PART 6

HYDRAULIC, WATER QUALITY AND ENGINEERING

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STORMWATER MANAGEMENT PLAN
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Stormwater Management Strategy

Carmichael Coal Mine Rail Construction Camp 3

750890/008

Prepared for
Adani Mining Pty Ltd

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1 Introduction

This conceptual Stormwater Management Strategy (SWMS) report has been prepared on behalf of Adani Mining Pty Ltd for the proposed Carmichael Coal Mine Rail Construction Camp 3 (the subject site).

The intent of this strategy is to provide an overview of the stormwater management aspects to support the Material Change of Use application for the rail construction camp. This SWMS report includes detailed policies, performance criteria and procedures to minimise the impact of the development on the physical and social environment.

This SWMS intends to address the operational phase of the construction camp that is expected to have a design life of approximately 2 years.

2 Existing Site and Proposed Development

2.1 Existing Site Description

The site of the Carmichael Coal Mine Rail Construction Camp 3 is located approximately 100km west by north of Moranbah, Queensland in the Isaac Regional Council. The proposed 9.3 hectare development area is situated on Lot 662 on PH1491, with the closest main road being Moray Bulliwallah Road situated approximately 2km east of the site. Refer to Cardno drawing number SP126801-RC03-01 for the Rail Camp 3 context plan.

A review of available aerial contour information showed that the camp site is situated at a level of approximately RL 206 m AHD. The existing site topography separates into two catchments with catchment A grading to the north-west and catchment B grading to the south-eastern corner of the lot. Catchment A and B generally grade at 0.3% and 0.4% respectively. Refer to Cardno drawing number 7508/90/08/-3.01 for the existing topography of the rail camp site.

2.2 Developed Site Description

It is proposed to establish a workers camp to support the construction of the proposed railway linking the Carmichael Coal Mine with the port terminals situated to the east. The developed site is to contain accommodation units to house approximately 400 staff with all associated services including sewerage and water treatment plants.

As minimal bulk earthworks are anticipated in order to construct the camp site, the developed condition site topography is expected to generally resemble the existing conditions with the subject site's catchments to continue to grade to the west and the south-eastern corner of the camp. Refer to Cardno drawing number 7508/90/08/-3.02 for the proposed development layout of Rail Camp 3.

3 Performance Criteria

As the lifespan for Rail Construction Camp 3 is anticipated to be only approximately 2 years, the establishment and operation of the camp site has been considered as a construction site for the lifetime of the rail construction project.

Based on this, the construction and operational phases of the proposed rail camp will be governed by the same performance criteria as outlined below.

The *'Queensland Water Quality Guidelines (2009)'* (QWQ guidelines) (which is referenced by the Environmental Protection (Water) Policy (2009), a subordinate document of the Environmental Protection Act (1994)) provides a summary of design objectives for the management of stormwater quality and flow for the construction phase of developments in Queensland. This summary provided in Table 8.2.1 of the QWQ guidelines outlines design objectives for a number of pollutants including sediment, nutrients, litter and hydrocarbons.

Based on the above information, the release criteria for controlled runoff events or pumped discharges from the construction site is to be as shown in **Table 3-1** below.

Table 3-1 Discharge Performance Criteria

Parameter	Release Criteria	Criteria Type
Total Suspended Solids	< 50 mg/L	Maximum
Coarse Sediments	To be retained on site	Descriptive
Turbidity (NTU)	< 10% above receiving water	Maximum
Nutrients (N and P)	Manage through Sediment Control	Descriptive
pH	6.5-8.5	Range
Litter	No visible litter washed from site	Descriptive
Hydrocarbons	No visible sheen on receiving water	Descriptive
Dissolved Oxygen	> 6 mg/L	Minimum
Stormwater drainage/flow management	Peak flows for 1-year and 100-year ARI event to match the pre-development condition of the site	Maximum

For the management of sediments, Table 8.2.1 of the QWQ guidelines outlines the following:

- Testing of suspended solids and pH within any temporary sediment basins is to occur prior to any controlled discharges.
- Testing of turbidity within the temporary sediment basins and the receiving waters, is to be performed before the controlled discharging of the sediment basins. If the turbidity of the sediment basin is greater than 10% above the receiving waters further dosing with gypsum or lime is required until acceptable levels are reached.

4 Stormwater Management Strategy

4.1 Stormwater Quality

Based on the limited lifespan of Rail Construction Camp 3 and the site's proximity to the adjacent railway corridor construction area, the primary objective of the proposed stormwater quality management strategy will be to control soil erosion on site and minimise sediment discharge to the downstream receiving local water courses using appropriate best management practices.

Refer to Cardno drawing number 7508/90/08/-3.02 for an indicative layout of the stormwater quality management measures proposed to be adopted to treat the contributing local catchment areas of rail construction camp 3.

4.1.1 Available Management Practices

A wide range of stormwater quality improvement devices are available to achieve the best practice stormwater management of runoff from a developed site. **Table 4-1** lists the most common stormwater quality improvement devices currently used locally, including their treatment efficiencies and the constraints of their use.

Table 4-1 Stormwater Management Practices

Treatment Technique	Pollutant Removal Efficiency (1)							Scale (2)	Constraints
				Nutrients					
	Litter & Debris	Coarse Sediment	Fine Sediment	Dissolved	Particulate	Metals	Hydrocarbons		
Litter baskets / racks	L-M							Local	Requires frequent maintenance
Sediment basins	L	M-H	L-M		L	L	L	Regional	Aesthetic and safety issues
Gross pollutant traps	H	H	L		L	L	L	Local/ Regional	Requires regular maintenance
Filter strips / buffer strips	L	M	L-M	L	L-M	L-M	L	Lot/Local	Requires flat terrain
Grass / vegetated swales	L	M-H	L-M	L	L-M	L-M	L	Local	Requires flat terrain
Extended detention basins	M	H	L-M	L	M	M	L	Regional	Requires pre-treatment, Large land area required
Infiltration trenches	L	M-H	M	L-M	M	M	M	Local	Requires pre-treatment
Bio-retention systems	L	M-H	M	L	M	M	L-M	Local	Requires pre-treatment
Porous pavements		L-M	L-M	L	M	M	M	Local	Not appropriate for steep sites and heavy traffic

Treatment Technique	Pollutant Removal Efficiency (1)							Scale (2)	Constraints
				Nutrients					
	Litter & Debris	Coarse Sediment	Fine Sediment	Dissolved	Particulate	Metals	Hydrocarbons		
Constructed wetlands	M-H	H	M	H	H	M-H	M	Regional	Requires pre-treatment, Not appropriate for steep sites, Large land area required
Community education								Regional	Community participation

Information Source: Queensland Urban Drainage Manual Table 11.05.4 (Typical pollutant removal efficiencies of treatment systems (2007). Benefit Ranking: L = Low Benefit, M = Medium Benefit, H = High Benefit.

Notes:

(1) Removal rates are provided for information only with the efficiency rating subject to adequate design. The actual removal rates used for detailed water quality modelling purposes should be in accordance with *MUSIC Modelling Guidelines Version 1.0 – 2010* prepared by Water by Design.

(2) Scales: Lot – less than 1 ha; Local – 1 to 10 ha; Regional – greater than 10 ha.

Given the features of the subject site, a number of the measures listed in **Table 4-1** above would not be considered appropriate to be incorporated into the stormwater treatment train for the proposed camp site.

Provided below is information on a number of the listed stormwater quality improvement devices including the suitability of these devices to be incorporated into the development of the subject site to treat stormwater runoff from the proposed construction camp site.

Litter Baskets/Racks

Litter baskets and trash racks are generally located upstream of other treatment measures such as extended detention basins or constructed wetlands. They are primarily used as a pre-treatment device for stormwater runoff, removing litter, debris and other gross pollutants from the runoff before it discharges into other secondary and tertiary treatment devices located downstream.

Gross Pollutant Traps (GPT) / Oil & Grit Separators

GPT / Oil and Grit Separators incorporated into the stormwater treatment train can contribute to the effective removal of solid pollutants, sediments and hydrocarbons from stormwater runoff from driveway and roadway areas of the proposed development site.

Generally GPTs and Oil and Grit Separators shall be designed to treat flows generated by the 3 month Average Recurrence Interval (ARI) rainfall event.

Sediment Basins

During the construction phase of the development sediment loads are expected to be higher due to areas being cleared and exposed for the construction of roads, services and buildings. It is recommended that as part of the erosion and sediment control plan prepared for the construction phase of the development some form of sediment basin will be utilised to help manage sediment transport off-site.

The use of sediment basins is considered appropriate for this rail construction camp development.

Vegetated Filter Strips / Buffer Strips

Filter / buffer strips can be either areas of planted vegetation or strips of retained vegetation left in its natural state. These vegetated areas may provide both an effective way of reducing peak flows and improving stormwater runoff quality. During the construction phase of the development the retention of existing vegetation in-conjunction with other erosion control measures can assist to stabilise exposed areas. In the case of the proposed development areas that grade away from the proposed road drainage network buffer strips along the rear of the allotments are considered one of the key stormwater management techniques, particularly where no other stormwater treatment techniques are possible. Upon completion of the rail camp construction works any exposed areas should be turfed, seeded or landscaped as soon as possible to reduce the risk of erosion.

It should be noted that in order for buffer strips to be effective, flow must be overland, and not concentrated. Therefore, flow spreaders may be required in conjunction with buffer strips to ensure optimal performance, particularly for those areas which drain away from the road.

The use of vegetated filter / buffer strips is considered appropriate for this development.

Grassed / Vegetated Swales

Grassed / vegetated swales are designed to treat stormwater runoff by ensuring sufficient detention time to allow the removal of nutrients and fine sediments. This is achieved through filtration and infiltration. Hydrocarbon removal will also be achieved through filtration and attachment to vegetation where biological breakdown of the hydrocarbons can occur.

Swale lengths and widths can vary dependent on the site conditions, however to operate most effectively swales need to be located on relatively flat grades no steeper than 4-5%. The use of vegetated swales is limited in steep slope areas, unless suitable scour protection measures are incorporated.

