

APPENDIX C TYPICAL ESC DESIGNS

Drainage Control measures – check dams; earth bank

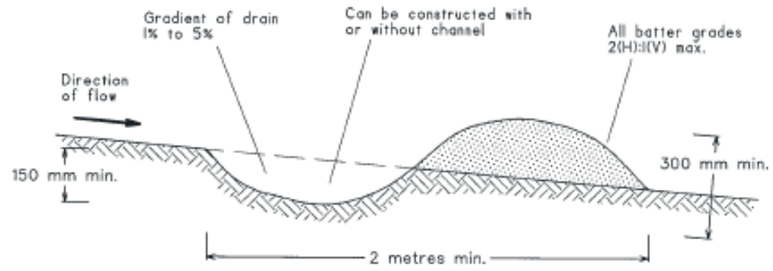


Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM **SD 5-4**

Figure 1. Rock check dam (Landcom 2004)



NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW) **SD 5-5**

Figure 2. Catch drain (Landcom 2004)

Revision	Date	Drawn	Description
2	23/06/20	TE	Issued
3	10/07/20	TE	Issued
4	01/12/20	TE	Updated for works
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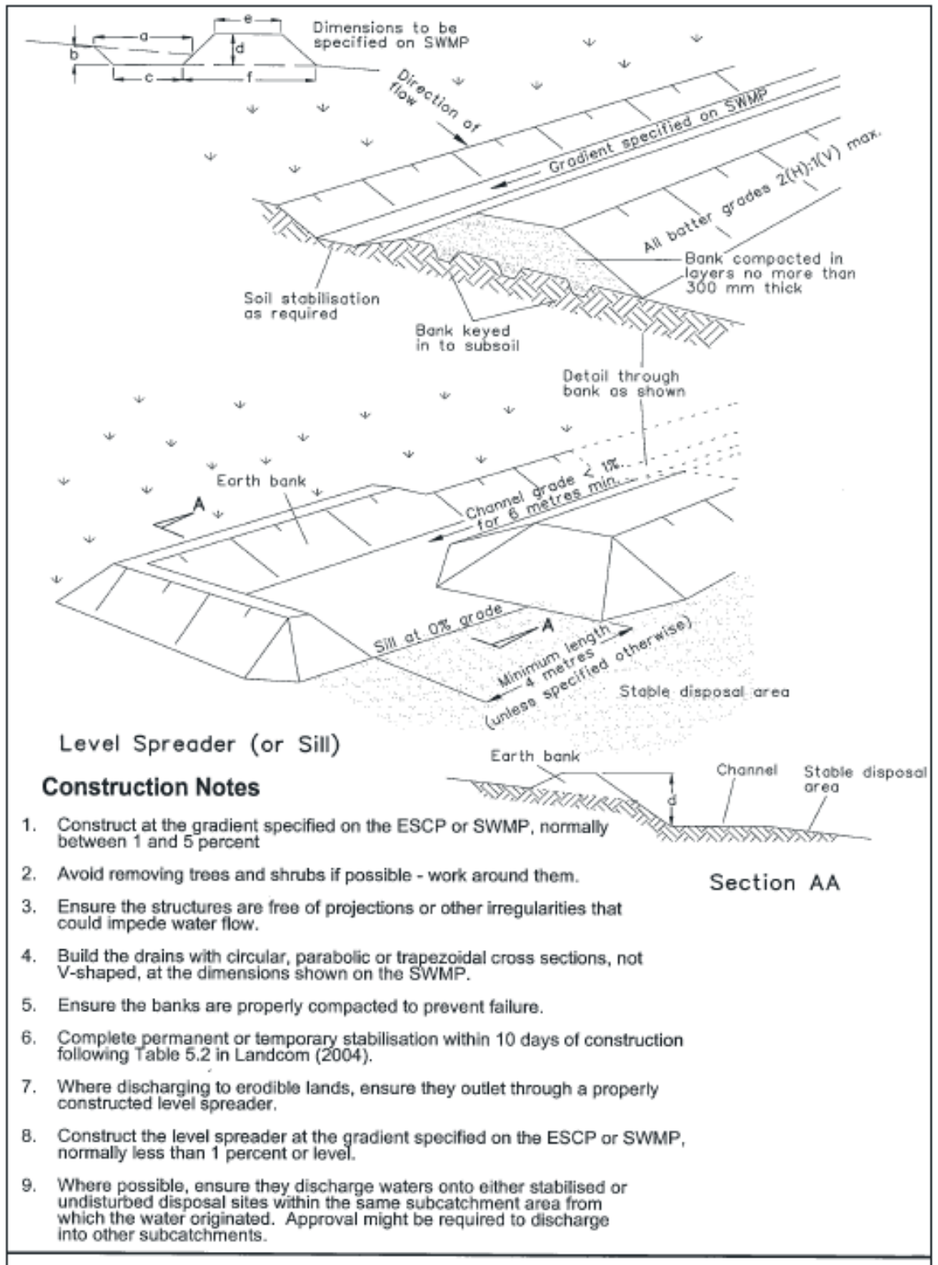
Tim Elder #4399

