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MOOLARBENCOAL

MOOLARBEN COAL OPERATIONS PTY LTD

STAGE 1 OPEN CUT & CHPP

WATER MANAGEMENT ASSESSMENT

AND

UPGRADE PROPOSAL REPORT

Report Prepared By Arkhill Engineers

DOCUMENT CONTROL SHEET

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Engineers Statement

I, Steven Charles Moylan, confirm that I am not an employee of the owner or operator of the facilities being assessed in this report.

This assessment has been carried out against recognised Industry Standards and Guidelines, and is not based on information that I know to be false or misleading.

The information included with this assessment is appropriate in scope and accuracy as understood, with no relevant information known to be withheld.

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Steven C. Moylan

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Date

Certifying Registered Professional Engineer

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1. EXECUTIVE SUMMARY

Arkhill Engineers (AE) have carried out a surface water management plan review for Moolarben Coal Operations Pty Ltd (MCO), for the Open Cut 1 (OC1) and CHPP water management facilities.

This report provides an assessment of the following key items:

- Water Balance for the MCO Stage 1 Approval (comprising Open Cut OC1 and the CHPP);
- Formulation of a revised water management strategy for Stage 1 considering:
    - Assessment of the CHPP Water Management Upgrade requirements;
    - Assessment of the Open Cut 1 Sediment Dam Upgrade requirements; and
- Review of the Rail Loop Stabilisation Works necessary to repair existing erosion control problems.

1.1 Water Balance Assessment

With regard to the water balance assessment, the primary objective was to prepare a water balance model to investigate the performance of existing infrastructure within the Stage 1 areas against historical rainfall, with investigations concentrating on system performance during above-average rainfall periods. Identification of what facilities underperformed and outperformed with regard to dam capacity and the ability to avoid unlicensed discharges by way of overflows from these dam facilities were then assessed.

Further, increasing the licensed discharge provisions from the site from the present 800kL/day maximum allowable limit to 10ML/day was considered.

The following key recommendations were identified:

- That the licensed discharge limit for MCO be increased from 800kL/day to 10ML/day;
- That a dedicated discharge point exist for the CHPP (via an upgraded Cockies Dam);
- That a dedicated discharge point exist for OC1 (via an upgraded Sediment Dam OC1-6); and
- That improvements in separating clean and dirty water in OC1 be initiated. This will enable better opportunity to discharge water from the OC1 facilities.

1.2 Water Management Strategy

With regard to the water management strategy for Stage 1, a review was performed to assess the existing operational setup and to identify shortcomings in the existing infrastructure. This work was initially conducted for MCO to address an amendment to EPL12932 requiring a Pollution Reduction Program (PRP) by the NSW Office of Environment and Heritage (OEH).

The review included the following key activities:

- Hydrological assessments of existing dam facilities and catchments areas within Open Cut 1 (OC1) and the Coal Handling Preparation Plant (CHPP);
- Hydrological assessments of the existing Bora Creek formation for 50year and 100year ARI rainfall events, with the assessment repeated to assess the future upstream diversion of Bora Creek around the CHPP Rail Loop; and
- Performing geotechnical investigations to areas of the CHPP to assess existing ground conditions and to identify specific design for proposed upgrade measures;

In terms of dirty water containment dams presently on site, the dams were generally designed for a 20year ARI – 1 hour duration rainfall event. In some cases, the existing dam capacities are in fact only suitable for containing surface runoff from a 2year ARI rainfall event. This concurs with MCO operating experience indicating the dam capacities are difficult to maintain and manage without unlicensed discharge occurring.

Following completion of the assessment, the following upgrade activities are recommended for the CHPP area:

- That the design rainfall event for dirty water dams at the CHPP site be upgraded from a 20year to a 50year Annual Exceedance Probability (AEP) design rainfall event and that the storm duration considered be increased from 1 hour to 24 hours duration;
- Upgrade sediment dams in line with the proposed amendment to the EPL12932 as directed by the NSW EPA, that sediment control dams are able to overflow if rainfall depth exceeds 44mm over a 5-day consecutive period (rainfall depth corresponds to 95%ile, 5-day rainfall for the Central Tablelands);
- At the CHPP, the following upgrades are proposed:
    - SD07;
    - SD10 including construction of new dam SD10(B) upstream of the existing dam;
    - SD12 including construction of a new enlarged dam adjacent to the existing dam;
    - SD14 including upstream clean water diversion drainage upgrades;
    - Upgrade to Cockies Dam including upstream clean water diversion drainage upgrades;
    - Construct diversion bund for Bora Creek to enable surface runoff to bypass the rail loop;
    - Remove and rehabilitate the unsuitable stockpiles presently located on the northern departure side of the rail loop.
    - Modify strategy for containing surplus dirty water at the CHPP, by utilising the two (2) existing large capacity dams inside the rail loop for containment of dirty water; and
    - Relocate the licensed discharge point from the CHPP Clean Water Dam (which is to be used in future for storage of surplus dirty water) to the upgraded Cockies Dam.
- At OC1, the following upgrades are proposed:
    - OC1-6 to be enlarged;
    - The licensed discharge point currently at OC1-7 to be moved to OC1-6;
    - That dewatering of sediment dams in OC1 be reconfigured and linked to OC1-6, to enable better separation of clean and dirty water within OC1, and improve potential to discharge surplus clean water from OC1 areas.

