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Cherrabah Granite Mine | Stormwater Management Plan V1.2 | 17/02/2017
INTRODUCTION

This Stormwater Management Plan has been prepared for the proposed Cherrabah Granite Mine development on land described as Lot 1000 SP268215. The site is located approx. 25km south of Warwick within the Southern Downs Regional Council and has a total area of 1988 ha. However the Mining Lease is confined to an approx 18ha area in the North West portion of the property. The Stormwater Management Plan (SMP) addresses the management of surface water flows impacted by the mine development, and recommends erosion and sediment control measures to reduce the amount of contaminated stormwater produced on site. The plan is centred on the use of preventative erosion control measures to reduce contaminated runoff along with sediment basins to intercept contaminated stormwater runoff and remove suspended fine material prior to discharge. The plan has been prepared on the following basis:

- Assessment of existing site conditions regarding stormwater design and devising a practical plan, implementation programme and timeline to conform to best practice environmental management.
- Determining site disturbed areas and designing associated water collection dams, sediment basins and drainage regimes on site to ensure that no contaminated water leaves the site untreated.
- Ensuring that all uncontaminated water from undisturbed areas is diverted around the disturbed area catchment.
- All basins and dams on site are designed to be Non-Referable and Non-Hazardous Materials Dams (3m-8m high).

Table 1 shows the Design Rainfall Intensity Table for the mine location for different Average Recurrence Intervals (ARIs).

### TABLE 1: DESIGN RAINFALL INTENSITY TABLE AT CHERRBABAH LOCATION

<table>
<thead>
<tr>
<th>Duration</th>
<th>EY</th>
<th>50%</th>
<th>20%</th>
<th>10%</th>
<th>5%</th>
<th>2%</th>
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<tr>
<td>1 min</td>
<td>2.1</td>
<td>2.4</td>
<td>3.3</td>
<td>3.9</td>
<td>4.6</td>
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<td>2 min</td>
<td>3.6</td>
<td>4.1</td>
<td>5.6</td>
<td>6.7</td>
<td>7.7</td>
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<td>14.0</td>
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<td>4 min</td>
<td>6.3</td>
<td>7.1</td>
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<td>11.7</td>
<td>13.5</td>
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<tr>
<td>5 min</td>
<td>7.4</td>
<td>8.4</td>
<td>11.6</td>
<td>13.8</td>
<td>16.0</td>
<td>19.0</td>
<td>21.2</td>
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<tr>
<td>10 min</td>
<td>11.8</td>
<td>13.4</td>
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<td>25.9</td>
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<tr>
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<td>16.9</td>
<td>23.4</td>
<td>28.0</td>
<td>32.6</td>
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<td>44.6</td>
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<td>29.6</td>
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<td>48.4</td>
<td>56.2</td>
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<td>2 hour</td>
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<td>36.0</td>
<td>49.6</td>
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<td>3 hour</td>
<td>35.7</td>
<td>40.0</td>
<td>54.0</td>
<td>63.9</td>
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<td>6 hour</td>
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<td>47.8</td>
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<td>86.8</td>
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<td>57.6</td>
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<td>90.3</td>
<td>104.3</td>
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<tr>
<td>24 hour</td>
<td>63.5</td>
<td>70.5</td>
<td>93.9</td>
<td>110.9</td>
<td>128.4</td>
<td>153.8</td>
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<td>48 hour</td>
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<td>86.5</td>
<td>116.0</td>
<td>137.5</td>
<td>159.9</td>
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<td>72 hour</td>
<td>86.3</td>
<td>96.4</td>
<td>130.1</td>
<td>154.7</td>
<td>180.3</td>
<td>215.2</td>
<td>242.6</td>
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<tr>
<td>96 hour</td>
<td>92.3</td>
<td>103.2</td>
<td>139.7</td>
<td>166.5</td>
<td>194.4</td>
<td>231.7</td>
<td>260.9</td>
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<tr>
<td>120 hour</td>
<td>96.5</td>
<td>107.9</td>
<td>146.3</td>
<td>174.7</td>
<td>204.3</td>
<td>243.4</td>
<td>274.1</td>
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<tr>
<td>144 hour</td>
<td>99.5</td>
<td>111.2</td>
<td>150.9</td>
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<td>211.2</td>
<td>251.9</td>
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<tr>
<td>168 hour</td>
<td>101.7</td>
<td>113.5</td>
<td>153.8</td>
<td>184.0</td>
<td>216.0</td>
<td>258.1</td>
<td>291.5</td>
</tr>
</tbody>
</table>
2 SITE CHARACTERISTICS

The site is characterised by moderately sloping terrain with steep sections, the natural fall is to the north where various gullies and watercourses convey runoff to the surrounding creek systems. There is one main ephemeral watercourse traversing the western boundary of the lease area and multiple small feeder gullies are present around and through the proposed operational area. The extraction area contains minimal vegetation with the exception of a segregated patch on the upper slope but all other areas within the lease maintain a cover of open forest woodland dominated by Eucalypts. The topography of the Mining Lease ranges from approx. RL830 in the south to a low of RL750m in the north. Other peaks on the site reach an elevation of 940m and the lowest point on site is on the north eastern boundary at 630mRL. The main receiving environment for stormwater is Lord John Creek which is a 4th order watercourse. The headwaters of Lord John Creek starts approx 100m south of the Mining Lease and flows around the western perimeter, it merges with other watercourses and was observed as a flowing creek some 9km downstream where it crossed O’Deas Rd. The majority of the catchment is relatively undisturbed bushland but does include some cropping land further down the catchment. The access road to the site also crosses several mapped watercourses that are part of the same Lord John Creek catchment.