The use of grassed / vegetated swales is considered appropriate for this development.

Infiltration Trenches

Infiltration trenches are predominantly dry shallow grassed areas that trap the first flush runoff. The trapped runoff then infiltrates through the filtration medium removing fine sediment and nutrients. The base of the infiltration trench should be lined with an adequately designed sub-surface perforated pipe drainage network to convey filtered runoff to the trench outlet before discharging to the downstream receiving environment.

Bio-retention Systems

Similar to vegetated swales, bio-retention systems are designed to treat stormwater runoff by ensuring sufficient detention time to allow the removal of nutrients and fine sediments. This is achieved through filtration, plant uptake, adsorption and biological degradation. Hydrocarbon removal will also be achieved through filtration and attachment to vegetation where the biological breakdown of hydrocarbons can occur.

Bio-retention systems contain an infiltration filter media, typically filled with sandy loam. All runoff collected within the system for the design storm event must pass through this filter. The filter media must be capable of sustaining vegetation growth as the vegetation is responsible for much of the uptake of nutrients within the system. The base of the bio-retention systems should be lined with an adequately designed sub-surface perforated pipe drainage network to convey the filtered runoff to the system outlet before discharging to the receiving system.

Bio-retention systems can be used in both flat areas and in steeper areas by stepping the system. Bio-retention systems can also be incorporated into the base of detention basins combining both stormwater quality and quantity into one area.

Porous Pavements

Porous pavements vary with design, but generally incorporate a surface material consisting of a grid / lattice system, modular clay / concrete blocks, or open-graded asphalt / concrete pavements with much of the fine aggregate material omitted. The surface material is bedded on a coarse sand filter layer constructed over a gravel drainage layer. The use of porous pavements can assist in the removal of fine particulate matter, hydrocarbons, nutrients and soluble pollutants from stormwater runoff.

Porous pavements are suited most to areas of low traffic volume and low runoff volume. Porous pavements are most effective when used at grades of less than 5%. Because of this, porous pavements are recommended to be used in the parking areas only.

Rainwater Tanks

In addition to providing a low cost supply of water to assist in reducing demand on water supply, rainwater tanks can also provide a reduction in peak flow rates from rainfall events with the provision of additional storage volume.

Level Spreader Devices

For roof area drainage that cannot be connected to a piped drainage network the concentrating of roof water runoff at a single discharge outlet can lead to erosion and scour problems. By utilising a level spreader at the outlet to disperse the overflows over a larger area, the flows will be less concentrated and velocities will be reduced, reducing the risk of erosion and the incidence of re-suspension of sediments. Level / flow spreaders should be located away from high pedestrian traffic areas and be directed towards vegetated buffer strips or other landscaped areas.

Constructed Wetlands

Constructed wetlands are a water quality treatment system comprising of an inlet pond, to remove coarse sediments, and a macrophyte zone, to remove fine particulates and soluble pollutants. Additionally, constructed wetlands also provide landscape value, passive recreation, wildlife habitat and flood control.

Wetlands are particularly useful on sites constrained by water and environmental sensitivity as they can be incorporated as an upstream component of existing waterbodies and environmentally sensitive aquatic features.

The dominant feature of the wetland is the macrophyte zone which comprises of vegetated marshes, shallow and deep pools.

Wetlands require reasonably large flat areas of land. Currently, bio-retention systems provide superior performance with a reduced footprint compared to wetlands. Given the relatively low rainfall and high evaporation that occurs in the region, there are also concerns in relation to constructed wetlands being dry for prolonged periods. Therefore this type of treatment device is not considered appropriate for the rail construction camp site.

4.1.2 Adopted Strategy

Based on the site constraints the following stormwater quality improvement devices and management practices are considered appropriate to be incorporated in the development of rail construction camp 3.

Rainwater tanks and level spreader devices

Due to the flat grades of the rail camp site it may not be possible to direct all roof area drainage to a piped drainage network that will be able to free drain to the nominated stormwater treatment and detention basins. Therefore in these instances it is suggested that the roof area drainage discharge to rainwater tank with a level spreader device attached to the outlet. As indicated above, this would assist in dispersing the outflows over a larger area to reduce the risk of erosion and the incidence of re-suspension of sediments.

Vegetated Swales

As grades across rail camp 3 are expected to be generally less than 4-5% the use of vegetated swales for stormwater treatment is considered appropriate. As noted above, due to the relatively flat grades across the subject site vegetated swales will be used for conveyance purposes throughout much of the site as an alternative to conventional piped drainage which is expected to be limited by depth.

Sediment Basins

As the primary target of this stormwater management strategy is to control soil erosion and minimise sediment transport from the camp site this type of device is considered the most appropriate control device for the rail construction camp.

With the lifespan of the construction camp anticipated to be approximately 2 years, the use of alternative devices such as bio-retention basins are limited as these types of devices generally take a period of approximately 2 years to appropriately establish.

The flexibility in the shape of sediment basins combined with the efficient pollutant retention rates for sediments that these systems provide make sediment basins ideal for the rail construction camp site.

In addition to the above listed stormwater management practices, other principals of water sensitive urban design that can be incorporated into the development of the rail construction camp include:

> Retention of existing drainage features, where possible;
> Protection of natural systems by limiting development to non-sensitive areas and providing adequate buffers between development and natural systems;
> Non-worsening of peak flow rates from site.

It should be noted that this stormwater management strategy has been based on a preliminary layout. Although stormwater treatment practices have been recommended for use in certain areas throughout the subject site, a number of treatment measures may be appropriate and the key principles of the stormwater management strategy will remain applicable despite potential layout changes.

Should the detailed design bring about changes to the proposed layout, Section 4.1.1 of this stormwater management strategy provides a list of alternative treatment practices that may be suitable for the site and could potentially be designed to meet the nominated water quality objectives. The key aim of this stormwater management strategy is that the practices listed as suitable for the site should be used in a manner which results in best practice stormwater management measures being incorporated into the development.

4.2 Stormwater Quantity

The intent of this stormwater quantity strategy for rail construction camp 3 is to manage runoff generated from the local contributing catchment area (i.e. the camp site area) only. Based on this, it is proposed to construct perimeter bunds along the upstream boundaries of the subject site to divert the local external contributing catchment areas around the camp site.

A regional hydrologic and hydraulic assessment of the railway corridor is currently being undertaken by others.

The purpose of this stormwater quantity management strategy is to avoid impacts on the downstream receiving properties and infrastructure, by ensuring that the peak flows discharging from the developed condition camp site area are equivalent to, or less than the peak flows expected from the existing condition site. It is proposed to incorporate an on-site detention basin into the rail camp site to control the developed condition peak flows discharging from the subject site for rainfall events up to and including the 100 year ARI event.

To control the peak rates of discharge from the proposed detention basin it will be necessary for the outlet arrangement to be designed to maintain peak flows equivalent to the existing condition peak discharges. It is noted that where a free draining piped outlet cannot be provided to drain the proposed detention basin within the footprint of the camp site area, a pump system will need to be provided.

The proposed detention basin will also be utilised as a sediment retention basin for water quality purposes. All water trapped within the sediment / detention basin is to be tested for compliance with the release criteria outlined in **Table 3-1** prior to a controlled release from the site or alternatively the water could be used for dust suppression or irrigation.

Due to the flat nature of the site, not all stormwater runoff generated within the camp site will be able to be conveyed to the proposed on-site detention basin with the use of a conventional pit and pipe drainage system. As a result it is proposed to use drainage swales to convey runoff to the nominated detention basin location.

The indicative location and minimum size of the proposed basin are shown on Cardno drawing number 7508/90/08/-3.02. Calculations for the sizing of the detention basin can be found in Section 6 of this report.

5 Stormwater Quality Assessment

As outlined above, the lifespan for Rail Construction Camp 3 is anticipated to be only approximately 2 years and therefore the operation of the camp site has been considered as a construction site for the lifetime of the rail construction project.

The works to be carried out on the site of rail construction camp 3 have the potential to increase the level of sediment laden runoff discharging from the site for the lifespan of the construction project. Based on this, the following assessment for the rail camp site has been undertaken to determine the on-site sediment retention storage requirements that will be necessary to retain the expected soil loss generated from the camp site construction area. Refer to Cardno drawing number 7508/90/08/-3.02 for the subject site local catchment areas adopted for the preliminary on-stormwater quality assessment.

5.1 Soil Loss Calculations

Data obtained from the Australian Soil Resource Information System on the 12th October 2012 shows the soils to be expected on the subject site are medium clays with an approximate clay content of 40 – 50%. The data obtained was from the national soil grid. This soil type is considered to be a dispersive soil (type D) and based on the Revised Universal Soil Loss Equation (RUSLE) the predicted soil loss rate has been estimated for each of the disturbed catchment areas located within the subject site.

Catchment parameters for the disturbed area of the subject site were based on existing contour information. These catchment parameters have been summarised in **Table 5-1** below.

Table 5-1 Catchment Parameters

Catchment No.	Internal / Site Catchment Area (ha)	Approx. Average Site Slope (%)
A	6.57	0.29
B	2.76	0.44

The results of the soil loss assessment using the revised soil loss equation are summarised in **Table 5-2** below. For more detailed information refer to the sediment loss calculations provided in Appendix C of this report.

Table 5-2 Soil Loss Parameters

Catchment No.	Rainfall Erosivity Factor (R)	Soil Erodibility Factor (K)	Slope Length / Gradient Factor (LS)	Erosion Control Practice Factor (P)	Ground Cover (C)	Soil Loss (A) (t/ha/yr)	Sediment Storage Volume (m^3)
A	2370	0.02	0.24	1.3	1.0	11	120
B	2370	0.02	0.24	1.3	1.0	11	50

Based on the information above, the soil loss within the disturbed area of catchments A and B have been estimated to be equivalent to Soil Loss Class 1 (0 to 150 tonnes/ha/yr), which classifies the site as a very low erosion risk as outlined in Table 3.1 of the 'Best Practice Erosion and Sediment Control (2008)' guidelines prepared by the International Erosion Control Association – Australasia.