St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

NOT TO SCALE	EE20038 – ESCP	REVISION: 5

Drainage control measures – earth diversion banks; RECPs

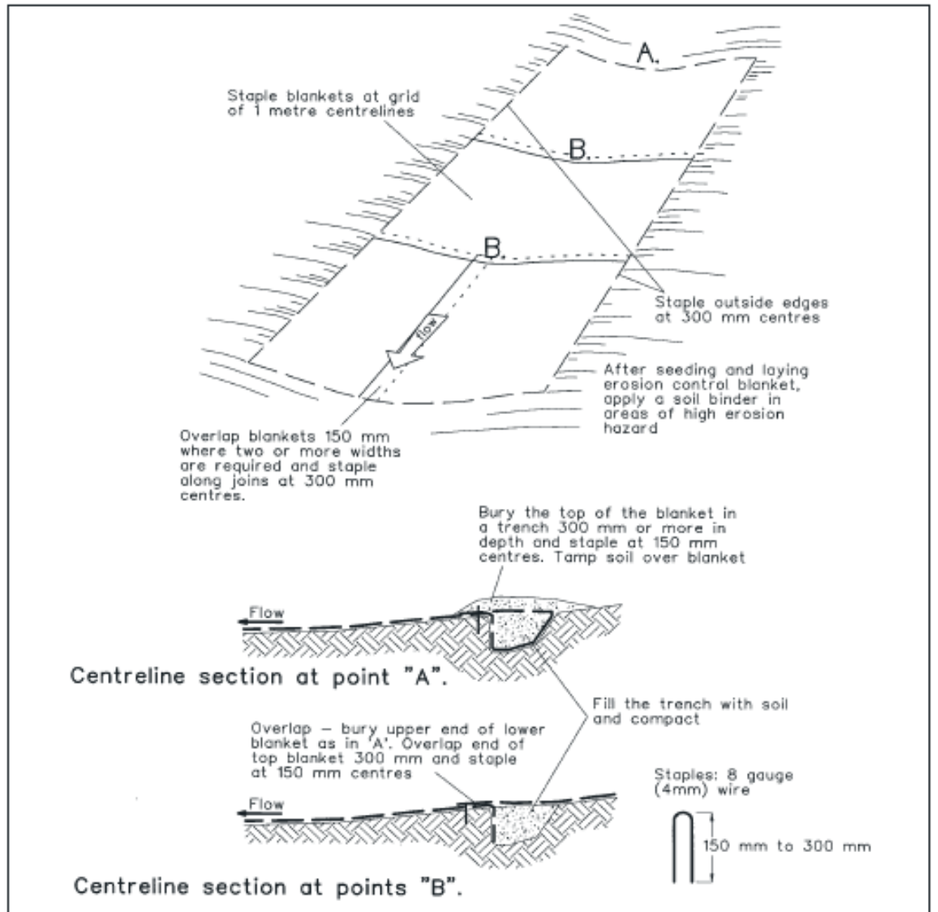


Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) **SD 5-6**

Figure 3. Diversion bank (Landcom 2004)



Construction Notes

1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

RECP : CONCENTRATED FLOW **SD 5-7**

Figure 4. Lined channel (Landcom 2004)

Revision	Date	Drawn	Description
2	23/06/20	TE	Issued
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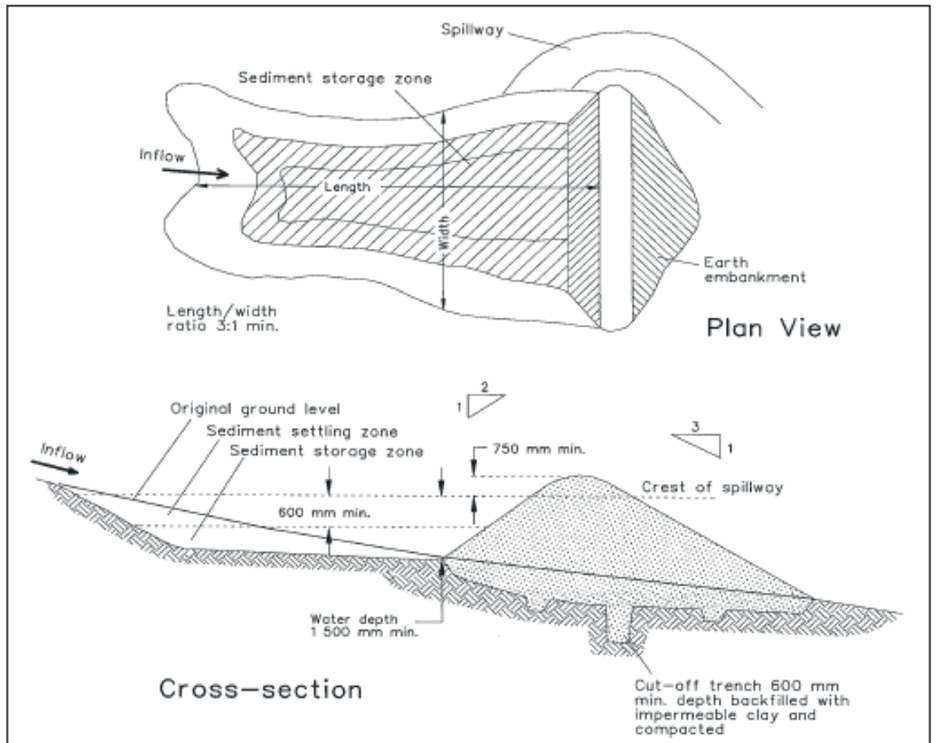
Tim Elder #4399

St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

NOT TO SCALE	EE20038 – ESCP	REVISION: 5

Sediment Control Measures - Sediment Basin (Type 1); Straw Bale Filter (Type 2/3)

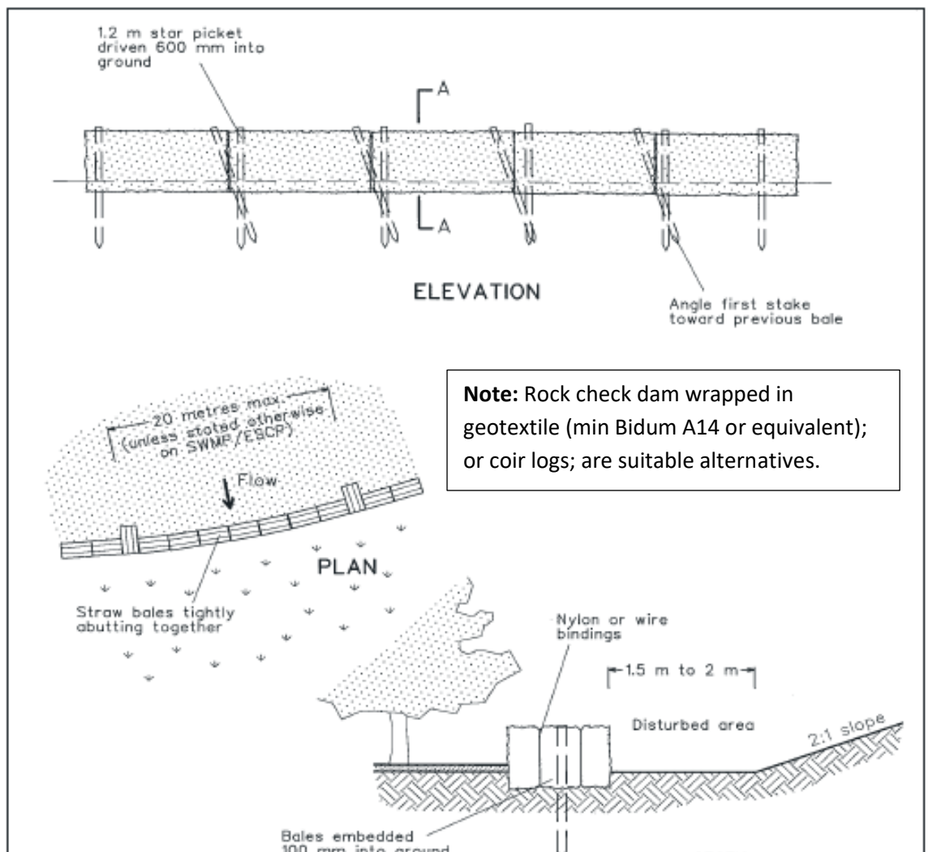


Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET
(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)
SD 6-4

Figure 5. Sediment Basin (Landcom 2004)



Note: Rock check dam wrapped in geotextile (min Bidum A14 or equivalent); or coir logs; are suitable alternatives.

Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

STRAW BALE FILTER **SD 6-7**

Figure 6. Straw Bale Filter (Landcom 2004)

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2	23/06/20	TE	Issued
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5	08/01/21	TE	Updated for modification approval

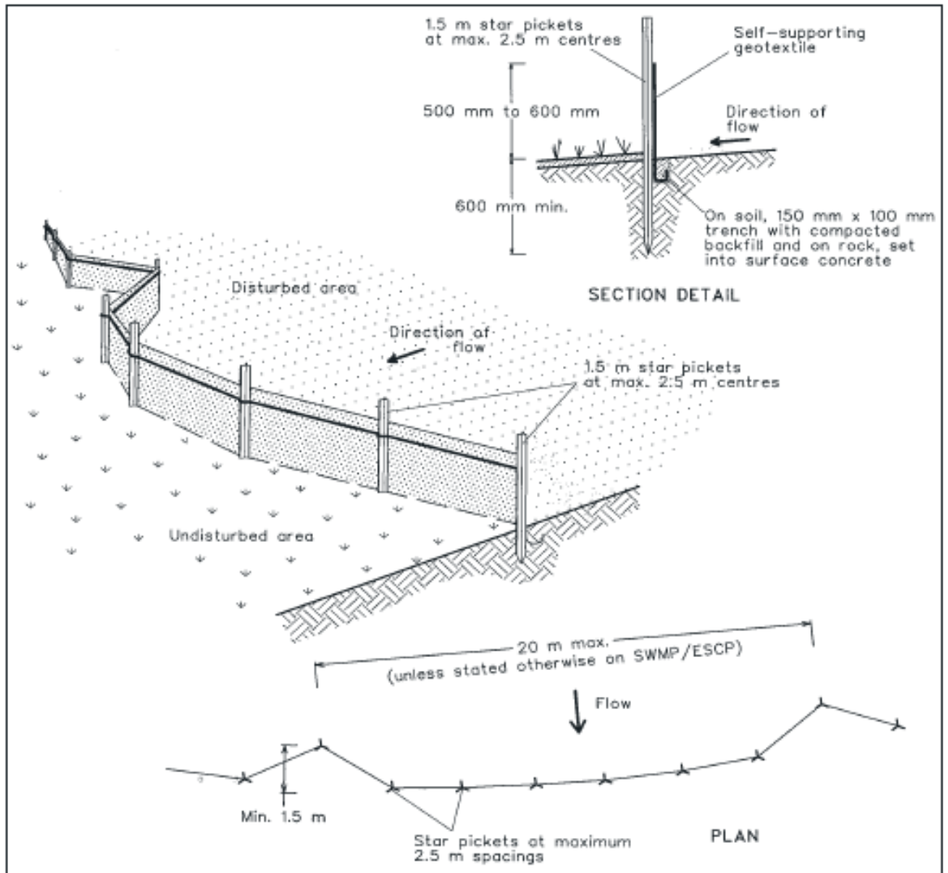
Tim Elder #4399

St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

NOT TO SCALE	EE20038 – ESCP	REVISION: 5

Sediment Control Measures - Sediment fence (Type 3); Stabilised exit

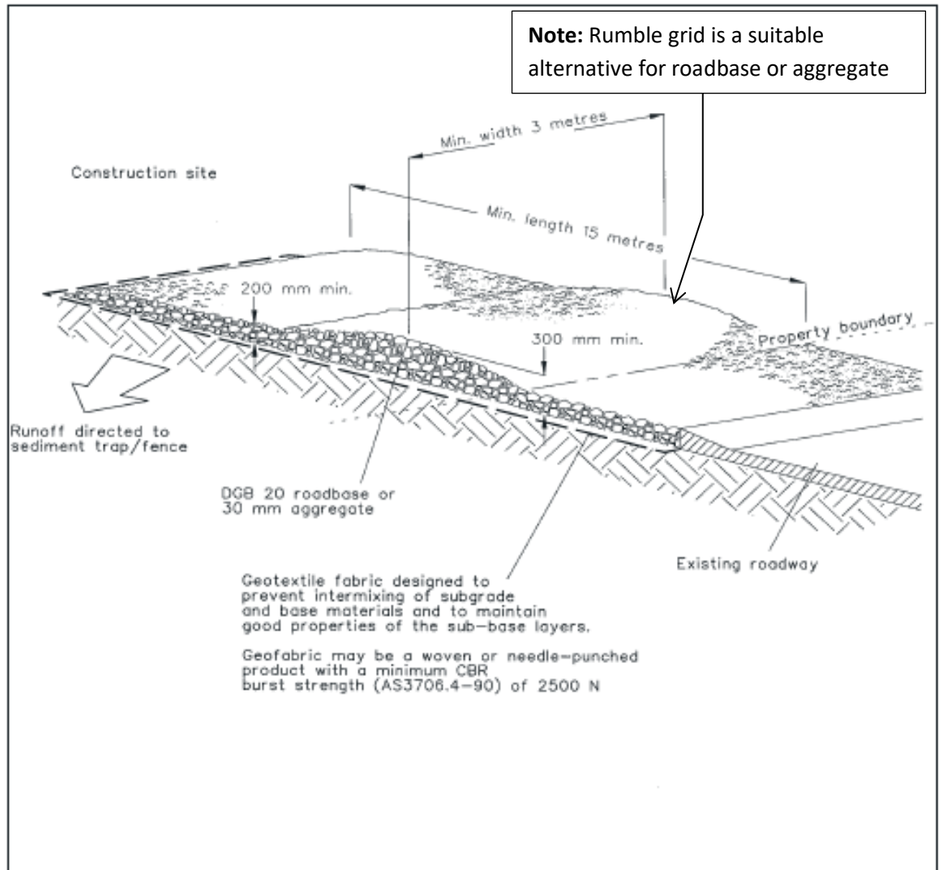


Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE **SD 6-8**

Figure 7. Sediment fence (Landcom 2004)



Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

STABILISED SITE ACCESS **SD 6-14**

Figure 8. Site access (Landcom 2004)

Revision	Date	Drawn	Description
2	23/06/20	TE	Issued
3	10/07/20	TE	Issued
4	01/12/20	TE	Updated for works
5	08/01/21	TE	Updated for modification approval