Extraction is carried out in campaign operations with dirty stormwater flowing to basins located at the downslope (northern) portion of the catchment. The catchment has been split into three areas, with Area 1a and 1b comprising the staged development of the Extraction Area 1. Area 2 comprises the western portion of the stockpile area (Stockpile Area 1) and Area 3 comprises the eastern portion of the stockpile area (Stockpile Area 2). Areas 2 and 3 incorporate a clean water bypass through the centre of the catchment to maintain the existing gully. No mining development will be undertaken within mapped watercourses or their buffer zone. Slopes within the mining catchment area vary significantly due to the granite outcrops but are generally between 1 in 3 and 1 in 15.

3 STORMWATER MANAGEMENT

This stormwater management plan focuses on the three catchment areas of the mine, comprising the extraction pit (Area 1a & 1b), the western stockpile area (Area 2) and the eastern stockpile area (Area 3). Each area has a stormwater management system designed to suit its needs and operate independently to allow development in stages. Emphasis is placed on reducing the quantity of uncontaminated stormwater entering the disturbed catchment areas through installation of diversion bunds around the disturbed areas.

Area 1 is the extraction area and slopes from south to north with a vertical drop of approx 50m over a 250m horizontal distance. The area has been split into two sub-catchments with Area 1a comprising the lower northern portion and Area 1b comprising the upper southern portion. Development will start in Area 1a and will progress into Area 1b after several years. The sediment basin requirements for each catchment have been assessed and a sediment basin has been designed for the base of the extraction area. It is likely to be an excavated sump due to the exposed outcrop. Due to the outcrop containing minimal vegetation, the area is anticipated to have a runoff coefficient of approx 0.83. Area 1a will have diversion bunds along its southern boundary to divert clean water and catch drains on the eastern and western boundaries to convey dirty water to the basin. Dirty stormwater flows to Basin 1a located at the northern edge of the pit where it is settled/treated prior to discharge. Basin 1a spillway is located on the northeast corner of the basin and it flows to the water storage dam via a lined catch drain. The spillway will be designed to a 1 in 50 year ARI peak flow. Once Area 1b is developed stormwater will be managed in a similar manner but the basin will be enlarged, the diversion bund will be relocated to the top of the slope and the eastern and western catch drains will be extended upslope to the top of the disturbed catchment. Refer SWP_001 for Area 1a & 1b details.
Area 2 is the western stockpile area adjacent to the extraction area and slopes from southwest to northeast with a vertical drop of approx 17.5m over a 125m distance. Area 3 is the eastern stockpile area and slopes from southeast to northwest with a vertical drop of approx 12.5m over a 140m distance. A clean water drain will run through the centre of the two areas to allow upslope clean water to continue along its original path in the gully. Access roads will traverse the area and cross the drains as required with culverts to be installed where necessary. Infrastructure within the stockpile areas includes a small site office and a shed so impervious areas are negligible. It is assumed that the stockpile areas will have a runoff coefficient of approx 0.75. Each stockpile area contains diversion bunds along the upslope boundaries and catch drains at the lower boundaries directing flow to a sediment basin at its lowest point. Area 2 is directed to Basin 2 and Area 3 is directed to Basin 3. Basin 2 will contain a spillway in the northeast corner and Basin 3 will contain a spillway in the northwest corner. Each basin spillway will be designed to a 1 in 50 year ARI peak flow. Refer SWP_002 for Area 2 & 3 details.

The Environmental Authority (EA) is likely to specify a minimum stormwater storage requirement as per best practice for a 1 in 10 year event over a 24hr duration, this corresponds to a total rainfall depth of 110.9mm. Water collected in the basins is allowed to settle and is then re-used for dust suppression or treated and discharged if it meets the water quality limits specified in the EA.

4 PROPOSED STORMWATER MANAGEMENT STRATEGY

The operators of the Cherrabah Granite Mine understand that it is more economically and environmentally sustainable to prevent the production of sediment than it is to treat contaminated stormwater. The key management strategies to reduce erosion and manage stormwater are by using proven erosion and sediment control measures.

4.1 EROSION CONTROL MEASURES

The key management strategies to reduce potential erosion are as follows:

- Minimise disturbed catchment area;
- Diversion bunds/drain; and
- Catch drain treatments

4.1.1 MINIMISE DISTURBED CATCHMENT AREA

The key to reducing the amount of erosion occurring on any site is by minimising the disturbed catchment area. Due to the geological formation of the resource, topographic land features and the selected extraction method, a benching extraction method has been employed. By completing a receding rim extraction method the disturbed area can be minimised with development in the extraction area to be staged.

4.1.2 DIVERSION BUND/S DRAINS

Undisturbed catchment areas above and around the mine workings should be identified, and if possible diversions should be established to reduce the amount of clean (uncontaminated) stormwater entering disturbed areas. These diversions would be in the form of a contour drain or diversion bund depending on soil type and practicality.

Contour drains are suitable for placement on slopes up to 18% with the drain grade designed at around 0.5-1.0%. Diversion drains can be installed on much steeper slopes provided the appropriate engineering design is applied to the structure. Care should be taken when selecting the material to construct diversion bunds as
the drains themselves would be susceptible to erosion. These will divert clean/contaminated stormwater to nearby watercourses or discharge points, appropriate protection will be established where diverted stormwater enters watercourses. ‘Diversion bunds’ and ‘contour drains’ are illustrated in Figures 1 and 2.

**FIGURE 1 DIVERSION BUND**


**FIGURE 2 CONTOUR DRAIN**

4.1.3 CATCH DRAIN TREATMENTS

Catch drains are designed to transport concentrated stormwater flow from one area to another, such as to transport contaminated stormwater to sediment basins or from a spillway to a discharge point. Appropriate treatments for catch drains includes lining the drain with rocks, geotextile material or ensuring the slope of the drain does not cause excessive water velocity and scouring. Maintaining the drains at regular intervals is important as is using large rocks of sufficient thickness to protect the underlying soil when lining the drain. If rock lining is used it is imperative that the drain is overcut to ensure that the design volume of the drain is maintained. The placement of rock check dams or a rock lining will reduce the peak water flow velocities and minimise scouring of the drain. Figure 3 outlines an example of a drain with rock lining.