1.3 Rail Loop Remediation

With regard to the CHPP Rail Loop, the existing areas of the rail loop have experienced variable degrees of erosion and scour issues to the embankment and cutting batters at the CHPP site. The rail loop requires frequent maintenance of cess drains at the toes of embankments to remove sediment and specific maintenance around drainage structures such as culverts.

An investigation of the rail loop was undertaken to assess the extent of damage prevalent to the rail loop. The investigation included data review of available information for the original design of the rail loop, site inspection and logging of the rail loop and its cuttings and embankments, laboratory testing of surface samples, engineering analysis and reporting.

The erosion and scour present to the various areas was risk assessed and categorised in terms of potential for future erosion and its likely effects on both serviceability of the rail loop and ongoing maintenance. A schedule was prepared indicating priorities for repairs with a view to reducing future instability and maintenance of the rail loop cuttings and embankments.

2. BACKGROUND

In late 2011, Arkhill Engineers (AE) carried out a surface water management plan review for Moolarben Coal Operations Pty Ltd (MCO), for all CHPP water management facilities.[1]

This was required by MCO to address an amendment to EPL12932 requiring a Pollution Reduction Program (PRP) by the NSW Office of Environment and Heritage (OEH).

The review considered the following items:

- The Protection of Environmental Operations (POEO) Act (1997), and MCO Environmental Protection Licence No. 12932.
- Capacity review of existing containment dams within the CHPP area.
- Review of calculations by various consultants in determining the design criteria, and upgrade requirements for the various dam facilities.
- Development of a Water Management Action Program, which includes the following:
    - The on-ground works proposed to be undertaken in order to upgrade shortcomings in existing infrastructure;
    - A review of the existing Stage 1 Water Management Plan (WMP), with respect to surface water management and erosion and sediment control facilities; and
    - Review methods for handling water following rainfall events at the CHPP.

All existing storage facilities designed previously under the existing Stage 1 WMP were previously designed for a 20year recurrence – 1 hour duration rainfall event, in accordance with the provisions of the Blue Book – “Soils and Construction – Managing Urban Stormwater, 4th Edition, March 2004.[2]

The AE report[1] recommended the following upgrades be considered:

- That the design rainfall event for dirty water dams at the CHPP site be upgraded from a 20year to a 50year Annual Exceedance Probability (AEP) design rainfall event;
- That the storm duration considered be increased from 1 hour to 24 hours duration;
- Upgrade CHPP sediment dams as necessary;
- Upgrade Cockies Dam;
- Construct a new Holding Dam to store captured runoff collected in the various dirty water sediment dams around the CHPP site;
- That MCO apply for an increase in the maximum allowable discharge limit for the site from 800kL/day to 10ML/day;
- Perform local improvement works to the existing Rail Culvert Basin, and rail loop in general; and
- Localised treatment and stabilisation of dispersive soils be performed where deemed necessary. This includes installation of protection bunding, lining of drains and batter chutes, and installation of temporary erosion and sediment controls.

In addition, MCO requested the upgrade works consider the following measures raised by the Environmental Protection Authority (EPA) in their assessment of the PRP proposal:

- To divert upstream catchment areas of Bora Creek around the north side of the CHPP Rail Loop;
- Remove the unsuitable stockpiles located adjacent to the Rail Loop and sediment dams SD3, SD4, SD5 and SD6;
- Determine what stabilisation works are required to batter areas of the Rail Loop; and
- Carry out further assessment of the site water balance for the Stage 1 approval, with regard to demonstrating that the request from MCO to increase the maximum allowable daily discharge off site from 800kL/day to 10ML/day is necessary.

AE were subsequently engaged by MCO to undertake a more detailed assessment of the following:

- Water Balance for the MCO Stage 1 Approval (comprising Open Cut OC1 and the CHPP);
- Formulate a revised MCO water management strategy for Stage 1 considering:
    - Assessment of the CHPP Water Management Upgrade requirements, in line with the PRP and site requirements;
    - Assessment of the Open Cut 1 Sediment Dam Upgrade requirements; and
- Rail Loop Stabilisation Works.