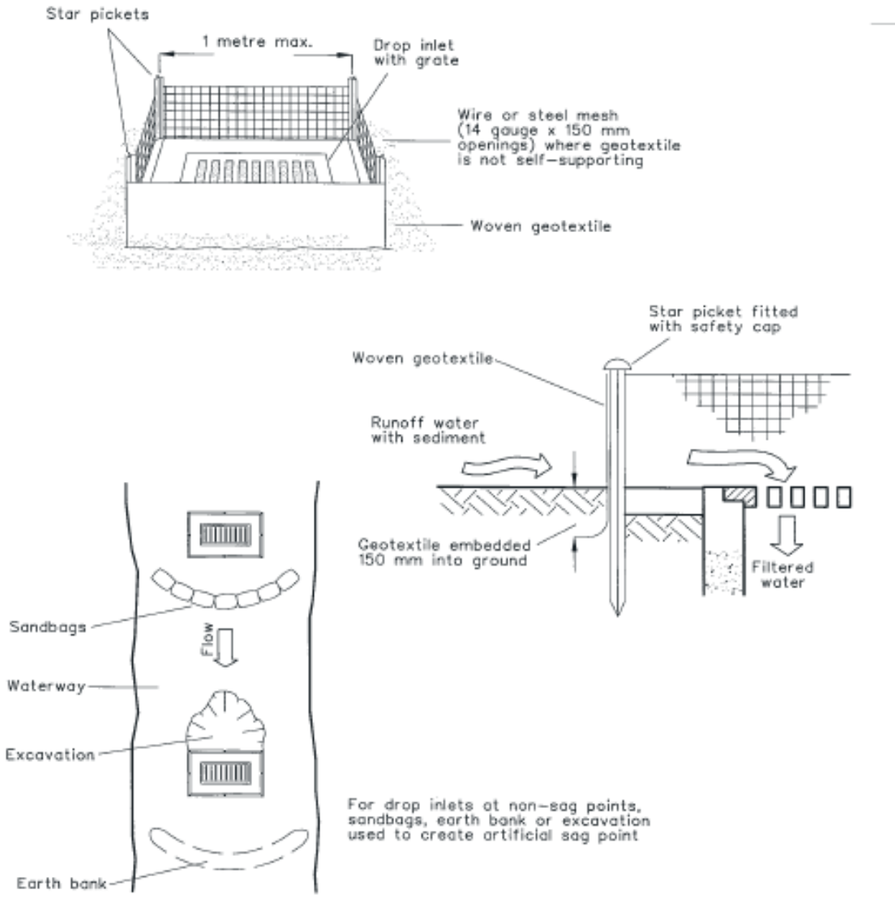
Tim Elder #4399

St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

NOT TO SCALE	EE20038 – ESCP	REVISION: 5

Sediment Control Measures – Inlet Filters

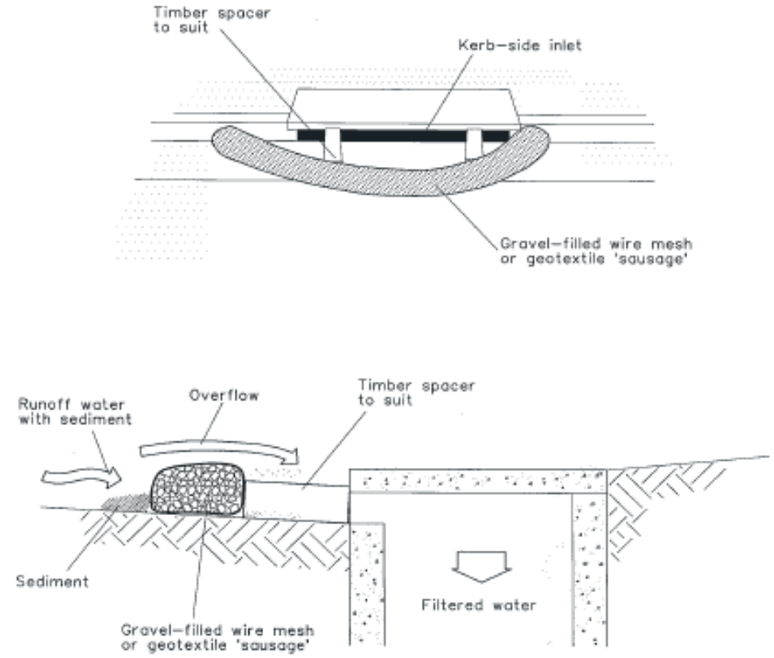


Construction Notes

1. Fabricate a sediment barrier made from geotextile or straw bales.
2. Follow Standard Drawing 6-7 and Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.
3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.
4. Do not cover the inlet with geotextile unless the design is adequate to allow for all waters to bypass it.

GEOTEXTILE INLET FILTER **SD 6-12**

Figure 9. Pit inlet filters (Landcom 2004)



NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

Construction Notes

1. Install filters to kerb inlets only at sag points.
2. Fabricate a sleeve made from geotextile or wire mesh longer than the length of the inlet pit and fill it with 25 mm to 50 mm gravel.
3. Form an elliptical cross-section about 150 mm high x 400 mm wide.
4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb inlet. Maintain the opening with spacer blocks.
5. Form a seal with the kerb to prevent sediment bypassing the filter.
6. Sandbags filled with gravel can substitute for the mesh or geotextile providing they are placed so that they firmly abut each other and sediment-laden waters cannot pass between.

MESH AND GRAVEL INLET FILTER **SD 6-11**

Figure 10. Kerb pit inlet filters (Landcom 2004)

Revision	Date	Drawn	Description
2	23/06/20	TE	Issued
3	10/07/20	TE	Issued
4	01/12/20	TE	Updated for works
5	08/01/21	TE	Updated for modification approval

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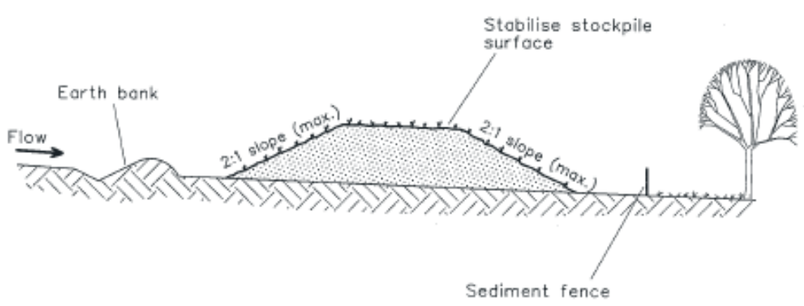
St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