FIGURE 3 ROCK LINING

Source: Introductory Erosion and Sediment Control Guidelines for Queensland Councils.

4.2 SEDIMENT CONTROL MEASURES

- Sediment fences,
- Check dams; and
- Sediment basins.

4.2.1 SEDIMENT FENCES

Sediment fences are suitable for coarse sediments in sheet flow environments. Sediment fences work on the same principle of gravity settling only on a much smaller scale than sediment basins. The placement of a sediment fence should be along the contour with the ends ‘turned up’ to create a small catchment area. Quantities of sediment fence should be in the order of 100m per 0.6ha of catchment area. Care should be taken not to install these fences in concentrated flow.

Sediment fences are recommended to be installed in areas where runoff is not directed to designated sediment basins during temporary earthworks. Where stockpiles (topsoil or mining products) are to be left for >90 days a sediment fence will be established immediately downslope of the stockpile to minimise the potential for sediment transport. Figure 4 illustrates sediment fences being used downslope from soil stockpiles.
4.2.2 CHECK DAM

Check dams can be used as a temporary sediment control device to capture coarse sediments from drainage systems. This type of barrier requires regular maintenance to prevent them filling up with sediment and overtopping. Care should also be taken to ensure erosion does not occur around the edge of the barrier.

Source: Introductory Erosion and Sediment Control Guidelines for Queensland Councils.
Coir Fibre Log Silt Berms can also be installed in catch drains or as check dams as a basic form of sediment capture. Logs are held in place with star pickets or wooden pegs but can only withstand low-medium velocity flows due to their frail structure. To assist with stability the logs can be placed with a rock backing for support. This type of treatment is short term as the log may become weak when waterlogged, typical use may be for short term excavations that do not currently drain to a sediment basin or for low flow catch drains as a pre-treatment system.

**FIGURE 6 COIR FIBRE LOG SILT BERMS**

Source: Bruce Highway Tiaro - Sunshine Coast Regional Council

### 4.2.3 SEDIMENT BASINS

Sediment basins have been designed and located to collect stormwater runoff from disturbed areas. Basins have been selected to trap coarse sediment during most storm events, and to trap fine sediment during frequent minor storm events. The design of these basins allows sufficient settling time for sediments to produce overflow conforming to the appropriate standards. The basins feature a protected inlet(s) and rock lined spillway. These basins act as a ‘last line of defence’ to settle out sediments before release during high rainfall events. Where required, water from the sediment basins will be re-used on site to ensure the basin maintains the design storage capacity in the case of an imminent rainfall event. Figure 7 shows a full sediment basin.
4.3 SEDIMENT BASIN CALCULATION

Table 4 (attached) shows the sediment basin calculations for the site, based on the planned disturbed catchment areas. The calculations shown in Table 4 are based on the following guidelines & information sources:

- Average Recurrence Intervals - Bureau of Meteorology Design Rainfall Intensity Chart,
- Best Practice Erosion & Sediment Control, International Erosion Control Association, (IECA, 2008),
- Stormwater Guideline for Environmentally Relevant Activities, Department of Environment and Heritage Protection, QLD Government. (EHP, 2014)

The EHP Stormwater Guideline recommends a sediment storage volume of 50% of the stormwater storage volume. This is considered impractical for the site and would result in an impractically large basin, an alternative figure of 20% has been selected. Given the ease of access for the sediment basins and the readily available machinery at the site a sediment storage volume of 20% of the stormwater storage volume is considered adequate and meets the intent of the EHP stormwater guideline. With appropriate management of the sediment build-up in the basins, the only consequence for the operator is a higher frequency of maintenance. The required volumes (settling zone plus 20% sediment storage zone) have been calculated for the current disturbed area using the 1 in 10 year, 24 hour rain event as detailed in the EHP Stormwater Guidelines for Environmentally Relevant Activities 2014. The key outcomes of the calculations for the site are:

- For **Area 1a Extraction Area**:
  - Required Basin Volume: 1,027 m³.

- For **Area 1b Extraction Area**:
  - Required Basin Volume: 2,534 m³.

- For **Area 2 Stockpile Area 1**:
  - Required Basin Volume: 733 m³.
For Area 3 Stockpile Area 2:
  - Required Basin Volume: \(1260\text{m}^3\).

Ongoing water quality testing should be conducted during storm events to determine if the proposed water treatment (flocculation using floc-blocks) is sufficient to treat the stormwater prior to discharge during high rainfall events. If sufficient treatment is provided using this in-line flocculation method during the design rain event (1 in 10 year), then the basin size may be able to be reduced accordingly.

### 4.4 STORMWATER TREATMENT & MONITORING

Stormwater collected in the basins needs to be managed appropriately to ensure the design storage volume (80% of the basin volume) is available within 5 days after a rain event. Water from the basins is used for various purposes on site including dust suppression, rehabilitation watering and other uses. Based on the soil types at the site and the surrounding dams it is anticipated that good settling rates will be achieved for coarse sediments but fine sediments will require flocculation. It is proposed to treat stormwater collected in the basins using a product called ‘DamClear Floc Bloc’ which is placed inside a cage at the inlet to the basin. Stormwater passing the Floc Bloc is treated and allowed to settle within the basin and water is then tested and discharged as required. Each Floc Bloc is designed to treat approx 300,000L, therefore after each rain event the cage shall be checked and a new Floc Bloc added if required. Care should also be given to ensuring the Floc Bloc cage is appropriately placed in the drain so that it comes in contact with stormwater in low and high flow scenarios.

![FIGURE 8 FLOC BLOC PLACEMENT](source: www.envirowarehouse.com.au)

Monitoring required for the development includes:

- Weather data including rainfall (rain gauge at the site office) and adverse weather conditions (such as high winds); and
- Water Quality Monitoring for sediment basins and any subsequent discharge water.