Following preliminary design works of the revised water management strategy per above, and subsequent discussions held with MCO, AE were directed by MCO to further investigate the following:

- MCO proposed not to proceed with the concept of constructing a Holding Dam on the north side of the rail loop, which was to be used for holding surplus dirty water. In lieu of this proposal, MCO plan to use the current CHPP Clean Water Dam east of the CHPP within the rail loop, as a further storage facility for surplus dirty water from the CHPP. This means the two existing dams inside the rail loop would now be used for storing dirty water only;
- MCO proposed to move the licensed discharge point for the CHPP to Cockies Dam in lieu of using the current clean water dam, which is now proposed to be used as additional capacity for storing dirty water; and
- AE were to investigate the capacity of sediment dams in line with the proposed amendment to the EPL12932 as directed by the NSW EPA, that sediment control dams SD03, SD04, SD05, SD06, SD07, SD08 and SD14 were able to overflow if rainfall depth exceeded 44mm over a 5-day consecutive period (rainfall depth corresponds to 95%ile, 5-day rainfall for the Central Tablelands).

The works performed by AE included undertaking geotechnical investigations, detailed hydrological and water balance assessments, development of conceptual civil designs and drawings for the upgrade measures, and preparation of budget cost estimates for the constructions works.

Initial consultation was held between representatives of MCO, the NSW EPA (Bathurst Office) and AE on Thursday 30 August 2012, to discuss the findings of the water balance assessment, and the proposed water management strategy for Open Cut OC1 and the CHPP.

The meeting was held to discus outcomes of the water balance assessment and the need to increase the maximum allowable daily discharge limit, and the proposed future water management strategy for the MCO Stage 1 Approval.

This report consolidates the investigations and assessments performed for Stage 1. The water balance assessment for the Stage 1 Approval is discussed further in **Section 3** of this report. The water management strategy proposed for OC1 and the CHPP is discussed in **Section 5 and 6** of this report.

3. WATER BALANCE ASSESSMENT

3.1 Objective

A water balance assessment was prepared by BMT WBM Pty Ltd and Arkhill Engineers for the Stage 1 Open Cut OC1 and CHPP areas. Consideration of Open Cut 2 (OC2), Open Cut 3 (OC3) and the future Underground 4 (UG4) was not included in this assessment. A copy of the assessment report is included in **Appendix A**. The following section provides a summary of the water balance model.

The primary objective of the water balance model was to ascertain the performance of existing infrastructure within the Stage 1 areas against historical rainfall, with investigations concentrating on system performance during above-average rainfall periods. Identification of what facilities underperformed and outperformed with regard to dam capacity and the ability to avoid unlicensed discharges by way of overflows from these dam facilities was then assessed.

Increasing the licensed discharge provisions from the site from the present 800kL/day to a maximum 10ML/day was considered.

Investigations into water sourcing and supply requirements for water deficit periods was not included in the scope of the study.

3.2 Study Area

The water balance assessment linked the existing OC1 and CHPP storage dams facilities, as an integrated network. A description of the existing water management system, and detailed plans and schematic of the existing system network are outlined in **Appendix A**.

In total, 28 individual catchment areas (15 subcatchment within the CHPP area, and 13 subcatchments within the OC1 area) were assessed comprising undisturbed bushland and grassed areas, road and building areas, and disturbed and active mining areas. The model included variable parameters for pervious and impervious surfaces, and SILO meteorological dataset (i.e. rainfall and evaporation) allowances obtained for the period 1900 to 2012 inclusive for the study area.

The model included stage-volume data for the various dam storages in OC1 as included in the water balance model. The stage-volume data used for the existing facilities was supplied by MCO as outlined in **Appendix B**. Volume data for the CHPP dam storages is as outlined by Arkhill Engineers.[1]

3.3 Water Users

The water balance model incorporated the following user nodes:

- Annual CHPP demand ~ 1302ML/yr.
- Annual dust suppression demand for OC1 ~ 400ML/yr.

3.4 Water Sources

3.4.1 Mine Pit Inflows

Using the MCO Water Management Plan,[3] the water balance model accounts for groundwater inflows to OC1 active mining areas using a constant annual inflow of 94ML.

3.4.2 Surface Water Infrastructure

The water balance model considered existing drainage diversions and dam capacities in determining the surface runoff inflows by the local contributing subcatchments to each sediment basin and point sources of water (such as inter-basin transfers, return flows from spills etc).

Existing topography of the undisturbed and disturbed areas, and active mining, emplacement and rehabilitated areas was used to assess inflows to all dams.

3.4.3 Ulan Water Sharing Agreement

It is acknowledged that an agreement is in place for MCO to access water from Ulan Coal Mines Limited (UCML) of a minimum 1000ML/yr under a formalised Water Sharing Agreement (WSA) for water transfer during water deficit periods.

The transfer of water from UCML reports to the CHPP Process Dam within the Rail Loop area, and is used primarily to cover water supply shortfalls to the CHPP. The CHPP Process Dam is the primary source for water supply to the CHPP, and the dam is designed as a Turkeys Nest facility with no contributing catchment area other than its own impoundment area.