5.2 Sediment Basin Calculations

In conjunction with the above information, the calculations for the total sediment basin volumes have been carried out and shown in **Table 5-3** below.

Table 5-3 Sediment Basin Calculations

Basin I.D	Volumetric Runoff Coefficient (Cv)	Catchment Area of Basin (A)	5 day total rainfall depth (R) [85%ile, 5day	Settling Zone Volume (10xCvxAxR)	Total Basin Volume (m^3)
A	0.58	6.57	32.50	1238	1358
B	0.58	2.76	32.50	520	570

A comparison of the total storage volumes required for sediment retention and for on-site detention will be carried out in Section 6 of this report. This comparison will be made to determine which design conditions will be considered as the critical case.

6 Stormwater Quantity Assessment

The local catchment peak discharges from the site of rail construction camp 3 are expected to increase in comparison to the existing condition peak flows as a result of the proposed development. This expected increase in peak discharge is the result of the increase in the percentage of impervious area and the reduction in flow travel time post development. Based on this, the following assessment of the pre-development and post development local catchment flows for the rail camp site has been undertaken to determine if there is an increase in post development flows from the subject site, and estimate the on-site detention storage requirements that may be necessary to attenuate any increase in flows discharging off-site. Refer to Cardno drawing number 7508/90/08/-3.02 for the subject site local catchment areas adopted for the preliminary on-site detention assessment.

6.1 Existing Conditions

The Rational Method was used to estimate the existing condition peak flow rates discharging from the local catchment areas of rail construction camp 3.

The Coefficient of Runoff value for the pre-developed site conditions was determined from Tables 4.05.3(a) *(Table of C10 values)* and 4.05.3(b) *(C10 values for Zero Fraction Impervious)* of the Queensland Urban Drainage Manual 2007 (QUDM). Based on available data of the subject site, the existing condition of the rail camp site was considered to have a fraction impervious of 0.0 and a land description equivalent to poor grass cover / low density pasture. A resultant C10 value of 0.66 was adopted for the pre-development site conditions.

A rainfall intensity frequency duration (IFD) chart was developed for the camp 3 area using the design rainfall IFD data available from the Bureau of Meteorology (BOM) website.

The Time of Concentration value for the existing site conditions of camp 3 was determined in accordance with Section 4.06 of QUDM. The Bransby-Williams' equation was used to estimate the overland flow travel time for the camp 3 local catchment area. The pre-development flow travel time for rail camp 3 was estimated based on the following parameters shown in **Table 6-1** below.

Table 6-1 Existing Time of Concentration Parameters

Catchment	Catchment Area (ha)	Stream flow path length (m)	Equal area of slope (%)
A	6.57	340	0.29
B	2.75	224	0.44

A summary of the parameters determined to estimate the pre-development 2, 5, 10, 20, 50 and 100 year ARI peak flow rates from the local catchment areas of rail construction camp 3 are provided in **Table 6-2** and **Table 6-3** below.

Table 6-2 Catchment A Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	6.57	6.57	6.57	6.57	6.57	6.57
Time of Concentration (min)	20	20	20	20	20	20
Rainfall Intensity (mm/hr)	69.2	90.9	104	121	144	162
Discharge (m^3/s)	0.71	1.04	1.25	1.53	1.99	2.34

Table 6-3 Catchment B Existing Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.56	0.63	0.66	0.69	0.76	0.79
Area (ha)	2.76	2.76	2.76	2.76	2.76	2.76
Time of Concentration (min)	15	15	15	15	15	15
Rainfall Intensity (mm/hr)	80	102	120	137	162	185
Discharge (m^3/s)	0.34	0.49	0.61	0.73	0.94	1.12

6.2 Developed Condition

Similar to the existing condition flows, the Rational Method was used to estimate the peak flow rates discharging from the developed condition local catchment area of rail camp 3.

As discussed above, the Coefficient of Runoff value for the developed site conditions was determined from Table 4.05.3(a) of QUDM. Based on the available rail construction camp 3 development layout plan, the developed condition of the rail camp site was considered to have a fraction impervious of 0.60, with a resultant C_{10} value of 0.75 adopted for the post-development site conditions.

The Time of Concentration value for the developed site conditions was determined for the contributing local catchment area in accordance with Section 4.06 of QUDM. From Table 4.06.2 *(Recommended roof drainage system travel times)* a standard inlet time of 5 minutes was adopted for the flow travel time to the surface drainage.

Due to the flat grades expected across the development area of rail camp 3, surface drainage utilised throughout the camp site is expected to be limited to the use of swale drains / open channels. Pipe drainage is expected to be limited to cross culverts utilised under roadways and footpaths to maintain trafficability during lower ARI events. Based on this, the additional surface drainage travel time was estimated using Figure 4.09 *(Flow travel time in pipes and channels)* of QUDM.

A summary of the parameters determined to calculate the 2, 5, 10, 20, 50 and 100 year ARI developed peak flow rates (with no detention) from the contributing local catchment areas of rail camp 3 are provided in **Table 6-4** and **Table 6-5** below.

Table 6-4 Catchment A Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.64	0.71	0.75	0.79	0.86	0.90
Area (ha)	6.57	6.57	6.57	6.57	6.57	6.57
Time of Concentration (min)	10	10	10	10	10	10
Rainfall Intensity (mm/hr)	90.6	120	137	160	191	215
Discharge (m^3/s)	1.05	1.56	1.88	2.30	3.01	3.53

Table 6-5 Catchment B Developed Condition Discharge Parameters

Parameter	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr
Coefficient of Runoff	0.64	0.71	0.75	0.79	0.86	0.90
Area (ha)	2.76	2.76	2.76	2.76	2.76	2.76
Time of Concentration (min)	6	6	6	6	6	6
Rainfall Intensity (mm/hr)	109	144	166	194	231	260
Discharge (m^3/s)	0.53	0.79	0.95	1.17	1.53	1.79

A comparison of the existing condition peak flows in **Table 6-2** and **Table 6-3** with the developed condition peak flows in **Table 6-4** and **Table 6-5** found that there is expected to be an increase in the peak flows discharging off site due to the increase in impervious area and the reduction in flow travel time on site.

On-site detention is proposed to be incorporated into the development works. This is to avoid impacts on downstream properties and infrastructure and to maintain the existing peak flow rate of runoff discharging from the developed site for all rainfall events up to and including the local catchment 100 year ARI event. The proposed on-site detention will help control the rate of discharge leaving the site.

6.3 Preliminary On-Site Detention

A preliminary assessment of the on-site detention storage requirements for the proposed rail camp 3 development area has been carried out using the initial sizing techniques outlined in Section 5.05.1 of QUDM. Based on the comparison of results outlined in Section 6.2 above, it will be necessary to incorporate on-site detention storage in order to maintain peak outflows equivalent to the existing conditions.

The on-site detention storage proposed for the site will be sized to maintain the equivalent pre-developed condition peak flows for local catchment rainfall events up to and including the 100 year ARI rainfall event. To control the peak rates of discharge from the nominated storage volume it will be necessary for the outlet arrangements to be designed to maintain the existing peak flows.

A comparison of the existing and developed condition peak flows for the rail camp site indicated that the 100 year ARI storm event resulted in the greatest increase in peak discharge. The results of the preliminary on-site detention analysis indicate that a minimum detention storage volume of approximately 1905m^3 for catchment A and 650 m^3 catchment B will be required to detain the increase in the 100 year ARI discharge and maintain the equivalent pre-developed 100 year ARI peak flow discharging off site.

It should be noted that the volume outlined may be subject to change if the final catchment areas differ from those adopted for this assessment. The stage storage characteristics and outlet configuration of the detention basin will be verified as part of the detailed design of the civil works for rail camp 3.

It is proposed to incorporate the stormwater detention and treatment into one common basin for each catchment. A comparison of the total storage volumes required for sediment retention, as outlined in Section 5 of this report, and for on-site stormwater detention has indicated that the volume required for on-site stormwater detention is more critical. Therefore the total storage volume adopted for the rail camp 3 stormwater treatment and detention basin A is a minimum of 1905m^3 and basin B is a minimum of 650m^3. Refer to Cardno drawing number 7508/90/08/-3.02 for the indicative layout and configuration of the stormwater treatment and detention basins for rail construction camp 3.

In accordance with Section 5.11 of QUDM it is recommended that any ponding within the basin should be limited to 1.2 metres at the deepest point above the basin invert. For deeper basins, suitable safety provisions (such as refuge mounds within large basins, fences and warning signs) should be provided.

6.4 Other Drainage Issues

6.4.1 Diversion of External Catchments

As the intent of this strategy is to manage the runoff from the rail construction camp area only, it is proposed to construct perimeter bunds along the upstream boundaries of the subject site to divert the local external contributing catchment areas around the camp site. Refer to Cardno drawing number 7508/90/08/-3.02 for the indicative locations of the external catchment diversion bunds proposed for rail camp 3. The final alignment and profile required for the diversion bunds will be confirmed as part of the detailed design of the civil works for rail camp 3.

7 Monitoring and Maintenance Schedules

7.1 Monitoring Schedule

A monitoring program will be established for the stormwater management devices as outlined below and shown in **Table 7-1**, **Table 7-2**, **Table 7-3** and **Table 7-4**.

Table 7-1 Monitoring Program for Sediment Basins

MONITORING ACTIVITY	FREQUENCY
Inspect sediment basin	- During construction - After each runoff event - Weekly during wet season - Prior to “stop work” or “site shutdown”
Inspect submerged inflow pipes	After each runoff event
Testing of Suspended Solids, pH, and Dissolved Oxygen	- Prior to controlled release - Immediately following rain events > 25mm in a 24 hour period

To maximise the effectiveness of the stormwater management measures for the roof drainage areas that do not connect directly to a piped drainage system, the following activities are suggested to regularly visually monitor the condition of the rainwater tanks and level spreader outlets.