Weather data needs to be relevant to the site, the nearest BOM weather station is approx 10km from the site (at Dalveen), this data may be sufficient but usually a rain gauge at the site entrance and general observations of adverse weather conditions noted in the site manager’s diary will be preferred.

Water quality monitoring will be undertaken by a person trained in NATA sampling practices and shall be in accordance with the EHP Monitoring and Sampling Manual 2009 or any more recent version. Samples are to
be analysed by an authorised NATA laboratory. Water quality sampling location and criteria is proposed in Table 2.

**TABLE 2: STORMWATER RELEASE CRITERIA**

<table>
<thead>
<tr>
<th>Release Point</th>
<th>Co-ordinates (GDA94)</th>
<th>Quality Characteristics</th>
<th>Limit</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS1</td>
<td>407,469mE</td>
<td>Total Suspended Solids</td>
<td>50mg/L (Maximum)</td>
<td>“Event Release”</td>
</tr>
<tr>
<td></td>
<td>6,853,883mS</td>
<td>pH</td>
<td>6.0 – 9.0 (Range)</td>
<td></td>
</tr>
</tbody>
</table>

4.5 SITE PRACTICES

The maintenance of the sediment basins shall be the responsibility of the site manager. An effective programme of stormwater management will be based on the following methodology:

- Ensure that maintenance of site roads and drains is carried out regularly. In addition, site drains that are prone to erosion are to be lined with coarse material to reduce the velocity of flow within the drains making sure the cross sectional area of the drain still maintains its function.
- No fuels or oils are to be stored on site, any temporary storage (such as on a service vehicle) will require spill kits to be made available to provide quick response to small spills.
- The site should be prepared for the annual wet season by cleaning out sediment from basins and drains prior to October 31 each year. Water collected in the sediment basins is either used for dust suppression or treated and discharged. Sediments removed from the basins are re-used for rehabilitation purposes on site.
- Monitoring of the water quality from the sediment basins in the event of an uncontrolled overflow as per the Environmental Authority conditions.
- Basins are based on a 1 in 10 year storm event over a 24 hour period. This design uses the methodology that during a prolonged rain event, fine sediments will settle within the basin, producing acceptable quality overflow.
- If release of contaminated stormwater occurs, then appropriate flood monitoring should be instigated. This includes:
  - Estimating the overflow rate. This may require the installation of a V-Notch weir.
  - Carrying out a water analysis investigation, specifically for sediment content/turbidity, if the discharge water is not clear.
  - Reporting the overflow to the Department of Environment and Heritage Protection (EHP).

TABLE 3 shows the key issues in relation to the Stormwater Management Plan.
### TABLE 3: KEY ISSUES – STORMWATER MANAGEMENT PLAN

<table>
<thead>
<tr>
<th>Key Issue</th>
<th>Methodology</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build-up of sediments/debris around site, deterioration of bunds or drains.</td>
<td>Before each wet season (Nov – March), carry out a site clean-up.</td>
<td>Use site machinery and possibly a grader to grade roads during wet season to reduce mud build up on tyres. Check and rehabilitate erosion prone areas. Re-establish sedimentation barriers. Barrier Material (min length 50m) and hardwood stakes to be stored on site.</td>
</tr>
<tr>
<td>Sediment builds up in site basins leading to insufficient settling volume and sediment entering drainage system</td>
<td>Insert additional temporary sediment controls such as rock check dams or coir fibre logs to trap additional sediment. Ensure basins are regularly cleaned out.</td>
<td>Install a depth indicator in basins to show sediment depth. Additional sediment controls can be installed upstream or downstream of the basins if required.</td>
</tr>
<tr>
<td>Erosion of drains due to high velocity water flow</td>
<td>Maintain drains, line with broken rock.</td>
<td>This should be checked after each large rain event.</td>
</tr>
<tr>
<td>Excessively high continuous rainfall event – basins breached/ contaminated stormwater bypasses sediment controls.</td>
<td>Assess situation. If possible divert flows away from sensitive areas.</td>
<td>Notify EHP for advice. Note basins are designed to settle coarse sediments prior to overflowing - coarse sediments can cause damage to sensitive creek systems.</td>
</tr>
</tbody>
</table>

### 5 COMPETENCY

Carl Morandy is an appropriately qualified person to complete the Stormwater Management Plan with the following qualifications:

- Bachelor of Engineering (Mining), University of Queensland St Lucia, graduated December 2008.
- Water Sampling to AS5667.1, AS5667.4, AS5667.6 & AS5667.11 by VGT Environmental Compliance Solutions, completed October 2011.
- Erosion and Sediment Control Advanced Training (5 day course) by Oxbow Consulting completed April 2012.
- Application for Chartered Professional Erosion and Sediment Control (pending final exam).
- Memberships: IECA Australasia, Institute of Quarrying Australia, AusIMM, Engineers Australia (Australasian Tunnelling Society).
- Managing Director of Ausrocks Consulting Mining Engineers with work in small mines and quarries since February 2010. Completed over 30 Stormwater Management Plans for sites during this time.