Transfer of water into the CHPP Process Dam facility is manually controlled by pumps from UCML, or from the existing CHPP Cleanwater Dam, or from OC1 Dam 10. Water is not to be sourced from UCML where surplus water is available for use within Stage 1 storages.

As the scope of this water balance assessment was not to assess water shortfall during deficit periods, and considering that in effect the WSA covers the direct supply required to the CHPP, no allowance has been made for the WSA in the water balance model.

3.5 Outcome

The water balance assessment predicts numerous unlicensed discharges would occur as overflows from the various dam facilities within the Stage 1 area, if historical rainfall from the past 112 years were to be repeated. A collection of time series charts for the predicted water level and spillage volumes simulated are included in the water balance report. **Appendix A** illustrates the time series charts for only those dams that are capable of unlicensed discharges off site.

Key storages that would experience unlicensed discharges are:

- Dams at the Open Cut - OC1-1, OC1-3, OC1-6, OC1-7, OC1-9 and OC1-10; and
- Dams at the CHPP – Process Dam, Cleanwater Dam, Cockies Dam, and SD14.

Clean and dirty water at the CHPP is more clearly separated compared with the current management system at the OC1. The contained clean water at the CHPP hence is deemed more suitable for discharge compared to the present operational setup of the OC1 where clean and dirty water is not separated. The assessment report highlights the need to improve the segregation of clean and dirty water within OC1. Further work has been conducted in this regard, and is discussed in **Section 5 and 6**.

With regard to increasing the present discharge limit in the EPL12932, key points to notes are as follows:

- A maximum discharge of 800kl/day from the CHPP Cleanwater Dam requires frequent discharges, and in many instances requires consecutive daily discharges. This level of discharge is extremely difficult for MCM to manage considering the need to accurately assess water quality and ensure it meets the EPL conditions prior to allowing discharge, considering continual pump in of water to the discharge points will be occurring post event, and large fluctuations in water quality would be expected; and
- A real time monitoring system may be required to monitor water quality, to improve MCM's ability to better manage water onsite, and ensure it is in accordance with the EPL.

With respect to the nominated 10ML/day discharge provision sought by MCO, this will allow the following:

- Improved condition for MCM to manage and handle water on site, and reduce the risks of unlicensed discharges;
- Such a discharge quota would allow the mine to hold more water on site, reducing the need to draw water from external sources in water deficit years. This means that operational water levels in storages may be kept higher, rather than near or at half storage capacity which results in management and maintenance improvements for the CHPP;
- The frequency of discharges is reduced, hence there is more opportunity to sample and test water quality to ensure it meets the EPL; and
- It allows the ability to dump water quickly when large rainfall is predicted or when downstream creek and river systems are in flood (hence reducing frequency of unlicensed discharges).

It is highlighted that the water balance model also predicts that there would be numerous instances where a deficit of water would occur if historical rainfall was to be repeated. The predicted deficit would be catered for however by the transfer of water from UCML under the WSA.

3.6 Recommendation

Based on findings of the investigations of the water balance assessment the following is recommended:

- That the licensed discharge limit for MCO be increased from 800kL/day to 10ML/day;
- That a dedicated discharge point exist for the CHPP (via Cockies Dam);
- That a dedicated discharge point exist for OC1 (via Sediment Dam OC1-6); and
- That improvements in separating clean and dirty water in OC1 be initiated. This will enable better opportunity to discharge water from the OC1 facilities.

The proposed future water management strategy for the CHPP and OC1 are discussed in further detail in **Section 5 and 6**.

4. EXISTING WATER MANAGEMENT PLAN OVERVIEW

4.1 General

MCO presently have a Water Management Plan (WMP),[3] which outlines the background to the current water management strategy for the Stage 1 approval.

The current EPL12932 has three (3) licensed discharge points as follows:

- CHPP clean water dam inside the rail loop, denoted as Discharge Point 1 in the EPL;
- Dam 10 located adjacent to the existing ROM stockpile, denoted as Discharge Point 2 in the EPL; and
- OC1-7 located adjacent to the Open Cut Entrance Road, denoted as Discharge Point 22 in the EPL.

Discharges are presently limited to 800kL per day from each of the above storages, however the total combined discharge from these three (3) facilities shall not exceed 800kL/day, and the discharges are subject to MCM complying with water quality requirements as outlined in EPL12932.

A description of the existing water management system, and detailed plans and schematic of the existing system network is outlined in **Appendix A**.