Table 7-2 Monitoring Program for Rainwater Tanks

MONITORING ACTIVITY	FREQUENCY
Observe water surcharging from surcharge weir/pipe/pit of tank	After major storm events > 25mm in 24 hrs
Inspect silt / litter trap	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect structural integrity / condition of device	6 monthly

Table 7-3 Monitoring Program for Level Spreader Devices

MONITORING ACTIVITY	RECOMMENDED FREQUENCY
Inspect for incidents of erosion / scour of soils	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter accumulation	3 monthly
Inspect for excessive wear & damage	
Inspect for build-up of sediments	
Inspect health of vegetation	

In the case of vegetated buffers and vegetated swales, the collection of water quality samples is unlikely to yield valuable results. Given this, no sample based monitoring is recommended for these treatment systems. Instead, an inspection based monitoring and maintenance scheme as detailed below is considered appropriate for these types of devices.

Table 7-4 Monitoring Program for Vegetated Swales

MONITORING ACTIVITY	FREQUENCY
Inspect for erosion / scour of invert & batters	After major storm events > 25mm in 24 hrs or 3 monthly
Inspect for weed inundation / litter & debris accumulation	3 monthly
Inspect for inappropriate access, excessive wear & damage to invert & batters	3 monthly
Inspect for build-up of sediments	3 monthly
Inspect condition of vegetation such as vegetation health & density	3 monthly
Inspect condition of inlet & outlet structures	After major storm events > 25mm in 24 hrs or 3 monthly

7.2 Maintenance Schedule

The on-going performance of the stormwater management devices will be dependent on the maintenance conducted.

The maintenance programs as outlined below and detailed in **Table 7-5**, **Table 7-6**, **Table 7-7** and **Table 7-8** are to be implemented for the stormwater treatment devices.

Table 7-5 Maintenance Program for Sediment Basins

MAINTENANCE ACTIVITY	FREQUENCY
Clean out accumulated sediment	Every 2 years as per sediment basin calculations or as required by results of monitoring
Check visible pipes for leaks	6 monthly or as required by results of monitoring
Check fill material for settlement	6 monthly or as required by results of monitoring
Remove all trash from basin and riser	6 monthly or as required by results of monitoring
De-silt submerged inflow pipes	6 monthly or as required by results of monitoring

Sediment basins must be operated and maintained in an effective operational condition. These structures must not be allowed to accumulate sediment volumes in excess of forty per cent (40%) sediment storage design capacity. Where sedimentation basins are used a marker shall be placed within the basin to show the level above which the design capacity occurs. Materials removed from sediment retention devices must be disposed of in a manner approved by the consent authority that does not cause pollution.

Table 7-6 Maintenance Program for Rainwater Tanks

MAINTENANCE ACTIVITY	FREQUENCY
Clean out silt / litter trap	6 monthly or as required by results of monitoring
Remove debris from surcharge weir / pipe / pit	
Dewater and clean out / de-silt tank	As required by monitoring

Table 7-7 Maintenance Program for Level Spreader Devices

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to landscaping / level spreaders	As required by monitoring
Watering, re-vegetating, grass cutting	
Removal of litter, debris, weeds & excessive sediment build up	

Table 7-8 Maintenance Program for Vegetated Swales

MAINTENANCE ACTIVITY	FREQUENCY
Repairs to swale profile	As required by results of monitoring
Irrigating, infilling of vegetation to maintain sufficient cover	As required by results of monitoring
Removal of litter, debris, weeds & excessive sediment build up	6 monthly or as required by results of monitoring
Mowing / pruning of swale vegetation to maintain optimal vegetation height	As required by results of monitoring

Reforming of any swale profile will be required when the design flow area of the swale is reduced by 25%.

8 Conclusions

In preparing this conceptual stormwater management strategy preliminary water quality and quantity assessments were undertaken for rail construction camp 3.

The objectives of this stormwater management strategy were to meet the performance criteria outlined in **Table 3-1** of this report. The outcome of this preliminary investigation has recommended the inclusion of a number of stormwater quality and quantity management measures detailed herein and summarised as follows:

> Numerous vegetated swales for treatment and conveyance purposes as indicatively shown on Cardno 7508/90/08/-3.02; and

> Two constructed sediment basins as described in Sections 5 and 6, and indicatively shown on Cardno 7508/90/08/-3.02.

The detailed design of the treatment and detention devices will need to comply with the information outlined within this stormwater management strategy, and with the relevant authority guidelines.

9 References

Department of Environment and Resource Management 2009, *Queensland Water Quality Guidelines (2009)*, Version 3 September 2009, Brisbane, QLD

Water by Design 2010, *MUSIC Modelling Guidelines Version 1.0 – 2010*, Brisbane, QLD

International Erosion Control Association (Australasia) 2008, *Best Practice Erosion and Sediment Control*, November 2008, Picton, NSW

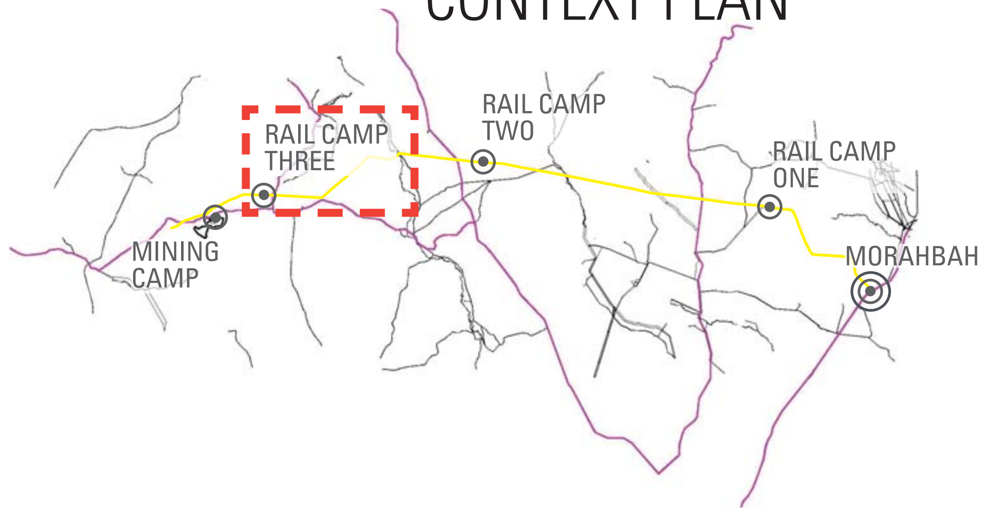
Department of Natural Resources and Water 2007, *Queensland Urban Drainage Manual 2007 (QUDM)*, Volume 1 Second Edition 2007, Brisbane, QLD