### 6 ATTACHMENTS

- Table 4: Sediment Basin Calculations
- Plans: SWP_001 & SWP_002
- Standard Fact Sheets
### TABLE 4: Sediment Basin Calculations

<table>
<thead>
<tr>
<th>Catchment Area</th>
<th>Area 1a - Extraction Area</th>
<th>Area 1b - Extraction Area</th>
<th>Area 2 - Stockpile Area 1</th>
<th>Area 3 - Stockpile Area 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disturbed Area (m²)</td>
<td>9,301</td>
<td>22,938</td>
<td>7,342</td>
<td>12,620</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall Depth</td>
<td>mm</td>
<td>110.9 1 in 10 yr ARI over 24hrs</td>
</tr>
<tr>
<td>Run-off Coefficient (C) Area 1</td>
<td>%</td>
<td>83% including effects from stockpiles &amp; seepage. IECA 2008, Table B7</td>
</tr>
<tr>
<td>Run-off Coefficient (C) Area 2 &amp; 3</td>
<td>%</td>
<td>75% including effects from stockpiles &amp; seepage. IECA 2008, Table B7</td>
</tr>
</tbody>
</table>

### Formulas

\[ Vs = A \times Cv \times \frac{R}{1000} \]

Where \( Vs \) = Settling Volume (m³), \( A \) = Catchment Area (m²), \( Cv \) = Volumetric Runoff Co-efficient, \( R \) = Rainfall depth (mm)

<table>
<thead>
<tr>
<th>Area 1a / Basin 1a</th>
<th>Required Volume for Settling (Vs)</th>
<th>m³</th>
<th>856</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum Sediment Storage Volume</td>
<td>m³</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>Minimum Total Basin Volume</td>
<td>m³</td>
<td>1,027</td>
</tr>
<tr>
<td>Area 1b / Basin 1b</td>
<td>Required Volume for Settling (Vs)</td>
<td>m³</td>
<td>2,111</td>
</tr>
<tr>
<td></td>
<td>Minimum Sediment Storage Volume</td>
<td>m³</td>
<td>422</td>
</tr>
<tr>
<td></td>
<td>Minimum Total Basin Volume</td>
<td>m³</td>
<td>2,534</td>
</tr>
<tr>
<td>Area 2 / Basin 2</td>
<td>Required Volume for Settling (Vs)</td>
<td>m³</td>
<td>611</td>
</tr>
<tr>
<td></td>
<td>Minimum Sediment Storage Volume</td>
<td>m³</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>Minimum Total Basin Volume</td>
<td>m³</td>
<td>733</td>
</tr>
</tbody>
</table>
(a) Parabolic catch drain with down-slope bank

(b) Triangular V-drain with down-slope bank

(c) Parabolic catch drain without bank

### Constructed dimensions of parabolic catch drains

<table>
<thead>
<tr>
<th>Drain type</th>
<th>Formed top width with or without bank</th>
<th>Formed depth with or without bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-A</td>
<td>1.6 m</td>
<td>0.30 m</td>
</tr>
<tr>
<td>Type-B</td>
<td>2.4 m</td>
<td>0.45 m</td>
</tr>
<tr>
<td>Type-C</td>
<td>3.6 m</td>
<td>0.65 m</td>
</tr>
</tbody>
</table>

### Constructed dimensions of triangular V-drains

<table>
<thead>
<tr>
<th>Drain type</th>
<th>Formed top width with or without bank</th>
<th>Formed depth with or without bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-AV</td>
<td>2.0 m</td>
<td>0.30 m</td>
</tr>
<tr>
<td>Type-BV</td>
<td>2.7 m</td>
<td>0.45 m</td>
</tr>
<tr>
<td>Type-CV</td>
<td>3.9 m</td>
<td>0.65 m</td>
</tr>
</tbody>
</table>
MATERIALS

ROCK:
(i) ALL ROCK MUST BE HARD, WEATHER RESISTANT, AND DURABLE AGAINST DISINTEGRATION UNDER CONDITIONS TO BE MET IN HANDLING, PLACEMENT AND OPERATION.
(ii) ALL ROCK MUST HAVE ITS GREATEST DIMENSION NOT GREATER THAN 3 TIMES ITS LEAST DIMENSIONS.
(iii) THE ROCK USED IN FORMATION OF THE DRAIN MUST BE EVENLY GRADED WITH 60% BY WEIGHT NOMINAL ROCK SIZE AND HAVE SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK, DIRT FINES, AND SMALLER ROCK MUST NOT EXCEED 5% BY WEIGHT.
(iv) THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.
(v) THE COLOUR OF THE RIPRAP SHALL BE IN [INSERT] AND MUST BE APPROVED BY THE ENGINEER. ONCE APPROVED, THE COLOUR SHALL BE KEPT CONSISTENT THROUGHOUT THE PROJECT.

GEOTEXTILE FABRIC: HEAVY DUTY NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDMA 24 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE OFFICER FOR ASSISTANCE.
2. PRIOR TO PLACEMENT, ALL ROCKS MUST BE VISUALLY CHECKED FOR SIZE, ELONGATION, CRACKS, DETORIATION AND OTHER VISIBLE THE DEGREE AND THROUGHNESS OF SUCH CHECKING MUST BE APPROPRIATE FOR THE POTENTIAL CONSEQUENCES ASSOCIATED WITH FAILURE OF THE STRUCTURE OR PURPOSE FOR WHICH THE MATERIAL WILL BE USED.
3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.
4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.
5. REMOVE ALL SOFT YIELDING MATERIAL; REPLACE WITH SUITABLE ON-SITE MATERIAL; COMPACT TO SMOOTH SURFACE.
7. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH CONCRETE FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10CM EVERY 10M FOR EACH 1% OF CHANNEL GRADIENT.
9. IF THE DRAIN IS CUT INTO A DISPERSE (SCOD) SOIL, THEN PRIOR TO PLACING FILTER CLOTH, THE EXPOSED DISPERSE SOIL MUST BE COVERED WITH A MINIMUM 200MM THICK LAYER OF NON-DISPERSE SOIL PRIOR TO PLACEMENT OF FILTER CLOTH OR ROCKS.
10. IF A FILTER CLOTH UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER CLOTH IS REQUIRED TO OVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300MM, AND SECURE ANCHOR PINS AT MINIMUM 1M SPACING ALONG THE OVERLAP.
11. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK.
12. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF Voids.
13. PLACE ROCK LINING TO THE EXTENT AND DEPTH INDICATED WITHIN THE APPROVED PLANS.
14. ENSURE THE ROCK IS PLACED IN AN APPROPRIATE MANNER TO AVOID DISPLACING UNDERLYING MATERIALS OR PLACING UNDEE IMPACT FORCE ON THE BEDDING MATERIALS.
15. ENSURE THE ROCK IS PLACED WITH A MINIMUM THICKNESS OF 1.5 TIMES THE NOMINAL ROCK SIZE (D50).
16. ENSURE MATERIALS THAT ARE D50 AND LARGER ARE POSITIONED FLUSH WITH THE SURFACE WITH SIZES AND SHAPES MATCHED TO THE DRAIN.
17. ENSURE PROJECTIONS ABOVE OR DEPRESSIONS UNDER THE SPECIFIED TOP SURFACE ARE LESS THAN 20% OF THE ROCK LAYER THICKNESS. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.
19. TO THE MAXIMUM DEGREE PRACTICABLE, THE MATERIAL BETWEEN LARGER ROCK MUST NOT BE LOOSE OR EASILY DISPLACED BY THE EXPECTED FLOW.
20. AFTER PLACEMENT OF THE ROCK LINING, ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.
21. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.
2. CLOSELY INSPECT THE OUTER EDGES OF THE Rock PROTECTION. ENSURE WATER ENTRY INTO THE ROCK-LINED AREA IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.
3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKINGS FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.
4. REPLACE OR REPOSITION THE SURFACE ROCK SUCH THAT THE DRAIN FUNCTIONS AS REQUIRED AND THE DRAIN'S REQUIRED HYDRAULIC CAPACITY IS NOT REDUCED.
5. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.
6. ENSURE SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.
7. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
MATERIALS