NOT TO SCALE | EE20038 – ESCP | REVISION: 5

Stockpiles, seedbed preparation

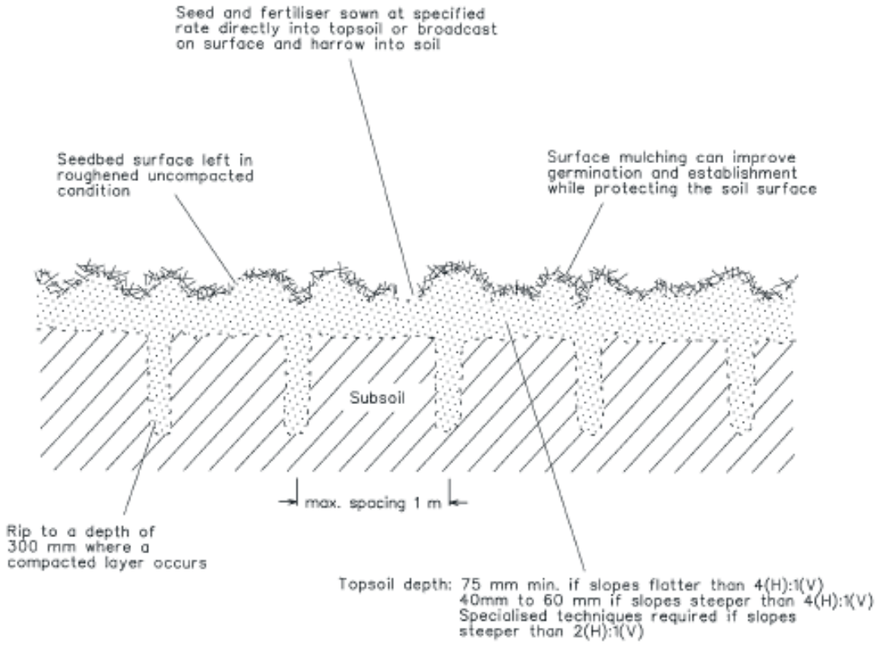


Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES **SD 4-1**

Figure 11. Stockpiles (Landcom 2004)



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION **SD 7-1**

Figure 12. Seedbed preparation (Landcom 2004)

Revision	Date	Drawn	Description
2	23/06/20	TE	Issued
3	10/07/20	TE	Issued
4	01/12/20	TE	Updated for works
5	08/01/21	TE	Updated for modification approval

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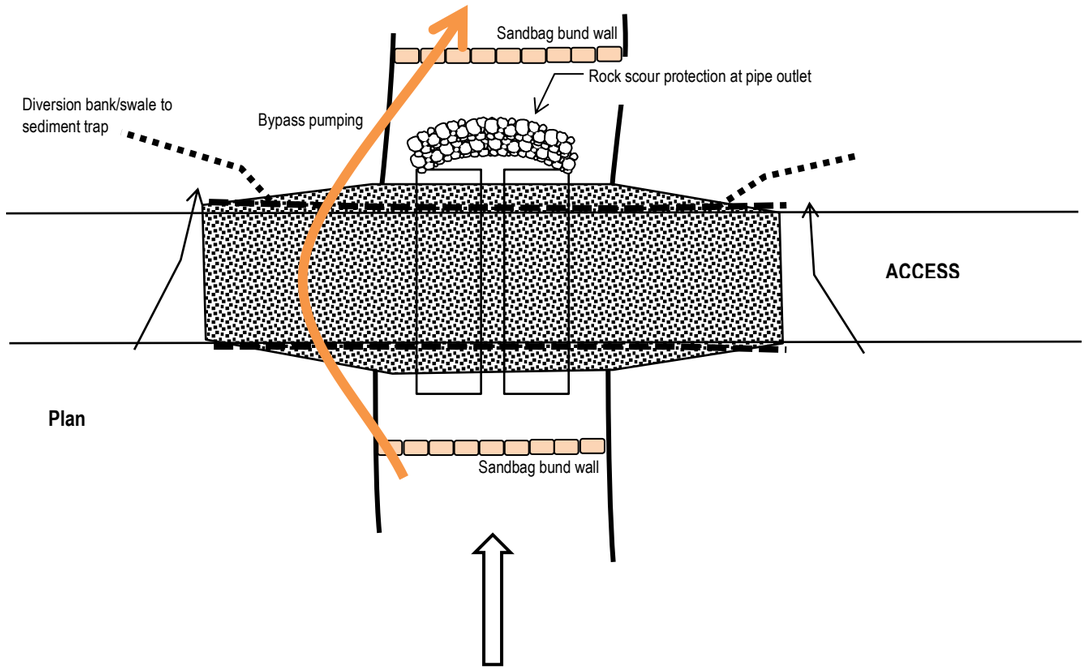
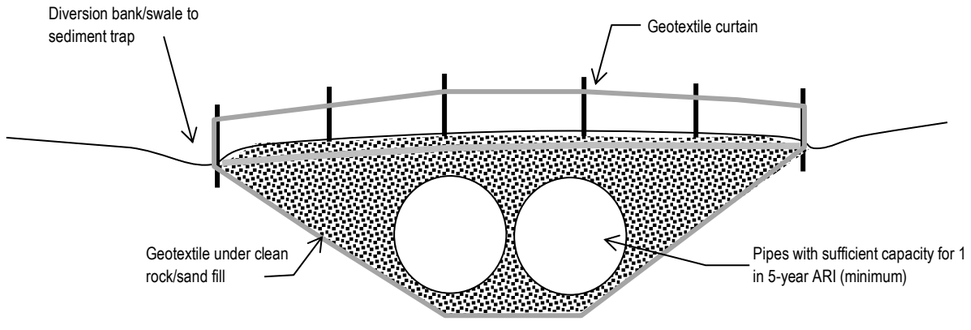
St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

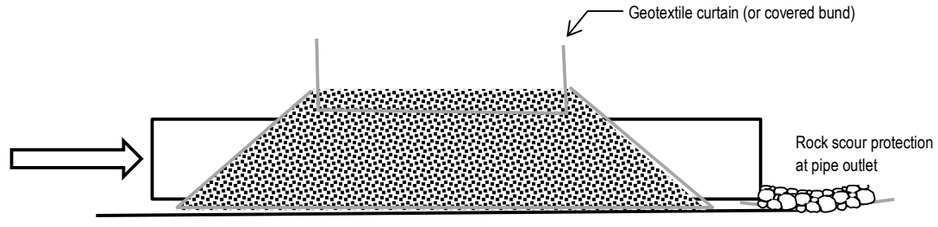
NOT TO SCALE	EE20038 – ESCP	REVISION: 5

Watercourse crossing (temporary)





Section



Section

Construction Notes:

1. Installation of crossing to occur during low flow conditions
2. During installation:
   - creek to be bunded upstream and downstream of crossing location (eg. sandbag bund wall) with bypass pumping in place
   - crossing is to be secured at the end of each day and in the event of rain (eg. covered with geotextile)
3. All rock to be ZERO FINES
4. Crossing to be structurally stable in 1 in 5-year storm event
5. Approaches to be protected with coarse clean rock
6. Construct diversions banks/swales on access road to direct runoff from approaches to sediment traps; (sediment traps include rock filter dam, sediment bags, silt fence, coir logs)
7. Secure geotextile from floor through and up sides of rock fill. Form geotextile curtain to contain crossing runoff
8. Install rock scour protection downstream of crossing
9. Remove sandbag bund walls and bypass pumping