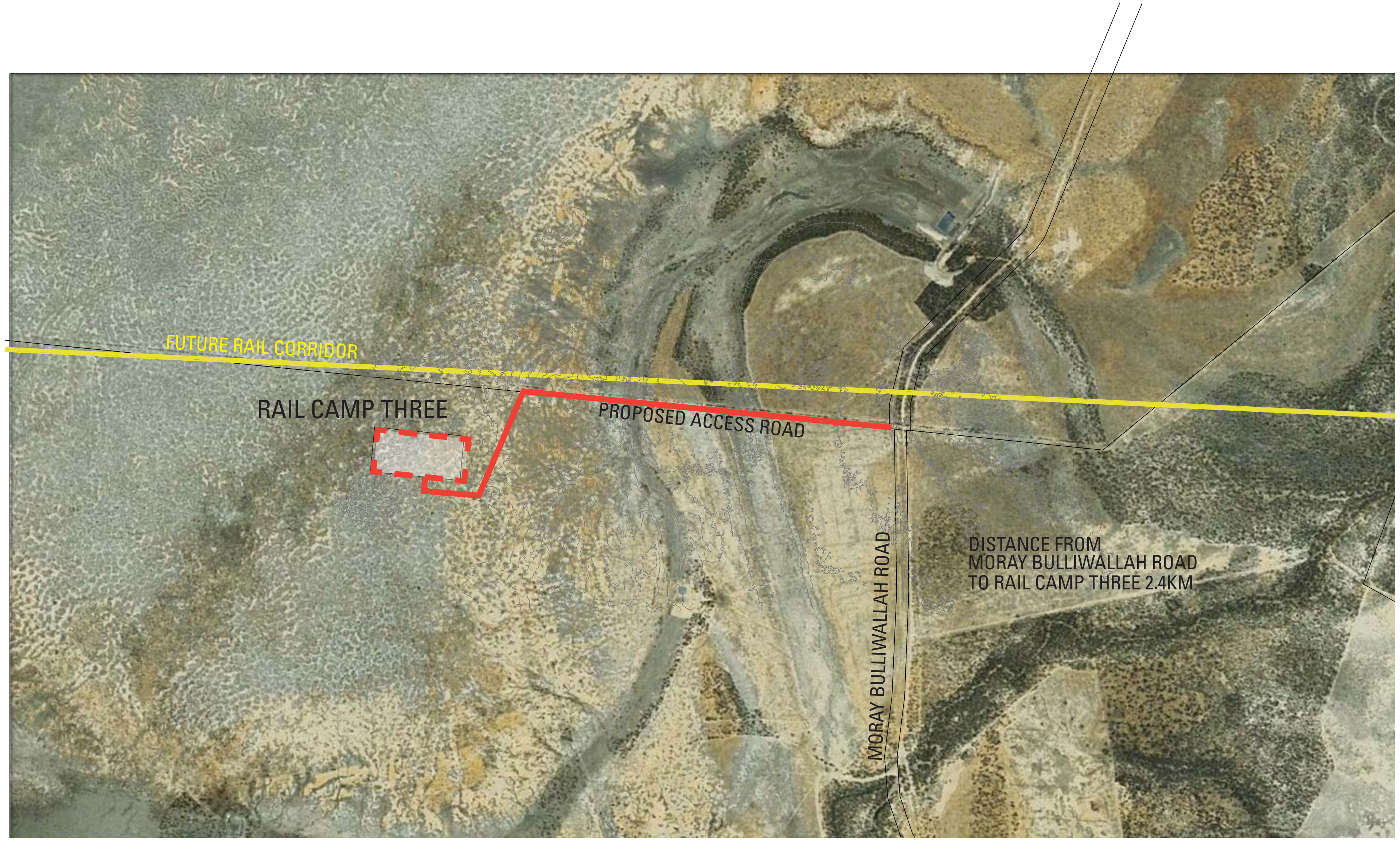
APPENDIX

A

REFERENCE DRAWINGS

RAILCAMP THREE
CONTEXT PLAN





scale 1:15,000 @ A3

TYPICAL SITE PHOTOS

Cardno
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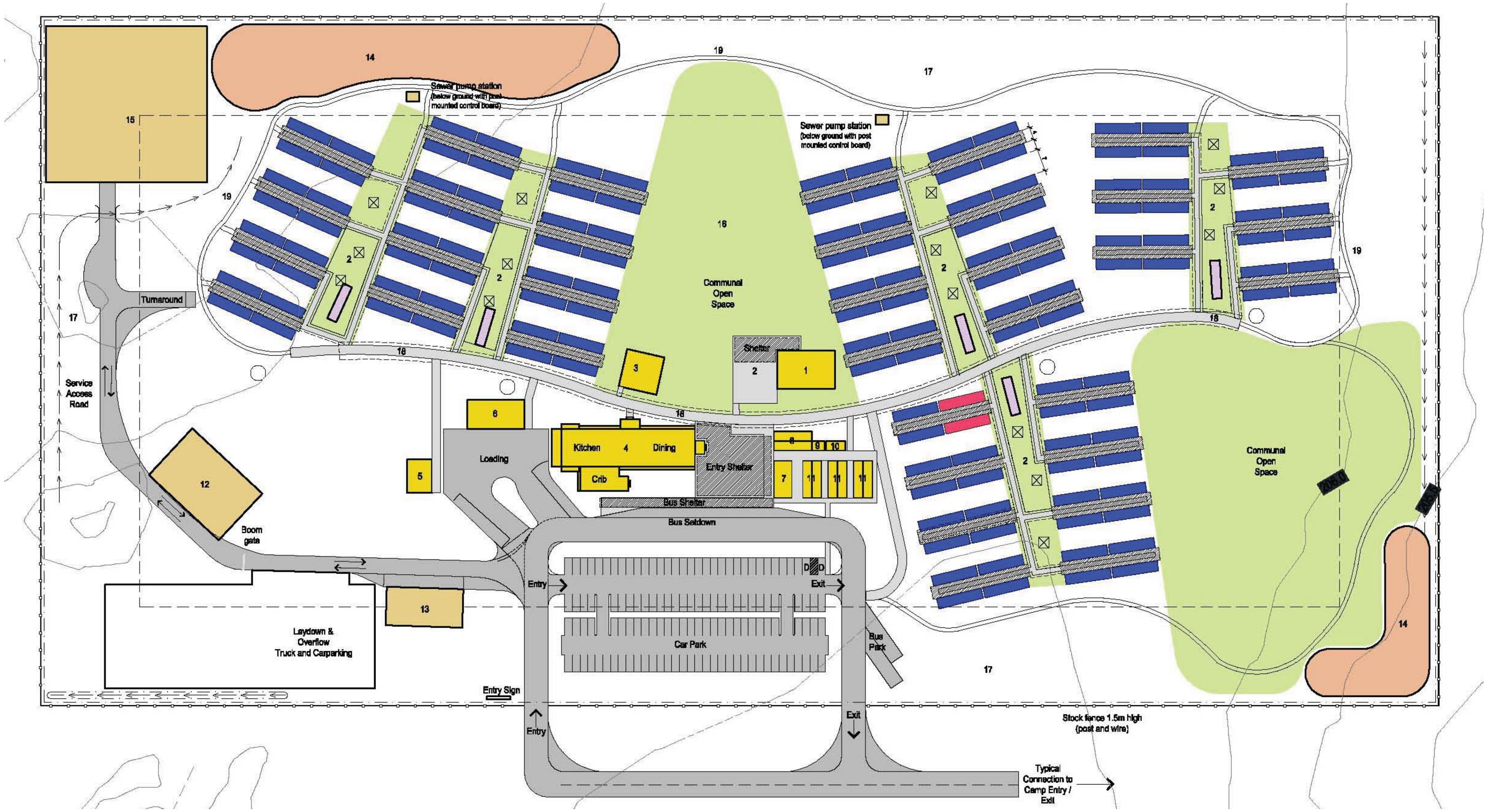
landscape architecture
urban design
environmental management

ADAMIN MINING Pty Ltd **RAIL CAMP 3**

DATE	DRAWING NO	ISSUE
18.10.12	SP126801 -RC03-01	A

RAILCAMP THREE
PLAN



LEGEND

COMMUNAL BUILDING	
ACCOMMODATION UNIT	
DISABLED UNIT	
LAUNDRY	
PATH	
INFRASTRUCTURE	
COMMUNAL OPEN SPACE	
DETENTION BASIN	

- 1 - Recreation Centre/ Wet Mess IT & Telephone
- 2 - BBQ & Shelter Areas
- 3 - Gym
- 4 - Kitchen/Dining
- 5 - Waste
- 6 - Maintenance / Linen Store
- 7 - Office
- 8 - Ablution M&F
- 9 - Ablution (Disabled)
- 10 - First Aid
- 11 - Lockers
- 12 - Water Treatment Plant
- 13 - Generator
- 14 - Detention Basin
- 15 - Sewerage Treatment Plant
- 16 - Communal Open Space
- 17 - Fire Break (30M wide)
- 18 - Central Path (3M wide) with Freestanding Awning
- 19 - Walking Track / Maintenance (1.2M - 2.5M wide)

Fire Tank Water
Catch Drain
Perimeter Bund
Perimeter Fence

ACCOMMODATION UNITS	405
DISABLED UNITS	2
CAR PARKING	125
DISABLED CARPARKING	2
BUS PARKING	2
EFFULENT DISPOSAL (based on 100m² per person)	4 ha
DETENTION BASIN	.34ha
TOTAL OPEN SPACE (including firebreak)	5.66 ha
TOTAL SITE AREA	9.38 ha

0 10 20 30 40 50 100
Scale 1:1500 @ A3 - Dimensions in metres

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ADAMIN MINING Pty Ltd **RAIL CAMP 3**

DATE	DRAWING NO	ISSUE
18.10.12	SP126801 -RC03-02	A

APPENDIX

B

FIGURES & SKETCHES

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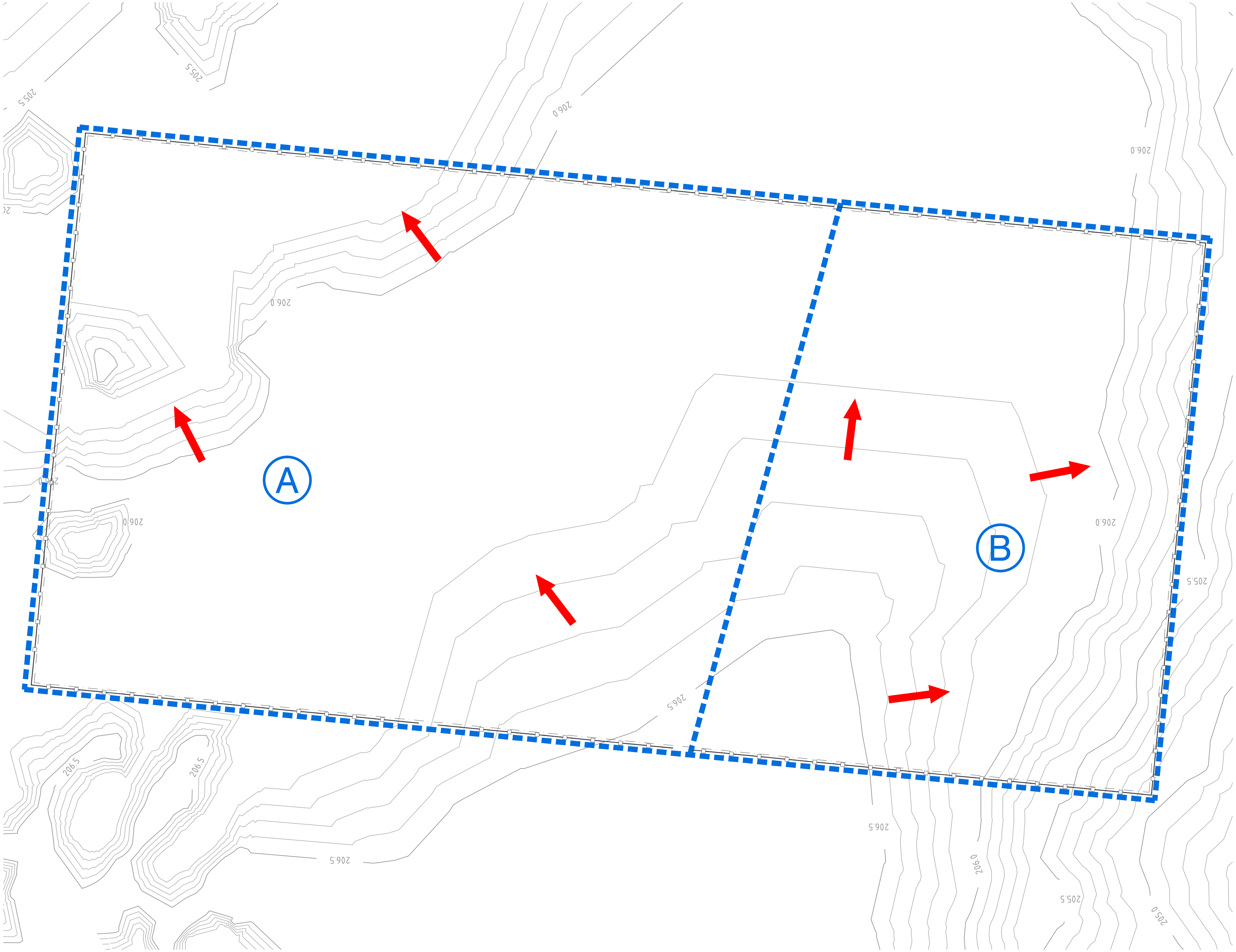
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES



LEGEND

- 258.0 — EXISTING SURFACE CONTOURS (0.1m INTERVALS)
- EXISTING OVERLAND FLOW DIRECTION
- CATCHMENT BOUNDARY
- (A) CATCHMENT LABEL

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO DETERMINE CONTRIBUTING CATCHMENT AREAS.