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

SANDBAGS: GEOTEXTILE BAGS (WOVEN SYNTHETIC, OR NON-WOVEN BIODEGRADABLE) FILLED WITH CLEAN COARSE SAND, CLEAN AGGREGATE, STRAW OR COMPOST.

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 PLACEMENT OF THE CHECK DAMS, ENSURE THE TYPE AND SIZE OF EACH CHECK DAM WILL NOT CAUSE A SAFETY HAZARD OR CAUSE WATER TO SPOIL OUT OF THE DRAIN.


4. ENSURE THE CHANNEL SLOPE IS 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 DIMENSIONS 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.

MAINTENANCE

1. INSPECT EACH CHECK DAM AND THE DRAINAGE CHANNEL AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CORRECT ALL DAMAGE IMMEDIATELY IF SIGNIFICANT EROSION OCCURS BETWEEN ANY OF THE CHECK DAMS, THEN CHECK THE SPACING OF DAMS AND WHERE NECESSARY INSTALL INTERMEDIATE CHECK DAMS OR A SUITABLE CHANNEL LINER.

3. CHECK FOR DISPLACEMENT OF THE CHECK DAMS

4. CHECK FOR SOIL SCOUR AROUND THE ENDS OF EACH CHECK DAM. IF SUCH EROSION IS OCCURRING, CONSIDER EXTENDING THE WIDTH OF THE CHECK DAM TO AVOID SUCH PROBLEMS.

5. IF SEVERE SOIL EROSION OCCURS EITHER UNDER OR AROUND THE CHECK DAMS, THEN SEEK EXPERT ADVICE ON AN ALTERNATIVE TREATMENT MEASURE.

6. REMOVE ANY SEDIMENT ACCUMULATED BY THE CHECK DAMS, UNLESS IT IS INTENDED THAT THIS SEDIMENT WILL REMAIN WITHIN THE CHANNEL.

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

REMOVAL

1. WHEN CONSTRUCTION WORK WITHIN THE DRAINAGE AREA ABOVE THE CHECK DAMS HAS BEEN COMPLETED, AND THE DISTURBED AREAS AND THE DRAINAGE CHANNEL ARE SUFFICIENTLY STABILISED TO RESTRRAIN EROSION, ALL TEMPORARY CHECK DAMS MUST BE REMOVED.

2. REMOVE THE CHECK DAMS AND ASSOCIATED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

Optional geotextile splash pad placed below dam to reduce erosion at the base of the check dam (generally not required)

Figure 1 - Layout and profile of check dams (rock check dams shown)
INSTALLATION

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

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

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

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

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

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

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

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

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

MAINTENANCE

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

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

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

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

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

REMOVAL

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

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

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

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

![Figure 1 - Typical profile of flow diversion bank formed from earth](image)

A minimum freeboard of 300 mm is recommended for non-vegetated earth embankments

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

Drawn: GMW  Date: Dec-09  Flow Diversion Banks: DB-01
Notes:
1. Sediment fence to be installed along a line of constant ground elevation wherever practical.
2. Both end of the sediment fence to extend up the slope at least 1m.
3. Support post to be spaced a maximum 2m unless the fence is supported by a top wire or wire mesh backing, in which case 3m maximum spacing.
4. Fence ‘returns’ shall be installed at maximum 20m spacing if fence is installed along the contour, otherwise 5 to 10m maximum spacing.
5. Minimum 4 staples or tie wires per stake.
(a) Type C (dry) basin with riser pipe outlet system

(b) Typical profile of Type F/D (wet) basin

(c) Typical arrangement of internal flow control baffles

(d) Type C (dry) basin with riser pipe outlet system (plan view)

Cases (a), (b), (c): \( W_e = A_S / (L_1 + L_2) \)
Cases (d): \( W_e = A_S / (L_1 + L_2 + L_3 + L_4) \)
Where: \( W_e = \) Effective width
\( A_S = \) Pond surface area
(after USDA, 1975)
MATERIALS

EARTH FILL: CLEAN SOIL WITH EMERSON CLASS 2(1), 3, 4, OR 5, AND FREE OF ROOTS, WOODY VEGETATION, ROCKS, AND OTHER UNSUITABLE MATERIAL. SOIL WITH EMERSON CLASS 4 AND 5 MAY NOT BE SUITABLE DEPENDING ON PARTICLE SIZE DISTRIBUTION AND DEGREE OF DISPERSION. CLASS 2(1) SHOULD ONLY BE USED UPON RECOMMENDATION FROM GEOTECHNICAL SPECIALIST. THIS SPECIFICATION MAY BE REPLACED BY AN EQUIVALENT STANDARD BASED ON THE EXCHANGEABLE SODIUM PERCENTAGE.