Figure 13. Temporary watercourse crossing

Revision	Date	Drawn	Description
2	23/06/20	TE	Issued
3	10/07/20	TE	Issued
4	01/12/20	TE	Updated for works
5	08/01/21	TE	Updated for modification approval

Tim Elder #4399

St Marys Intermodal Freight Hub

Erosion & Sediment Control Plan - Typical Designs

NOT TO SCALE	EE20038 – ESCP	REVISION: 5

APPENDIX D INSPECTION CHECKLIST

Erosion & Sediment Control Inspection Checklist

Conducted by: Date:

Location/Area: Date of previous rain event:

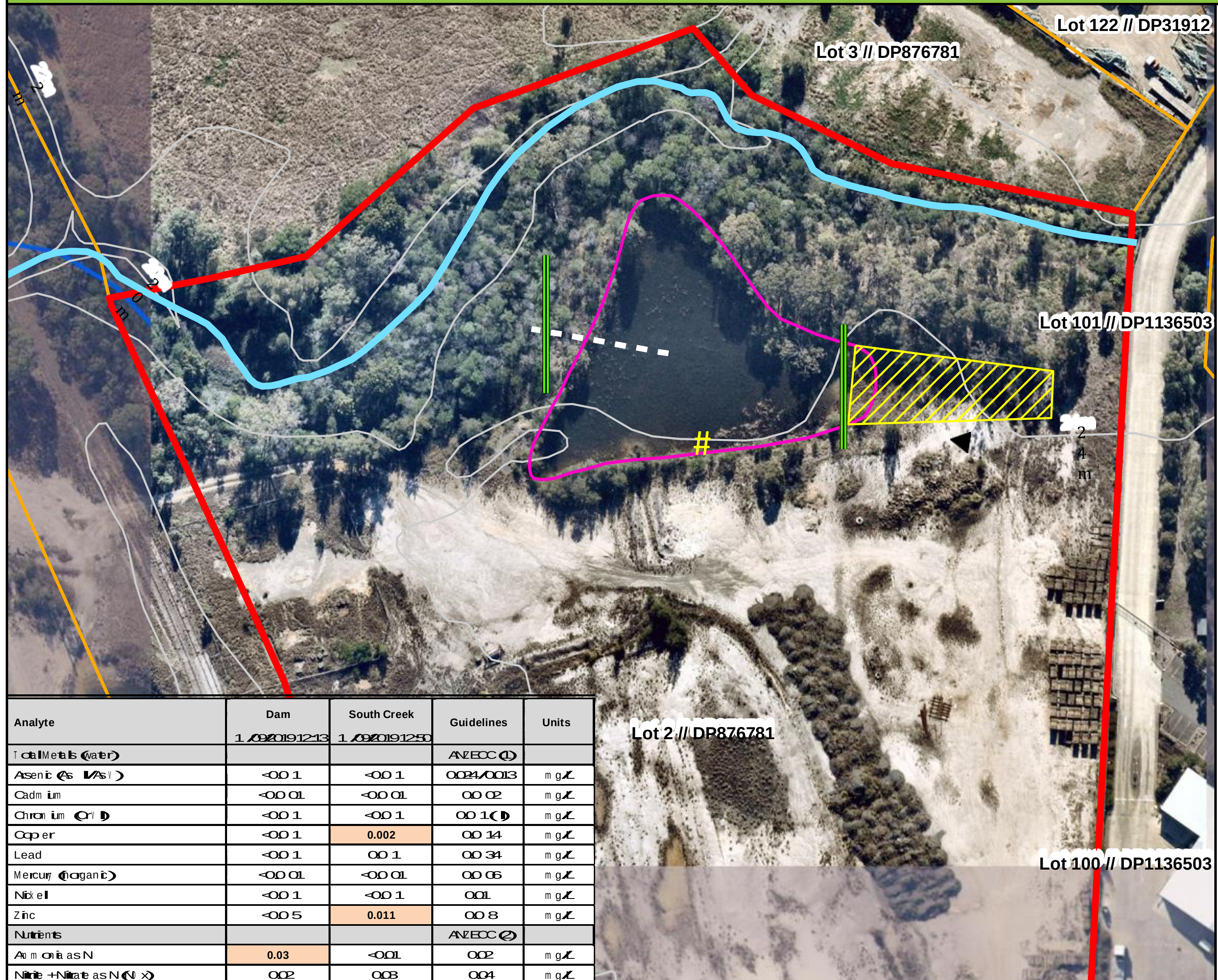
Priority:		
	1. Stop work	4. Fix within 24hrs
	2. Fix immediately	5. Fix within 48hrs
	3. Fix within 12hrs	6. Fix within 72hrs

ITEM	STATUS Y/N/NA	COMMENTS	PRIORITY	CORRECTIVE ACTION
Summary				
Erosion and sediment controls installed consistent with ESCP				
ESCP is current and applicable to stage of works				
Erosion and sediment controls effectively implemented and maintained				
Clean and dirty water adequately separated				
No evidence of off-site sediment, scouring, erosion or pollution				
Entry/exit rumble grids and stablilised areas clear of excessive sediment				
No evidence of sediment tracking on to public road system				
Adequate stockpiles of emergency ESC materials exist on site.				
Erosion Control				
High traffic areas, laydowns, ancillary areas protected with hardstand surface				
Site access & egress points stabilised				
Exit points free of sediment/mud tracking				
Soil binder use				
Dust suppression being carried out				
Drainage control				
Clean water diverted around work area				
Clean water diversion protected against erosion				
Clean water diversion includes stable outlet				
Dirty water directed to sediment control device				
Dirty water diversion protected against erosion				
Dirty water diversion includes sumps or check dams				
Dirty water diversion includes stable outlet				
Watercourse crossings installed as per the ESCP				
Crossings stable & functional				

Sediment Control				
Check dams are installed as per ESCP (rock size, lower in center)				
Check dams are functioning as intended				
Available sediment capacity > 25%				
Sediment basins installed and functional as per design (primary spillway, emergency spillway, inlet chutes, sediment storage zone)				
Flocculation required				
Desilting required				
Disposal location identified for desilt location				
Dewatering				
Dewatering of excavations required				
Dewatering in accordance with procedure and permit conditions				
Predicted wet weather additional checks				
All portable site facilities and laydown areas within the southern portion of site				
All fuels and chemicals stored in the southern portion of site				
All machinery parked in the southern portion of site				
Sludge drying bays and containment cell within the southern portion of site				
Temporary excavations backfilled, protected or stabilised				
Additional comments:				
Evidence of corrective action closeout				
Signature of inspector:				