4.2 Water Management Principles

The principle strategy for the WMP is as follows:

- In general clean water is to be released from site.
- All clean water runoff from upstream undisturbed areas is passed around the CHPP areas via a network of open drains or cutoff dams, and is free to drain into downstream creeks or river systems.
- All cleanwater runoff from disturbed areas shall be passed through sedimentation dams. Following the rainfall event, the water within the sediment dams will be sampled and tested, and subject to the water quality condition as determined, the following will occur:
    - If deemed clean water (i.e. test results are within allowable limits), the water will ultimately be transferred to the licensed discharge points, and discharged under EPL12932.
    - If deemed dirty water (i.e. test results exceed allowable limits), the water will be transferred to the CHPP process dam, or another on-site process dam, and reused by the mine.
    - In both cases, the intent is to quickly dewater and desilt the sediment dams so that the original capacity of the dam is reinstated, and the next rainfall event can be contained.
- All dirty water runoff from CHPP stockpile areas, coal handling plant areas, active mining and disturbed areas shall be contained within existing collection dams, and reused by the mine.
- Ulan Coal Mines Limited (UCML) supply water to MCM under a Water Sharing Arrangement of 1000ML/yr (negotiable) during deficit periods. This water shall cease to be supplied following rainfall periods to prevent likelihood of spilling from containment dams, until such time as the captured runoff water is reused.

These water management principles will be maintained in development of the future Water Management Strategy for Stage 1.

4.3 Surface Water Management

4.3.1 Clean Surface Runoff Water

4.3.1.1 CHPP

Currently, diversion drainage systems contain and divert clean water from undisturbed catchment areas upstream of mine infrastructure, around and through the CHPP facilities to enable clean water to pass into Bora Creek. Refer to **Appendix A** for further overview and discussion.

This includes the following areas:

- Diversion of clean water from the northern extremities of the CHPP Rail Loop into Bora Creek. This diversion consists of unlined open drains;
- Diversion of clean water from the upstream range area south of the CHPP, and east of the coal handling plant infrastructure into the CHPP. Water passes through a series of diversions and culverts below public road, service easements and rail infrastructure prior to reaching the CHPP area, where it then discharges into a rock lined open drain that feeds into Bora Creek;
- SD09, which collects runoff from the sealed carpark, gravel pad, and grassed areas around the MCO Main Office Facility;
- SD11, which collects runoff from upstream undisturbed areas and releases into Bora Creek; and
- The internal rail loop catchment area, downstream of Cockies Dam, SD08 and the CHPP Process Dam.

4.3.1.2 Open Cut OC1

Diversion drainage systems at OC1 contain and divert clean water from upstream catchment areas around the active mining areas, or into cutoff dams to enable the clean water to ultimately be conveyed to the Goulburn River. Refer to **Appendix A** for further overview and discussion.

The surface runoff water from these areas is primarily from undisturbed catchments comprising bushland or grassed areas. The surface runoff traverses through and around the facilities via a network of rock lined and unlined protection drains.

In the case of cutoff dams above active mining areas, diversion drains convey surface runoff into the dams, where the water is allowed to settle any solids. An example of this is OC1 Strip 6 Dam. The water is then randomly sampled and tested to assess water quality, prior to MCO determining whether the water is suitable to be discharged off-site, or pumped into the dirty water system where it is reused on site.

4.3.2 Sediment Laden Surface Runoff Water

4.3.2.1 CHPP

Currently at the CHPP, diversion drainage systems contain and divert sediment laden water from disturbed catchment areas not exposed to any contamination with coal or rejects material into sediment dams. The surface runoff water from these areas is primarily from material emplacement areas, access roads, and rail loop areas etc. The flows from these areas include sediment transportation caused by dispersive soils which exist in, and around the CHPP.

This includes the following areas:

- Sediment dam SD03, which collects runoff from rail loop unsuitable emplacement area;
- Sediment dam SD04, which collects runoff from rail loop unsuitable emplacement area;
- Sediment dam SD05, which collects runoff from rail loop unsuitable emplacement area;
- Sediment dam SD06, which collects runoff from rail loop unsuitable emplacement area;
- Sediment dam SD07, which collects runoff from rail loop unsuitable emplacement area;
- Sediment dam SD08, which collects runoff from within the rail loop;
- Sediment dam SD14, which collects runoff from the rail loop and undisturbed clean water areas;
- Cockies Dam, which collects runoff from disturbed areas within the rail loop; and
- CHPP cleanwater dam, which is a turkeys nest facility, that receives clean water from all other dams, plus water from the northern borefields.

Further discussion of catchment studies and hydrology assessment for these areas, and recommended upgrade requirements for these facilities is discussed in **Section 5 and 6**.

4.3.2.2 Open Cut OC1

Currently at OC1, diversion drainage systems contain and divert sediment laden water into sediment dams. The surface runoff water from these areas is primarily from material emplacement areas, access roads, and other disturbed surface areas currently in the process of rehabilitation.