ADANI MINING PTY LTD - CARMICHAEL COAL MINE PROJECT

RAIL CAMP 3 - STORMWATER MANAGEMENT STRATEGY
EXISTING FEATURES LAYOUT PLAN

The contents of this plan are conceptual only. All areas and dimensions are approximate and subject to relevant studies, Survey, Engineering and Council approval.

Cardno
Cardno (Qld) Pty Ltd ACN: 051 074 992
Level 2 Podium Level - Emerald Lakes Town Centre
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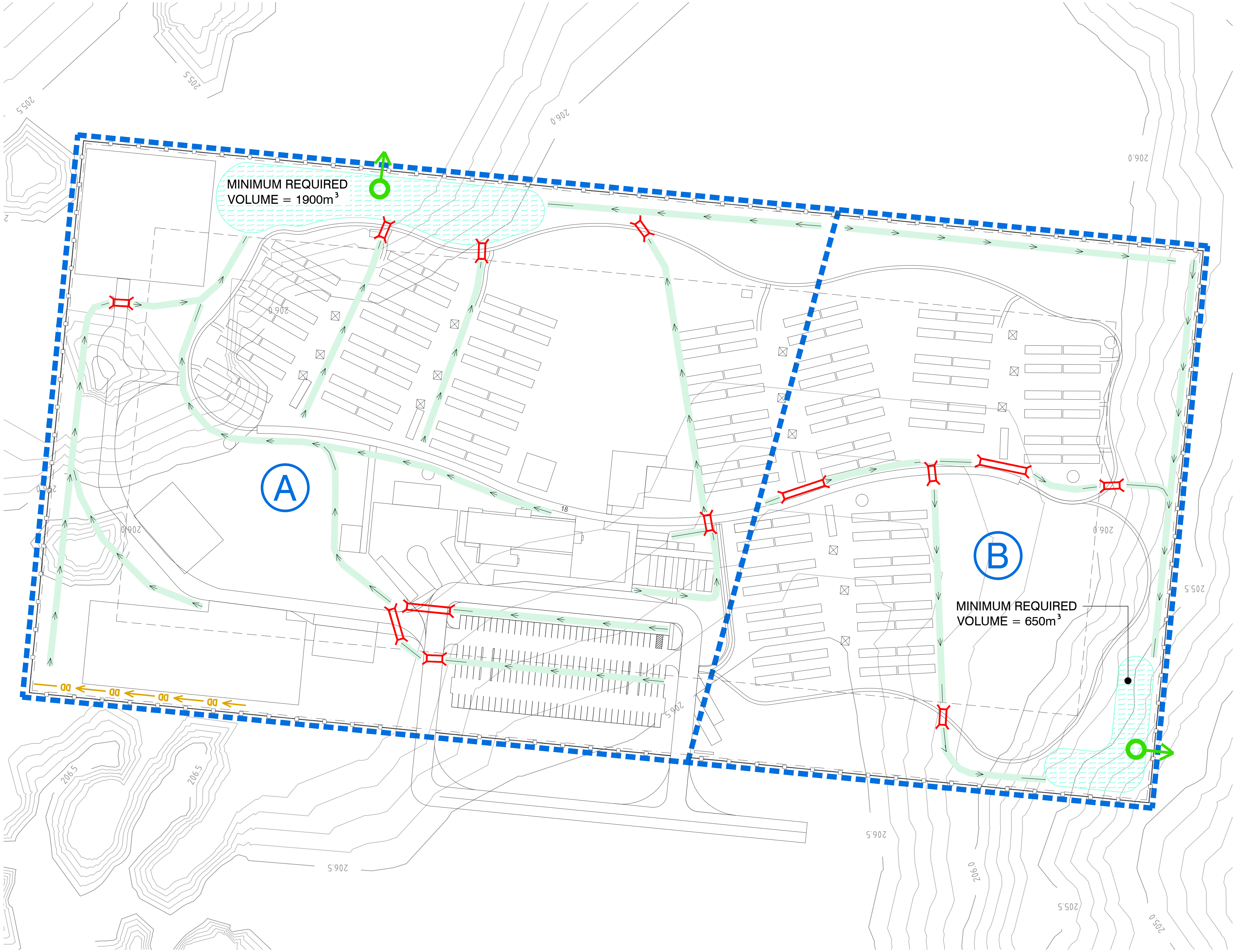
Quality Endorsed Company

REF NUMBER: 7508/90/08-3.01 (A)
DATE: 19/10/2012

7.5 0 7.5 15 22.5 30 37.5m
1:750 - A1 1:1500 - A3

P:\750890 – Adani Rail\03 Design\Cad\03 Sketches\SWMP SKETCHES\75089008 – CAMP 3

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES



LEGEND

- EXISTING SURFACE CONTOURS (0.1m INTERVALS)
- DEVELOPED CATCHMENT BOUNDARY
- CATCHMENT LABEL
- INTERNAL STORMWATER DRAINAGE SWALE AND FLOW DIRECTION (INDICATIVE LOCATION ONLY)
- PROPOSED CULVERT (INDICATIVE LOCATION ONLY)
- DD PROPOSED DIVERSION DRAIN. REFER NOTE 6.
- PROPOSED SEDIMENT/DETENTION BASIN AND INDICATIVE OUTLET. REFER NOTE 7.

NOTES:

1. CONTOURS ARE BASED ON AERIAL SURVEY. DETAILED SURVEY WILL BE REQUIRED TO CONFIRM CONTRIBUTING CATCHMENT AREAS FOR DETAILED DESIGN.
2. WHERE THE ROOF AREA DRAINAGE CANNOT BE PROVIDED WITH A FREE DRAINING CONNECTION TO THE PROPOSED SEDIMENT/DETENTION BASIN THE ROOF AREA DRAINAGE TO DISCHARGE TO RAINWATER TANK WITH A LEVEL SPREADER ATTACHED TO OUTLET.
3. SOME MINOR RE-GRADING WILL BE REQUIRED ONCE EXACT SITE CONDITIONS ARE DETERMINED.
4. WHERE A FREE DRAINING PIPED OUTLET CANNOT BE PROVIDED TO DRAIN THE SEDIMENT/DETENTION BASIN WITHIN THE FOOTPRINT OF THE CAMP SITE AREA, A PUMP WILL NEED TO BE PROVIDED.
5. ALL WATER TRAPPED WITHIN THE SEDIMENT/DETENTION BASIN IS TO BE TESTED FOR COMPLIANCE WITH THE RELEASE CRITERIA OUTLINED IN THE SWMS PRIOR TO A CONTROLLED RELEASE OFF-SITE.
6. CONSTRUCT DIVERSION BUND TO DIVERT EXTERNAL LOCAL CONTRIBUTING CATCHMENTS AROUND THE RAIL CAMP SITE. EXTENT AND SIZE OF THE BUND TO BE CONFIRMED AS PART OF THE DETAILED DESIGN. VELOCITY CONTROL MEASURES TO BE PROVIDED AT THE DOWNSTREAM END OF DIVERSION BUNDS TO DISPERSE CONCENTRATED FLOWS.
7. BASIN SPILLWAY LOCATION AND SIZE TO BE CONFIRMED AS PART OF THE DETAILED DESIGN.

ADANI MINING PTY LTD - CARMICHAEL COAL MINE PROJECT

RAIL CAMP 3 - STORMWATER MANAGEMENT STRATEGY
DEVELOPED CONDITIONS LAYOUT PLAN

The contents of this plan are conceptual only. All areas and dimensions are approximate and subject to relevant studies, Survey, Engineering and Council approval.

Cardno (Qld) Pty Ltd ACN: 051 074 992
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Quality Endorsed Company

REF NUMBER: 7508/90/08-3.02 (A)
DATE: 19/10/2012

7.5 0 7.5 15 22.5 30 37.5m
1:750 - A1 1:1500 - A3

P:\750890 – Adani Rail\03 Design\Cad\03 Sketches\SWMP SKETCHES\75089008 – CAMP 3

APPENDIX C

WATER QUALITY CALCULATIONS

Cardno

VOLUME OF SEDIMENT BASIN: TYPE D SOILS

PROJECT:- Carmichael Coal Mine - Camp No. 3
Catchment A
DESIGNER:- P.H
JOB No:- 750890
DATE:- 18/Oct/12

Basin Volume = Settling Zone Volume + Sediment Storage Zone Volume

Sediment Storage Zone Volume

Sediment storage zone taken as 50% of settling zone capacity or
the storage capacity required for the 2 year soil loss as calculated by the RUSLE

A **R.K.LS.P.C (RUSLE (Appendix E - IECA))**

A	=	Computed soil loss (tonnes/ha/yr)			
S	=	2 Year ARI, 6 Hour Storm Event	=	10.40	*mm/hr*
R	=	Rainfall Erosivity Factor	=	1804	(Appendix E Tables E1 or E2 - IECA)
or	=	$164.74\ (1.1177)^{S}\ S^{0.6444}$	=	**2370.05**	*(use if no chart exists)*
R	=	from above	=	2370	
K	=	Soil Erodibility Factor	=	0.02	(Appendix E Tables E4 or E5 - IECA)
LS	=	Slope Length / Gradient Factor	=	0.24	(Appendix E Table E3 - IECA)
P	=	Erosion Control Practice Factor	=	1.30	(Appendix E Table E11 - IECA)
C	=	Ground Cover	=	1.00	(Appendix E Tables E6 - E10 - IECA)

A Soil Loss = **11.092** **(tonnes/ha/yr)**

V Volume = **9** **(m^3/ha/yr)**

Disturbed Surface Area (ha) = 6.57 *ha*

Computed soil loss = **59** *m^3/yr*

Sediment Storage Zone Volume = **120** *m^3 (Assuming regeneration after 2 years)*