Annexure D **Dam Dewatering Plan**

Dam Dewatering Plan: ADDRESS (Lot 2 DP 876781)



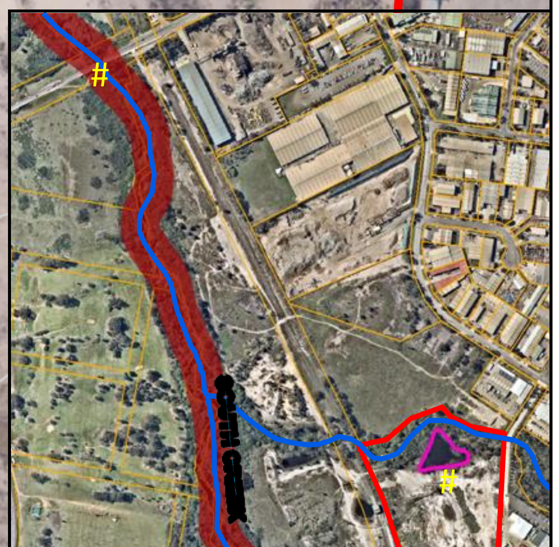
Analyte	Dam 11/09/2019 12:13	South Creek 11/09/2019 12:50	Guidelines	Units
Total Metals (water)			ANZECC (1)	
Arsenic (As III/As V)	<0.001	<0.001	0.024/0.013	mg/L
Cadmium	<0.0001	<0.0001	0.0002	mg/L
Chromium (Cr VI)	<0.001	<0.001	0.001 (VI)	mg/L
Copper	<0.001	**0.002**	0.0014	mg/L
Lead	<0.001	0.001	0.0034	mg/L
Mercury (inorganic)	<0.0001	<0.0001	0.0006	mg/L
Nickel	<0.001	<0.001	0.011	mg/L
Zinc	<0.005	**0.011**	0.008	mg/L
Nutrients			ANZECC (2)	
Ammonia as N	**0.03**	<0.01	0.02	mg/L
Nitrite + Nitrate as N (NOx)	0.02	0.03	0.04	mg/L
Total Kjeldahl Nitrogen as N (TKN)	0.7	0.5		mg/L
Total Nitrogen as N (NOx+TKN)	**0.7**	**0.5**	0.35	mg/L
Total Phosphorus as P	<0.01	**0.05**	0.025	mg/L
Reactive Phosphorus as P (filterable RP)	<0.01	<0.01	0.02	mg/L
Biological			ANZECC (3)	
Faecal Coliforms	~43	~28	1000	CFU/100mL
Biological Oxygen Demand	<2	2	15	mg/L
Physicochemical			ANZECC (2)	
Temperature	17.54	10.3		°C
pH	7.7	7.3	6.5–8	pH units
Dissolved Oxygen (% saturation)	113.4	**59.8**	85	% sat
Dissolved Oxygen (mg/L)	10.51	6.47		mg/L
Turbidity	9.7	19.3	50	NTU
Oxidation reduction potential (ORP)	190	16		mV
Conductivity	135	**760**	30	µS/cm
Salinity	0.1	0.4		ppt
Alkalinity	5	98		ppm
Total suspended solids	<5	<5		mg/L

*values in bold outside ANZECC trigger values

(1) 95% Level of Protection for Freshwater

(2) Default trigger values for low land rivers in south-east Australia (values for NSW & Vic east flowing coastal rivers)

(3) Guidelines for recreational water quality and aesthetics: Secondary contact



Legend

- Site
- Dam
- Cadastre
- 1:25,000 waterway mapping (DPI)
- Creek Centreline (ELA)
- Contours (2m)
- Water quality sample point
- Pump clear water
- Pump sludge material
- Slope
- Recommended erosion control

GDA 1994 MGA Zone 56

0 10 20 40

Metres

www.ecoaus.com.au

Version 1

Prepared by: Ian Dixon; DATE: 12/09/2019

(02) 4201 2208 <iand@ecoaus.com.au>

Dam size, volume and catchment

Surface area = 3,257m². Max depth estimated as 1m. Volume = 1.3ML (0.4 x Surface Area x Depth / 1000). Surrounding land is industrial/commercial. Catchment size of dam is <4ha. Land slopes from east to west at 1:150 grade. Nearest receiving creek is 35m downslope to the west which then flows to South Creek (mapped as Key Fish Habitat by NSW Fisheries). Water testing occurred in the dam and receiving waterway at South Creek at Christie St.

Likely contamination issues

Sediment testing will occur post-dewatering to determine its waste classification or suitability for reuse. Water within the dam was generally better than water downstream in South Creek (see table to the left). In the dam, only Ammonia and Total Nitrogen concentrations exceeded ANZECC trigger values, but not by a large amount. Although Ammonia concentration was lower in South Creek, the creek fell outside of guideline trigger values for two heavy metals (Copper and Zinc), Total Nitrogen, Total Phosphorus, Dissolved Oxygen and Conductivity. The dam water had low Faecal Coliform concentration and low Biological Oxygen Demand, and is therefore suitable for irrigation and secondary human contact.

Method of dewatering and fate of water

The dam is offline and collects surface runoff from a small cleared catchment. Most of the adjacent land near the dam is highly compacted crushed rock, which would not soak water into the soil if the dam water was irrigated across it. Given the dam water quality is overall better than the water in South Creek downstream, it is reasonable to slowly discharge the dam into the adjacent ephemeral creek leading to South Creek. Dewatering of this dam should occur prior to any vegetation removal, to help slow flows and prevent erosion and sedimentation downstream. Discharged water should have a turbidity of <50 NTU before it reaches the creek. The intake pipe should be floated to avoid drawing bottom sludge into the pump. Clear water should be pumped over the wall into rows of staked hay bales upslope of the ephemeral creek. These hay bales will absorb the initial velocity and dissipate flows across a broader area before reaching the channel. Discharge rate should not exceed the holding capacity of the downstream waterway, or cause scouring of bed and bank. Bottom sludge material and remaining turbid water should be excavated and dried on site. As there is minimal suitable land to work with, the dam may need to be compartmentalised with a bund to temporarily store sludge material while the aquatic fauna are rescued from the deepest part of the dam.