This includes the following areas:

- Sediment dam OC1-1, which collects runoff from the environmental bund;
- Sediment dam OC1-2, which collects runoff from the environmental bund;
- Sediment dam OC1-3, which collects runoff from the environmental bund;
- Sediment dam OC1-4, which collects runoff from the environmental bund;
- Sediment dam OC1-5, which collects runoff from the environmental bund;
- Sediment dam OC1-6, which collects runoff from the environmental bund and the surface areas of the mine spoil emplacement areas;
- Workshop dam, which collects runoff from the low level environmental bund immediately north of the OC1 MIA complex; and
- Sediment dam OC1-9, which collects runoff from disturbed areas below OC1-Dam 10.

Further discussion of catchment studies and hydrology assessment for these areas, and recommended upgrade requirements for these facilities is discussed in **Section 5 and 6**.

4.3.3 Dirty Surface Runoff Water

4.3.3.1 CHPP

Currently, diversion drainage systems contain and divert dirty saline content water from coal handling infrastructure catchment areas at the CHPP facilities into collection dams. The water from these areas is primarily from stockpile areas (raw coal and product coal), access roads, and hardstand areas etc.

Dirty surface runoff water is contained at the following locations:

- SD01, which collects runoff from the CHPP product stockpile;
- SD02, which collects runoff from the CHPP product stockpile;
- SD10, which collects runoff from the CHPP raw coal stockpile / ROM Pad;
- SD12, which has small catchment below CHPP dams SD01, and is secondary containment for SD01 spillages;
- Emergency Tailings Dam, which captures emergency tailings discharge from the CHPP, and local runoff from around the plant hardstand areas; and
- CHPP process dam, which is a turkeys nest facility, that receives dirty water from all other dams, plus water from UCML, and the northern borefields.

Further discussion of catchment studies and hydrology assessment for these areas, and recommended upgrade requirements for these facilities is discussed in **Section 5 and 6**.

4.3.3.2 Open Cut OC1

Currently at OC1, diversion drainage systems contain and divert dirty saline content water from active mining areas, material emplacement areas, access roads, MIA areas etc.

Dirty surface runoff water is contained at the following locations:

- Active mining and borrow pit areas;
- MIA Dam, which collects runoff from the MIA hardstand and laydown areas, refuel bay, vehicle washbay, workshop and other related facilities;
- 200ML Dam, which is a turkeys nest facility that receives water pumped from active mining areas;
- Dam OC1-7, which receives water pumped from the MIA dam and the 200ML dam; and

- Dam OC1-10, which receives water pumped from OC1-7, and in turn supplies water to the CHPP Process Dam.

Further discussion of catchment studies and hydrology assessment for these areas, and recommended upgrade requirements for these facilities is discussed in **Section 5 and 6**.

5. HYDROLOGICAL MODELLING

5.1 CHPP Scope

The hydrological modelling tasks completed included the following:

- RAFTS hydrologic modelling analysis to estimate the runoff volume for the 50-year Average Recurrence Interval (ARI) of major storage dams containing dirty surface runoff water; and
- Hydraulic modelling of Bora Creek to estimate flood extents during the 50-year and 100-year ARI rainfall events for the existing and proposed (or re-aligned) creek condition.

AE were also directed by MCO to undertake design capacity calculations of sediment dams in accordance with the EPA requirements, and per provisions of the Blue Book[2], considering a rainfall depth of 44mm over any consecutive 5 day period (where rainfall depth corresponds to the 95th percentile 5 day rainfall for the Central Tablelands). It is understood that the sediment dams will be permitted to fill and overflow via defined spillways in the event that this rainfall depth is exceeded over a consecutive 5 day period.

5.2 OC1 Scope

The hydrological modelling tasks completed included development of a RAFTS model to estimate the runoff volume for the 50-year Average Recurrence Interval (ARI) of Sediment Dam OC1-6, which is proposed to be used as the future licensed discharge facility for OC1.

AE were also directed by MCO to undertake design capacity calculations of sediment dams in accordance with the EPA requirements, and per provisions of the Blue Book[2] considering a rainfall depth of 44mm over any consecutive 5 day period (where rainfall depth corresponds to the 95th percentile 5 day rainfall for the Central Tablelands).

It is understood that the sediment dams will be permitted to fill and overflow via defined spillways in the event that this rainfall depth is exceeded over a consecutive 5 day period.

5.3 Modelling

5.3.1 Objective

The objective of the hydrological modelling was to determine the design runoff volume and peak inflows generated by subcatchments draining to the existing sediment dams and design hydrographs for all catchments (clean and disturbed) draining to Bora Creek. The hydrological modelling was also conducted to determine the flood extents along Bora Creek for the 50-year ARI and 100-year ARI design events under existing creek alignment, and proposed future creek realignment conditions.

For analysis of dam capacity requirements, the peak flow rate and total runoff volume were estimated for the 50-year ARI design events using methods contained in Australian Rainfall & Runoff (ARR) Vol. 2, (ARR, 2001). The sediment dams identified as having insufficient storage capacity in the PRP study by AE[1] were considered only.