RISER PIPE: MINIMUM 250mm DIAMETER.

SPILLWAY ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED ROCK WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL (DS) ROCK SIZE. LARGE ROCK SHOULD DOMINATE WITH SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. THE SPECIFIC GRAVITY SHOULD BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

CONSTRUCTION


2. 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.

3. BEFORE STARTING ANY CLEARING OR CONSTRUCTION, ENSURE ALL THE NECESSARY MATERIALS AND COMPONENTS ARE ON THE SITE TO AVOID DELAYS IN COMPLETING THE WORKS BEGINS.

4. INSTALL REQUIRED SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE PROPOSED EARTHWORKS TO CONTROL SEDIMENT RUNOFF DURING CONSTRUCTION OF THE BASIN.

5. THE AREA TO BE COVERED BY THE EMBANKMENT, BORROW PITS AND INCIDENTAL WORKS, TOGETHER WITH AN AREA EXTENDING BEYOND THE LIMITS OF EACH FOR A DISTANCE NOT EXCEEDING FIVE (5) METRES ALL AROUND MUST BE CLEANED OF ALL TREES, GRASS, STUMPS, ROOFS, DEAD TIMBER AND RUBBISH AND DISPOSED OF IN A SUITABLE MANNER. DELAY CLEARING THE MAIN POND AREA UNTIL THE EMBANKMENT IS COMPLETE.

6. ENSURE ALL HOLES MADE BY GRUBBING WITHIN THE EMBANKMENT FOOTPRINT ARE FILLED WITH SOIL MATERIAL, ADEQUATELY COMPACTED, AND FINISHED FLUSH WITH THE NATURAL SURFACE.

7. BEFORE CONSTRUCTION OF THE CUT-OFF TRENCH OR ANY ANCILLARY WORKS WITHIN THE EMBANKMENT FOOTPRINT, ALL GRASS GROWTH AND TOPSOIL MUST BE REMOVED FROM THE AREA TO BE OCCUPIED BY THE EMBANKMENT AND MUST BE DEPOSITED CLEAR OF THIS AREA AND RESERVED FOR TOPDRESSING THE COMPLETING THE EMBANKMENT.

8. EXCAVATE A CUT-OFF TRENCH ALONG THE CENTRE LINE OF THE EARTH EMBANKMENT, CUT THE TRENCH TO STABLE SOIL MATERIAL, BUT IN NO CASE MAKE IT LESS THAN 600mm DEEP. THE CUT-OFF TRENCH MUST EXTEND INTO BOTH ABUTMENTS TO AT LEAST THE ELEVATION OF THE RISER PIPE CREST. MAKE THE MINIMUM BOTTOM WIDTH WIDE ENOUGH TO PERMIT OPERATION OF EXCAVATION AND COMPACTION EQUIPMENT, BUT IN NO CASE LESS THAN 600mm MAKING THE SLOPES OF THE TRENCH NO STEEPER THAN 1:1 (V:1).

9. ENSURE ALL WATER, LOOSE SOIL, AND ROCK ARE REMOVED FROM THE TRENCH BEFORE BACKFILLING COMMENCES. THE CUT-OFF TRENCH MUST BE BACKFILLED WITH SELECTED EARTH-FILL OF THE TYPE SPECIFIED FOR THE EMBANKMENT, AND THIS SOIL MUST HAVE A MOISTURE CONTENT AND DEGREE OF COMPACTION AS THAT SPECIFIED FOR THE SELECTED CORE ZONE.

10. MATERIAL EXCAVATED FROM THE CUT-OFF TRENCH MAY BE USED IN CONSTRUCTION OF THE EMBANKMENT PROVIDED IT IS SUITABLE AND IT IS PLACED IN THE CORRECT ZONE ACCORDING TO ITS CLASSIFICATION.

11. SCARIFY AREAS ON WHICH FILL IS TO BE PLACED BEFORE PLACING THE FILL.

12. ENSURE ALL FILL MATERIAL USED TO FORM THE EMBANKMENT MEETS THE SPECIFICATIONS CARRIED BY A SOIL SCIENTIST OR GEOTECHNICAL SPECIALIST.

13. THE EMBANKMENT MATERIALS MUST CONTAIN SUFFICIENT MOISTURE SO IT CAN BE FORMED BY HAND INTO A BALL WITHOUT CRUMBLING. IF WATER CAN BE SQUEEZED OUT OF THE BALL, IT IS TOO WET FOR PROPER COMPACTION. PLACE FILL MATERIAL IN 150 TO 250mm CONTINUOUS LAYERS OVER THE ENTIRE LENGTH OF THE FILL AREA AND THEN COMPACT BEFORE PLACEMENT OF FURTHER FILL.

14. PLACE RISER PIPE OUTLET SYSTEM, IF SPECIFIED, IN APPROPRIATE SEQUENCE WITH THE EMBANKMENT FILLING REFER TO SEPARATE INSTALLATION SPECIFICATIONS.

15. UNLESS OTHERWISE SPECIFIED ON THE APPROVED PLANS, COMPACT THE SOIL AT ABOUT 11% TO 2% WET OF OPTIMUM AND 95% MODIFIED OR 100% STANDARD COMPACTION.

16. WHERE BOTH DISPERSIVE AND NON-DISPERSIVE CLASSIFIED EARTH-FILL MATERIALS ARE AVAILABLE, NON-DISPERSIVE EARTH-FILL MUST BE USED IN THE CORE ZONE. THE REMAINING CLASSIFIED EARTH-FILL MATERIALS MUST ONLY BE USED AS DIRECTED BY [INSERT TITLE].