Day 1	Day 2-6 (or longer)	Day 7	Day 8-9	Ongoing
Install bunds to divert surface flow. Install erosion controls (e.g. silt fence, hay bales and/or geotextile fabric) and prepare pump pad. The pump intake head is best positioned on a floating device above the deepest part of dam, held in position with ropes spanning the dam. It is difficult to move the pipe when the water is low, so it's easiest to install when dam is full. Test discharge and diversion to ensure no erosion/sedimentation occurs downstream. Avoid disturbing vegetation where water will travel. Notify **Aquatic Ecologist**.	Pump water into adjacent ephemeral creek at a slow rate that does not cause erosion or transport of large amounts of woody debris in that channel. Update **Aquatic Ecologist**.	During final 0.3–0.5m of dewatering allow **Aquatic Ecologist** to rescue fauna in one day. Water will become turbid as levels drop and when ecologists wade over muddy bottom. This water should be discharged away from the drainage line and onto dry open land where mud can settle. To allow rapid fauna rescue, pump inlet needs to be large enough to suck sediment (e.g. 4–6 inch). Earthworks machinery can push sediment across the dam to assist final fish capture (adjusted to suit conditions and ecologist's instructions). Grade escape ramp for fauna hidden in bottom sediment overnight.	Clear surrounding vegetation if part of works plan. Leave escape ramp for fauna trapped overnight (two nights).	Remove sediment and commence reconstruction.

Dam Decommissioning Work Method Procedure; and Sediment and Erosion Control

See Contractor's/Proponent's specifications plus recommendation on this map.

Appropriate permit applications

This dam removal is part of DA. If the dam is licensed with WaterNSW, they require notification of dam decommissioning to remove it from the register. Website: www.waternsw.com.au/Water-licensing/Applications/default.aspx; Email: Customer.Helpdesk@waternsw.com.au; Phone: 1300 662 077.

Presence of fauna (terrestrial and aquatic) and action plan for any species detected.

Observations during a brief field survey (11/09/2019) found there is no permanent bird population occupying or nesting in the dam. Prints in the soft edge suggest at least one bird species visits the dam, likely *Egretta novaehollandiae* (White-faced Heron). One common species of frog was heard calling in the fringing *Juncus* sp., *Crinia signifera* (Common Eastern Froglet). Large numbers of small-bodied pest fish were observed in the shallows, *Gambusia holbrooki* (Plague Minnow). Other pest species may occur, such as *Carassius auratus* (Wild Goldfish), but given the shallow and clear water Carp are not expected to occur in this dam. No native fish or aquatic reptiles were observed, although based on dewatering activities nearby, it is predicted the following native aquatic fauna could inhabit the dam: *Anguilla australis* (Shortfin Eel), *Anguilla reinhardtii* (Longfin Eel), *Chelodina longicollis* (Eastern Long-necked Turtle) and *Philypnodon grandiceps* (Flathead Gudgeon). No aquatic or noxious weeds were detected in or immediately surrounding the dam.

During dewatering, an aquatic ecologist should be on site to handle aquatic fauna. This will only be performed by a person with the following licenses/approvals: Section 37 *Fisheries Management Act 1994* (for fish); Biodiversity Conservation Licence – *Biodiversity Conservation Act 2016* (for turtles, frogs, wetland birds) (may not be required if the DA Conditions specify an Aquatic Ecologist is to be involved); and an Animal Research Authority (issued by the Secretary's Animal Care & Ethic Committee). The likely **aquatic fauna handling procedures** are:

i. **NOTICE:** The Aquatic Ecologist is to notify NSW Fisheries of the activity 48 hours prior to fish relocation (unless an agreement is in place), including locations of dewatered and relocation sites (see regional office contacts https://www.dpi.nsw.gov.au/contact-us/local-office). Fisheries require permits to be carried by the licensed ecologist, who should also display a sign clearly showing licence number (if working in public areas, especially when releasing fauna to local creek).

ii. **PLANNING:** The dewatering schedule should allow time for fish rescue, especially during the final 0.3–1m water depth (to be advised by Aquatic Ecologist). Fauna should be captured in one day so pumps need to be of an adequate size and placed in an area free from mud and debris (e.g. inside excavator bucket or screened sump pit). If wetland birds are observed nesting, or young birds (chicks) are using the dam, advise the Aquatic Ecologist immediately for advice. Depending on species and age, birds may be able to relocate themselves. Chicks will need temporary refuge during dewatering; or works may need to be postponed.

iii. **CAPTURE:** Fish are to be collected by hand nets during the final day of dewatering. This is most effective when the water is <0.3m deep. Dissolved oxygen concentration will drop rapidly as water volume decreases, especially in warm water or if lots of fish are present. Larger bodied fish should be targeted first. Wetland birds will scavenge for small fish in the shallows (e.g. Gambusia). Most small fauna will likely remain uncaptured in the dam until the water becomes very shallow (especially eels and turtles). Eels are best captured by large hand nets in water <30cm deep, although they burrow into mud. When the water is extremely low, turtles and fish may head towards the intake pump (placed in deepest part). This area should be monitored to intercept fauna (e.g. stand in water next to intake). Turtles will burrow into mud and may require observation and rescue the following morning but can also move themselves to suitable nearby habitat if an escape ramp is graded. For safety, at least two people are required when wading and handling heavy tubs of water/fish up banks (excavator can dig access steps/ramp).

iv. **RELOCATE:** Native fish healthy enough for relocation are to be contained and transported in an aerated tub/bucket/tank to an appropriate dam/lake/waterhole/creek. NSW Fisheries advise that the host location should be large enough to accommodate additional fish, especially predatory eels. Additional release sites may be needed. Do not overstock tubs or leave in direct sun for extended periods. Aeration can be provided by battery aquarium pumps or manual turbulence if only stored for a short period. Turtles can be transported in a shaded tub with a wet hessian bag placed inside for moisture and support during transport. Tadpoles can be transported in small buckets.

v. **RELEASE:** Water from the receiving waterbody should be mixed slowly over 5–10 minutes with the tank water to allow fish to acclimatise to the new water quality. Care should be taken when releasing fauna not to also transfer weeds or invasive species (e.g. Carp eggs and Gambusia). Transfer animals via hand nets, rather than tipping the tub with water. Eels can be released on land a few metres from edge and pointed towards the water.

vi. **PESTS:** Exotic fish (e.g. Carp, Gambusia, Goldfish, Redfin Perch, Spotted Livebearer) are to be intercepted, euthanised and disposed of in accordance with the ecologist's Animal Research Authority (issued by the Secretary's Animal Care & Ethic Committee). Exotic *Trachemys scripta* (Red-eared Slider Turtle) are to be contained humanely and DPI immediately notified (Biosecurity Line – 1800 680 244). They will collect the live turtle from the ecologist.

vii. **POST-DEWATERING:** An escape ramp should be graded to allow trapped fauna to escape overnight. Sediments should be left up to two nights to allow hidden fauna to emerge, unless the ecologist confirms there are no fauna remaining (site specific assessment). Earthworks staff should notify the appointed aquatic ecologist if stranded fish or turtles are observed post-dewatering.