For analysis of Bora Creek, the peak flow rate and inundation profiling were estimated for the 50-year and 100-year ARI design events using methods contained in Australian Rainfall & Runoff (ARR) Vol. 2, (ARR, 2001).

Event based rainfall-runoff modelling has been undertaken using RAFTS-XP modelling software. RAFTS-XP is a non-linear runoff routing model to estimate runoff hydrographs using either an actual event (recorded rainfall time series) or a design storm utilising Intensity Frequency Duration (IFD) together with dimensionless storm temporal patterns outlined in ARR (2001).

To assess dam capacity requirements, a model was developed to estimate the runoff volume and peak flowrate of individual (local) sub-catchment areas draining to existing sediment dams for a range of storm durations (15 minutes to 3 days) utilising the temporal patterns outlined in ARR (2001).

For the Bora Creek assessment, a model of all contributing areas (i.e. local sub-catchments including the Stage 1 CHPP facilities and surrounding clean catchments) was prepared to estimate design hydrographs for subsequent hydraulic modelling of Bora Creek. This second model includes all existing sediment basins as reported by Arkhill (2011) and hydrograph lagging to account for attenuation of peak flows occurring between sub-catchments.

Hydraulic modelling has been undertaken using one dimensional (1D) HECRAS, and the fully two-dimensional (2D) software modelling package TUFLOW. TUFLOW is specifically beneficial where the hydrodynamic behaviour in coastal waters, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.

TUFLOW also has the ability to simulate one-dimensional channels and drainage infrastructure (e.g. levees, culverts, floodgates etc) and provides superior assessment compared against 1D network models.

5.3.2 Sub-catchment Delineation

A combination of LiDAR point data previously supplied by MCO and the 1 second SRTM Derived Digital Elevation Model (hydrologically enforced) data available from Geoscience Australia (Gallant et al., 2011) were used to delineate sub-catchments for the study area.

Subcatchment areas draining to each sediment dam were mapped and used to develop the RAFTS-XP model.

In general, the catchment delineation carried out for the Bora Creek assessment broadly represents the points of entry of local drainage systems to the existing sediment dams and to Bora Creek as defined by local topography and natural gully formations present in the catchments upstream.

The total catchment area draining to Bora Creek is approximately 639 hectares.

The total catchment area was divided into 30 sub-catchments corresponding to existing sediment dams and key discharge locations along the length of Bora Creek. The sub-catchment boundaries adopted for the hydrologic modelling are shown in **Appendix C**.

5.3.3 Catchment Characteristics

Table 1 presents a summary of the key RAFTS-XP input parameters adopted for each sub-catchment, including sub-catchment area and catchment slope. Catchment slopes are estimated from the surface elevation data and the equal-area slope method.

A key parameter in the rainfall-runoff modelling is the impervious area of each sub-catchment. Based on aerial photography, the upstream catchment is largely pervious (undisturbed bushland) with some clearing evident along the overbank (floodplain) areas of Bora Creek.

Impervious surfaces in the catchment have been determined according to the proportionate landuse identified within each sub-catchment from aerial photography. The CHPP pad, buildings and other hardstand surfaces associated with the Emergency Tailings Dam (ETD) and Site Office are the main sources of impervious area present in the study area. Overall, these impervious surfaces account for a small fraction (<0.3%) of the total catchment area. For all other sub-catchments, a nominal imperviousness of 1% has been adopted.

To account for reduced infiltration capacity expected from surfaces in these catchments, the Initial Loss (IL) and Continuing Loss (CL) model parameter were adjusted accordingly. For the ETD sub-catchment, the IL and CL values were assumed to be 2 mm and 0 mm/hr respectively, and for the Site Office, hardstand surfaces such as roof and carpark areas were assumed to 1.5 mm and 0 mm/hr respectively. An IL of 10 mm and CL of 2.5 mm/hr were adopted to reflect undisturbed bushland, open pasture (bushland clearing) and grassed areas for all other sub-catchments (i.e. the majority of the total catchment).

Surface roughness characteristics were selected based on professional judgement and best practice standards. Manning's n values of 0.080 and 0.060 were adopted for undisturbed catchments and disturbed catchments respectively. For impervious (i.e. roof and carpark) and pervious (i.e. grass) surfaces in the Site Office catchment, Manning's n values of 0.015 and 0.030 were applied.

An assumed flow velocity of 0.5 m/s was used (and later supported by results of the hydraulic modelling) for the estimating of temporal lags between sub-catchments.