17. WHERE SPECIFIED, CONSTRUCT THE EMBANKMENT TO AN ELEVATION 10% HIGHER THAN THE DESIGN HEIGHT TO ALLOW FOR SETTLING. OTHERWISE FINISHED DIMENSIONS OF THE EMBANKMENT AFTER SPREADING OF TOPSOIL MUST CONFORM TO THE DRAWING WITH A TOLERANCE OF 75mm FROM THE SPECIFIED DIMENSIONS.

18. ENSURE DEBRIS AND OTHER UNSUITABLE BUILDING MATERIALS WERE NOT PLACED WITHIN THE EARTH EMBANKMENT.

19. AFTER COMPLETION OF THE EMBANKMENT ALL LOOSE UNCOMPACTED EARTH-FILL MATERIAL ON THE UPSTREAM AND DOWNSTREAM BATTER MUST BE REMOVED PRIOR TO SPREADING OF TOPSOIL.

20. TOPSOIL AND REVEGATE/STABILISE ALL EXPOSED EARTH AS DIRECTED WITHIN THE APPROVED PLANS (continued on SB-05)
SPILLWAY CONSTRUCTION:
21. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPoil HEAP.
22. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BoxING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.
23. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.
24. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PROTRUDE AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPPER END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.
25. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.
26. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.
27. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADIENT MASS OF ROCK WITH A MINIMUM OF Voids. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.
28. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APARENT.
29. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION. EMBANKMENT OF SETTLING POND.
30. THE AREA TO BE COVERED BY THE STORED WATER OUTSIDE THE LIMITS OF THE BORROW PITS MUST BE CLEARED OF ALL SCRUB AND RUBBISH. TREES MUST BE CUT DOWN STUMP HIGH AND REMOVED FROM THE IMMEDIATE VICINITY OF THE WORK.
31. ESTABLISH ALL REQUIRED INFLOW CHUTES AND INLET BALLETS, IF SPECIFIED, TO ENABLE WATER TO DISCHARGE INTO THE BASIN IN A MANNER THAT WILL NOT CAUSE SOIL EROSION OR THE RE-SUSPENSION OF SETTLED SEDIMENT.
32. INSTALL A SEDIMENT STORAGE LEVEL MARKER POST WITH A CROSS MEMBER SET JUST BELOW THE TOP OF THE SEDIMENT STORAGE ZONE (AS SPECIFIED ON THE APPROVED PLANS). USE AT LEAST A 75mm WIDE POST FIRMLY SET INTO THE BASIN FLOOR.
33. IF SPECIFIED, INSTALL INTERNAL SETTLING POND BALLETS. ENSURE THE CREST OF THESE BALLETS IS SET LEVEL WITH, OR JUST BELOW, THE ELEVATION OF THE EMERGENCY SPILLWAY CREST.
34. INSTALL ALL APPROPRIATE MEASURES TO MINIMISE SAFETY RISK TO ON-SITE PERSONNEL AND THE PUBLIC CAUSED BY THE PRESENCE OF THE SETTLING POND. AVOID STEEP, SMOOTH INTERNAL SLOPES APPROPRIATELY FENCE THE SETTLING POND AND POST WARNING SIGNS IF UNSUPERVISED PUBLIC ACCESS IS LIKELY OR THERE IS CONSIDERED TO BE AN UNACCEPTABLE RISK TO THE PUBLIC.
MAINTENANCE OF SEDIMENT BASIN
1. INSPECT THE SEDIMENT BASIN DURING THE FOLLOWING PERIODS:
   (i) DURING CONSTRUCTION TO DETERMINE WHETHER MACHINERY, FALLING TREES, OR CONSTRUCTION ACTIVITY HAS DAMAGED ANY COMPONENTS OF THE SEDIMENT BASIN. IF DAMAGE HAS OCCURRED, REPAIR IT.
   (ii) AFTER EACH RUNOFF EVENT, INSPECT THE EROSION DAMAGE AT FLOW ENTRY AND EXIT POINTS. IF DAMAGE HAS OCCURRED, MAKE THE NECESSARY REPAIRS.
   (iii) AT LEAST WEEKLY DURING THE NOMINATED WET SEASON (IF ANY) OTHERWISE AT LEAST FORTNIGHTLY.
   (iv) PRIOR TO, AND IMMEDIATELY AFTER, PERIODS OF STOP WORK OR SITE SHUTDOWN.
2. CLEAN OUT ACCUMULATED SEDIMENT WHEN IT REACHES THE MARKER BOARD/POST, AND RESTORE THE ORIGINAL STORAGE VOLUME. PLACE SEDIMENT IN A DISPOSAL AREA OR, IF APPROPRIATE, MIX WITH DRY SOIL ON THE SITE.
3. DO NOT DISPOSE OF SEDIMENT IN A MANNER THAT WILL CREATE AN EROSION OR POLLUTION HAZARD.
4. CHECK ALL VISIBLE PIPE CONNECTIONS FOR LEAKS, AND REPAIR AS NECESSARY.
5. CHECK ALL EMBANKMENTS FOR EXCESSIVE SETTLEMENT, SLUMPING OF THE SLOPES OR PIPING BETWEEN THE CURTAIN AND THE EMBANKMENT, MAKE ALL NECESSARY REPAIRS.
6. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE BASIN AND RISER.
7. SUBMERGED INFLOW PIPES MUST BE INSPECTED AND DESILTED (AS REQUIRED) AFTER EACH INFLOW EVENT.
REMOVAL OF SEDIMENT BASIN
2. BEFORE STARTING ANY MAINTENANCE WORK ON THE BASIN OR SPILLWAY, INSTALL ALL NECESSARY SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE SEDIMENT BASIN.
3. ALL WATER AND SEDIMENT MUST BE REMOVED FROM THE BASIN PRIOR TO THE DAM’S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
4. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT, AND STABILISE AND/OR REVEGETATE AS REQUIRED TO ESTABLISH A STABLE LAND SURFACE.