Settling Zone Volume

Settling Zone Volume = **10 x Cv x A x R(y%ile, 5day)**

10	=	Unit Conversion Factor	=	10.00	
Cv	=	Volumetric Runoff Coefficient	=	0.58	(Appendix B Table B7 - IECA)
A	=	Catchment Area of the Basin (ha)	=	6.57	*ha*
R(y%ile, 5day)	=	5 day total rainfall depth (mm) which is not exceeded in y percent of rainfall events.	=	32.50	(Appendix B Tables B5 or B6 - IECA)

Settling Zone = **1238.45** **m^3 Settling Zone Volume**

Depth of Basin = Basin Depth, min. 0.6 m = 1.00 *m*

TOTAL BASIN VOLUME = **Settling Zone Volume + Sediment Storage Zone Volume**
= **1358.45** **m^3**
= **1358** **m^3**

BASIN VOLUME PER HECTARE = **207** **m^3**

Using a ratio of 1:3, pond size = **21 x 64 m**

Cardno

VOLUME OF SEDIMENT BASIN: TYPE D SOILS

PROJECT:-	Carmichael Coal Mine - Camp No. 3 Catchment B	**DESIGNER:-**	P.H
JOB No:-	750890	**DATE:-**	11/Oct/12

Basin Volume = Settling Zone Volume + Sediment Storage Zone Volume

Sediment Storage Zone Volume

Sediment storage zone taken as 50% of settling zone capacity or
the storage capacity required for the 2 year soil loss as calculated by the RUSLE

A **R.K.LS.P.C (RUSLE (Appendix E - IECA))**

A	=	Computed soil loss (tonnes/ha/yr)			
S	=	2 Year ARI, 6 Hour Storm Event	=	10.40	*mm/hr*
R	=	Rainfall Erosivity Factor	=	1804	(Appendix E Tables E1 or E2 - IECA)
or	=	$164.74\ (1.1177)^{S}\ S^{0.6444}$	=	**2370.05**	*(use if no chart exists)*
R	=	from above	=	2370	
K	=	Soil Erodibility Factor	=	0.02	(Appendix E Tables E4 or E5 - IECA)
LS	=	Slope Length / Gradient Factor	=	0.24	(Appendix E Table E3 - IECA)
P	=	Erosion Control Practice Factor	=	1.30	(Appendix E Table E11 - IECA)
C	=	Ground Cover	=	1.00	(Appendix E Tables E6 - E10 - IECA)

A Soil Loss = **11.092** **(tonnes/ha/yr)**

V Volume = **9** **(m^3/ha/yr)**

Disturbed Surface Area (ha) = 2.76 *ha*

Computed soil loss = **25** *m^3/yr*

Sediment Storage Zone Volume = **50** *m^3 (Assuming regeneration after 2 years)*

Settling Zone Volume

Settling Zone Volume **= 10 x Cv x A x R(y%ile, 5day)**

10	=	Unit Conversion Factor	=	10.00	
Cv	=	Volumetric Runoff Coefficient	=	0.58	(Appendix B Table B7 - IECA)
A	=	Catchment Area of the Basin (ha)	=	2.76	*ha*
R(y%ile, 5day)	=	5 day total rainfall depth (mm) which is not exceeded in y percent of rainfall events.	=	32.50	(Appendix B Tables B5 or B6 - IECA)

Settling Zone = **520.26** **m^3 Settling Zone Volume**

Depth of Basin = Basin Depth, min. 0.6 m = 1.00 *m*

TOTAL BASIN VOLUME **= Settling Zone Volume + Sediment Storage Zone Volume**
= 569.96 m^3
= 570 m^3

BASIN VOLUME PER HECTARE **= 207 m^3**

Using a ratio of 1:3, pond size **= 14 x 41 m**

APPENDIX D

WATER QUANTITY CALCULATIONS

Camp Site No.3 - 2 year ARI flow

Existing Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
F_2xC_{10}	0.56	
C_2	0.56	
Time of conc	20	mins
Intensity	69.2	mm/hr
Flow	0.71	m^3/s
Total Flow	0.71	m^3/s
Volume	850.2	m^3

Developed Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
F_2xC_{10}	0.64	
C_2	0.64	
Time of conc	10	mins
Intensity	90.6	mm/hr
Flow	1.05	m^3/s
Total Flow	1.05	m^3/s
Volume	632.4	m^3

Detention Basin Sizing (preliminary)

Peak inflow	1.05	m^3/s
Peak outflow	0.71	m^3/s
Volume	843.26	m^3
r	0.33	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
152.59	276.47	160.33	214.53	276.47

Applying peak flow only factor 2
Required volume is - 553 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is.........

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	29.6	12.0	354.7	
1.0	37.6	20.0	751.2	552.9

Existing Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
F_2xC_{10}	0.56	
C_2	0.56	
Time of cor	15	mins
Intensity	80	mm/hr
Flow	0.34	m^3/s
Total Flow	0.34	m^3/s
Volume	309.7	m^3

Developed Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
F_2xC_{10}	0.64	
C_2	0.64	
Time of cor	6	mins
Intensity	109	mm/hr
Flow	0.53	m^3/s
Total Flow	0.53	m^3/s
Volume	191.8	m^3

Detention Basin Sizing (preliminary)

Peak inflow	0.53	m^3/s
Peak outflo	0.34	m^3/s
Volume	255.71	m^3
r	0.35	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
51.56	90.56	54.00	71.06	90.56

Applying peak flow only factor 2
Required volume is - 181 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is.........

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	6.3	12.0	75.8	
1.0	14.3	20.0	286.4	181.1

Cardno

Camp Site No.3 - 5 year ARI flow

Existing Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_5 x C_{10}$	0.63	
C_5	0.63	
Time of conc	20	mins
Intensity	90.9	mm/hr
Flow	1.04	m^3/s
Total Flow	1.04	m^3/s
Volume	1248.2	m^3

Developed Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_5 x C_{10}$	0.71	
C_5	0.71	
Time of conc	10	mins
Intensity	120	mm/hr
Flow	1.56	m^3/s
Total Flow	1.56	m^3/s
Volume	936.2	m^3

Detention Basin Sizing (preliminary)

Peak inflow	1.56	m^3/s
Peak outflow	1.04	m^3/s
Volume	1248.30	m^3
r	0.33	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
231.23	416.18	242.79	323.71	416.18

Applying peak flow only factor 2
Required volume is - 832 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is.........

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	47.0	12.0	564.3	
1.0	55.0	20.0	1100.5	832.4

Existing Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_5 x C_{10}$	0.63	
C_5	0.63	
Time of coı	15	mins
Intensity	102	mm/hr
Flow	0.49	m^3/s
Total Flow	0.49	m^3/s
Volume	441.3	m^3

Developed Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_5 x C_{10}$	0.71	
C_5	0.71	
Time of coı	6	mins
Intensity	144	mm/hr
Flow	0.79	m^3/s
Total Flow	0.79	m^3/s
Volume	283.2	m^3

Detention Basin Sizing (preliminary)

Peak inflow	0.79	m^3/s
Peak outflo	0.49	m^3/s
Volume	377.57	m^3
r	0.38	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
83.12	142.22	86.81	112.67	142.22

Applying peak flow only factor 2
Required volume is - 284 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is.........

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	12.8	12.0	153.3	
1.0	20.8	20.0	415.5	284.4

Cardno

Camp Site No.3 - 10 year ARI flow

Existing Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{10}xC_{10}$	0.66	
C_{10}	0.66	
Time of conc	20	mins
Intensity	104	mm/hr
Flow	1.25	m^3/s
Total Flow	1.25	m^3/s
Volume	1503.2	m^3

Developed Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{10}xC_{10}$	0.75	
C_{10}	0.75	
Time of conc	10	mins
Intensity	137	mm/hr
Flow	1.88	m^3/s
Total Flow	1.88	m^3/s
Volume	1125.1	m^3

Detention Basin Sizing (preliminary)

Peak inflow	1.88	m^3/s
Peak outflow	1.25	m^3/s
Volume	1500.15	m^3
r	0.33	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
276.22	498.01	290.08	387.11	498.01

Applying peak flow only factor 2
Required volume is - 996 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	57.3	12.0	687.0	
1.0	65.3	20.0	1305.0	996.0

Existing Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{10}xC_{10}$	0.66	
C_{10}	0.66	
Time of coı	15	mins
Intensity	120	mm/hr
Flow	0.61	m^3/s
Total Flow	0.61	m^3/s
Volume	546.5	m^3

Developed Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{10}xC_{10}$	0.75	
C_{10}	0.75	
Time of coı	6	mins
Intensity	166	mm/hr
Flow	0.95	m^3/s
Total Flow	0.95	m^3/s
Volume	343.6	m^3

Detention Basin Sizing (preliminary)

Peak inflow	0.95	m^3/s
Peak outflc	0.61	m^3/s
Volume	458.16	m^3
r	0.36	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
96.01	166.70	100.42	131.35	166.70

Applying peak flow only factor 2
Required volume is - 333 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	15.8	12.0	190.1	
1.0	23.8	20.0	476.8	333.4

Camp Site No.3 - 20 year ARI flow

Existing Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{20}xC_{10}$	0.69	
C_{20}	0.69	
Time of conc	20	mins
Intensity	121	mm/hr
Flow	1.53	m^3/s
Total Flow	1.53	m^3/s
Volume	1836.4	m^3

Developed Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{20}xC_{10}$	0.79	
C_{20}	0.79	
Time of conc	10	mins
Intensity	160	mm/hr
Flow	2.30	m^3/s
Total Flow	2.30	m^3/s
Volume	1379.7	m^3

Detention Basin Sizing (preliminary)

Peak inflow	2.30	m^3/s
Peak outflow	1.53	m^3/s
Volume	1839.60	m^3
r	0.33	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
342.34	615.35	359.40	478.84	615.35

Applying peak flow only factor 2

Required volume is - 1231 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	71.9	12.0	863.0	
1.0	79.9	20.0	1598.4	1230.7

Existing Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{20}xC_{10}$	0.69	
C_{20}	0.69	
Time of coı	15	mins
Intensity	137	mm/hr
Flow	0.73	m^3/s
Total Flow	0.73	m^3/s
Volume	655.1	m^3

Developed Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{20}xC_{10}$	0.79	
C_{20}	0.79	
Time of coı	6	mins
Intensity	194	mm/hr
Flow	1.17	m^3/s
Total Flow	1.17	m^3/s
Volume	421.7	m^3

Detention Basin Sizing (preliminary)

Peak inflow	1.17	m^3/s
Peak outflc	0.73	m^3/s
Volume	562.21	m^3
r	0.38	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
124.65	212.83	130.17	168.74	212.83

Applying peak flow only factor 2

Required volume is - 426 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	21.6	12.0	259.2	
1.0	29.6	20.0	592.1	425.7

Camp Site No.3 - 50 year ARI flow

Existing Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{50}xC_{10}$	0.76	
C_{50}	0.76	
Time of conc	20	mins
Intensity	144	mm/hr
Flow	1.99	m^3/s
Total Flow	1.99	m^3/s
Volume	2393.6	m^3

Developed Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{50}xC_{10}$	0.86	
C_{50}	0.86	
Time of conc	10	mins
Intensity	191	mm/hr
Flow	3.01	m^3/s
Total Flow	3.01	m^3/s
Volume	1803.9	m^3

Detention Basin Sizing (preliminary)

Peak inflow	3.01	m^3/s
Peak outflow	1.99	m^3/s
Volume	2405.17	m^3
r	0.34	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
451.43	809.45	473.80	630.44	809.45

Applying peak flow only factor 2
Required volume is - 1619 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	96.2	12.0	1154.2	
1.0	104.2	20.0	2083.6	1618.9

Existing Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{50}xC_{10}$	0.76	
C_{50}	0.76	
Time of coı	15	mins
Intensity	162	mm/hr
Flow	0.94	m^3/s
Total Flow	0.94	m^3/s
Volume	848.4	m^3

Developed Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{50}xC_{10}$	0.86	
C_{50}	0.86	
Time of coı	6	mins
Intensity	231	mm/hr
Flow	1.53	m^3/s
Total Flow	1.53	m^3/s
Volume	549.9	m^3

Detention Basin Sizing (preliminary)

Peak inflow	1.53	m^3/s
Peak outflo	0.94	m^3/s
Volume	733.19	m^3
r	0.38	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
165.22	280.71	172.44	222.96	280.71

Applying peak flow only factor 2
Required volume is - 561 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	30.1	12.0	361.1	
1.0	38.1	20.0	761.8	561.4

Camp Site No.3 - 100 year ARI flow

Existing Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of conc	20	mins
Intensity	162	mm/hr
Flow	2.34	m^3/s
Total Flow	2.34	m^3/s
Volume	2809.9	m^3

Developed Case
Internal Catchment A

Area	6.57	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{100}xC_{10}$	0.90	
C_{100}	0.90	
Time of conc	10	mins
Intensity	215	mm/hr
Flow	3.53	m^3/s
Total Flow	3.53	m^3/s
Volume	2118.8	m^3

Detention Basin Sizing (preliminary)

Peak inflow	3.53	m^3/s
Peak outflow	2.34	m^3/s
Volume	2825.10	m^3
r	0.34	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
531.09	951.86	557.39	741.48	951.86

Applying peak flow only factor 2

Required volume is - 1904 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	114.0	12.0	1367.8	
1.0	122.0	20.0	2439.7	1903.7

Existing Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.66	
$F_{100}xC_{10}$	0.79	
C_{100}	0.79	
Time of coı	15	mins
Intensity	185	mm/hr
Flow	1.12	m^3/s
Total Flow	1.12	m^3/s
Volume	1011.0	m^3

Developed Case
Internal Catchment B

Area	2.76	ha
(using QUDM Vol 1. Book 2. Chapter 4.0)		
C_{10}	0.75	
$F_{100}xC_{10}$	0.90	
C_{100}	0.90	
Time of coı	6	mins
Intensity	260	mm/hr
Flow	1.79	m^3/s
Total Flow	1.79	m^3/s
Volume	645.8	m^3

Detention Basin Sizing (preliminary)

Peak inflow	1.79	m^3/s
Peak outflc	1.12	m^3/s
Volume	861.12	m^3
r	0.37	

Required storage volume

Culp	Boyd	Carroll	Basha	Maximum
187.54	321.93	195.94	254.73	321.93

Applying peak flow only factor 2

Required volume is - 644 m^3.

Assuming a rectangular basin with 1 in 4 side slopes
and maximum depth of 1.0 metres, required surface area is………

Depth (m)	Length (m)	Width (m)	Area (m^2)	Volume (m^3)
0.0	35.2	12.0	422.9	
1.0	43.2	20.0	864.8	643.9

ELECTRICAL REPORT PREPARED BY CARDNO

Cardno
Shaping the Future

Adani Temporary Rail Camps 1, 2, 3

Electrical Load Estimate

Prepared for: Cardno

Date: 23 October 2012

1.0 ELECTRICAL LOAD ESTIMATE

1.1 The Proposed Development

The proposed development includes the staged construction of a workers' accommodation village and includes 405 air conditioned single-bed accommodation units and associated central facilities – including dining halls, recreational facilities and administration – and distributed facilities such as laundries and car parking.

1.2 Occupancy and Operation

Occupancy on the site will be variable both throughout the day/week and throughout the year. The exact occupancy of the camp, including the proportional split between shifts, is not yet known and in any case is subject to change over time. For the purposes of maximum demand in this report, the worst case – 100% of workers on day shift returning at 7pm – is assumed.

The operation and utilisation of central facilities will also be subject to these bulk worker movements (for example, meal preparation leading up to worker arrival, and food/beverage service after arrival); however these facilities will operate on a more or less continuous basis.

4.3 Typical Accommodation Block Load Estimate

The table below is based on the Atco 14.4 x 3.3 three person unit drawing. There will be other types of units installed such as disabled access units however the four person unit will be the typical unit installed.

Accommodation Electrical Load Items	**Per Unit (Watts) 1 phase**	**Averaged 3 phase load per unit (Watts)**
Lighting	60	
Television	50	
Fridge (Westinghouse WRM1300WC)	100	
General Power (laptop, phone charger)	100	
Hot Water (Rheem 235 Litre heat pump)	250	
Air-conditioning (TECO 2.66kW split system)	740	
Accommodation Electrical Load Estimate	**1,300 1ph**	**434 3ph**

1.3 Site Based Load Estimate

The table below illustrates various insulation and air conditioners for the accommodation units.

Description	Qty / Area	Per Unit (kVA)	Total (kVA)
Accommodation Unit Power (three phase load)	405	0.434	176.4
Kitchen Diner Power (40VA/m^2)	590	0.04	23.6
Kitchen Diner Air Conditioning (80VA/m^2)	590	0.08	47.2
Office Power (40VA/m^2)	72	0.04	2.9
Office Air Conditioning (80VA/m^2)	72	0.08	5.8
Gym Power (40VA/m^2)	144	0.04	5.8
Gym Air Conditioning (80VA/m^2)	144	0.08	11.6
Recreation Centre Power (30VA/m^2)	216	0.03	6.5
Recreation Centre Air Conditioning (80VA/m^2)	216	0.08	17.3
Laundry Power (60VA/m^2)	36	0.06	2.2
Exterior Lighting (1VA/m^2)	56000	0.001	56
Sewer Treatment Plant	1	50	50
Subtotal			404.9
Contingency 20%	20%		81
Total Electrical Demand			**486 kVA**

Insignificant electrical loads such as ablution and linen electrical loads are included in the contingency allowance

1.4 Sustainable Options

Solar panels can be installed to reduce the daytime electrical loading however a solar system will not however reduce the site's peak demand which is expected to occur around 6-8pm. As a result this system will reduce daytime diesel usage costs but not generator sizes.

1.5 Generator Recommendation

1.5.1 Investigation / Feasibility

The camp will be supplied via onsite diesel generation plant with associated fuel storage.

Based on our experience, and advice from colleagues at Power and Water Corporation (Northern Territory), two likely plant suppliers were identified – Cummins and Caterpillar. Of these, it is understood that Cummins have better plant availability and so we have held initial discussions with them. This does not preclude the consideration of Caterpillar or other suppliers at the next stage of design.

To serve the site's maximum demand of 486kVA, a total of two (2) 600kVA 415V generators would be required (one duty, one standby). The larger kVA rating is required as the generators are designed for 0.8 power factor and the anticipated power factor for the mining camp is close to unity. The location of these generators needs to be carefully considered due to the noise and emissions implications of large diesel generation sets.

1.5.2 Fuel Storage

The camp will be supplied via onsite diesel generation plant with associated fuel storage. At full load a single Cummins C700 640kVA prime rated generator uses approximately 140 litres of diesel per hour at full load. Based on a six day refuelling schedule a single 20,000L double bunded diesel tank is required to service both generators. Refer to figure 7 below.

Figure 7 – typical self-bunded diesel storage units.

1.5.3 Available Capacity and Timeframe

The standard lead time for the generators is 12 weeks if there are not units available onshore. The lead time for the 20,000 litre fuel tanks is 12 weeks.

1.5.4 Operation and Maintenance Costs

Assuming the generators are loaded on average to 75% of their rated capacity with a fuel usage of 100 litres per hour and an assumed price of diesel at $1.60/litre results in a monthly fuel cost of approximately $115,000/month.

The anticipated maintenance cycle for the generators would be 1,000 hours. Assuming approximately 12 hours/day duty, each set would require maintenance every 12 weeks. Oil changes would occur every 4,000 hours or every 11 months per set. Major overhaul of each set would be required every three years. On this basis maintenance costs would be in the order of $40,000 per year.

2.0 RECOMMENDATIONS AND CONCLUSION

Based on the above, it is recommended that for the purposes of design and supply to the site, a 'base' (worst case) maximum demand value of **486kVA** be adopted. This value allows for an occupancy of 405 units all on day shift, and further includes a 20% design contingency.

It is recommended two generators are installed in a duty / standby arrangement. The recommended generator size is **600kVA** with a **20,000 litre** double bunded diesel tank to serve both generators on a six day refuelling schedule.