Table 1 Sub-catchment Properties

Sub-catchment	Area (ha)	Slope (%)
CC1	100.7	2.8
CC2	34.0	3.0
CC3	50.4	5.4
CC4	90.8	3.6
CC5	23.6	4.6
CC6	7.7	11.3
CC7	31.4	4.1
CC8a	67.4	3.9
CC8b	5.2	2.6
CC9	30.8	5.2
CC10	83.7	4.6
CC11	24.8	1.8
CC12	4.4	1.7
CC13	5.7	2.2
Cockies Dam	12.8	1
Emergency Tailings Dam	6.0	0.5
Office Site	1.1	1.8
Rail Loop Dam	7.5	1.9
SD01	14.4	1.5
SD02a	2.2	1.5
SD02b	5.1	1.5
SD03	1.4	0.5
SD04	2.4	0.5
SD05	0.6	0.5
SD06	2.1	0.5
SD07	0.5	1.5
SD08	2.2	1.5
SD10	9.7	2.7
SD11	8.8	2.5
SD12	1.3	3.6

5.4 Bora Creek Modelling

5.4.1 Model Extent and Topography

A 2D model was developed covering the full extent of Bora Creek and its floodplain. The ability of the model to provide an accurate representation of the flow distribution on the floodplain ultimately depends upon the quality of the underlying topographic model.

A high resolution (2 metre by 2 metre) Digital Terrain Model (DTM) was prepared for the existing condition of the study area from LiDAR data provided by MCO. The ground surface elevation for the TUFLOW model grid points are sampled directly from the DTM established for the model area. Additional ground control information was also incorporated to define important ground controls and hydraulic structures in the study area, which included the:

- Ulan Road embankment (assumed RL 415.5 m AHD) and underlying RCP culverts (5 x 1350mm);
- Rail Loop embankment (RL 432m AHD) and underlying Corrugated Metal Pipes (CMP) culverts (3 x 2400mm); and
- Proposed bund diversion as designed by Arkhill Engineers. Refer to Sketch No. SK3445-004-0 in **Appendix D**.

Culvert structures were simulated as a nested 1D element within the domain of the 2D model. The earth bund proposed to divert runoff from the catchments to the north of the Rail Loop (i.e. the proposed creek re-alignment condition) was included in the model by stamping the design profile onto the existing DTM.

5.4.2 Hydraulic Roughness

The development of the TUFLOW model requires the assignment of different hydraulic roughness zones. These zones are delineated from aerial photography and cadastral data identifying different land-uses (e.g. bushland, cleared land, roads, urban areas, etc) for modelling the variation in flow resistance.

For the present study, Manning's n roughness values of 0.060 and 0.040 were adopted for the main creek channel (clean, winding, vegetated along banks) and floodplain (cleared, scattered brush) respectively. Manning's n roughness values of 0.013 and 0.021 were assigned to the RCPs and CMPs beneath Ulan Road and the Rail Loop respectively.

5.4.3 Boundary Conditions

A normal depth flow condition (corresponding to a channel slope of 2%) was adopted as the downstream boundary condition.

Local catchment runoff hydrographs were applied directly to the hydraulic model. The hydrographs for the 50-year and 100-year ARI design rainfall events were derived from the RAFTS-XP model developed for the existing configuration and storage properties of sediment dams.

Minor modifications to the RAFTS-XP and TUFLOW models were necessary to account for the proposed creek re-alignment and configuration of sediment dams draining to the Rail Loop, which included:

- increasing the capacity of Cockies Dam; and
- relocation of inflow locations for clean water catchments CC2 and CC3 to enter on the upslope side of the earth bund (refer to **Appendix C**).

5.5 Results

5.5.1 CHPP Sediment Dam Capacities

The previous investigation of CHPP dam facilities as part of the surface water management plan review by AE[1], as determined by GSS Environmental Engineers using a design methodology in accordance with the Blue Book[2], found the following dams had insufficient storage capacity to contain runoff from the 50year-24hour duration rainfall event:

- SD01;
- SD04 to SD08;
- SD10;
- SD12; and
- SD14.

Of these facilities, SD04, SD05 and SD06 are to be decommissioned following removal of the unsuitable stockpile areas on the northern departure side of the rail loop. Hence, upgrades were initially only deemed necessary for SD01, SD07, SD08, SD10, SD12 and SD14. AE conducted a separate comparative analysis of these dams using RAFTS.

The total runoff volume was determined for the 12-hour, 24-hour, 30-hour, 36-hour, 48-hour and 72-hour design rainfall storms with the maximum result shown in **Table 2**, and the peak flowrate and critical storm duration in **Table 3**. For all sediment dam catchments, the maximum runoff volume occurred during the 30-hour design rainfall event. The critical storm with respect to peak flowrates for the various subcatchments was 2 hours.

Table 2 illustrates the Blue Book calculations as initially determined by GSS Environmental Engineers, RAFTS analysis results, and the EPA revised conditions for sediment dams. As the EPA minimum design provisions for the sediment dams under EPL12932 are now understood to be revised to 44mm rainfall depth over a 5 day period as discussed previously, the minimum design requirements for dam capacities are now governed by this requirement. Copy of Blue Book[2] calculations are shown in **Appendix E** for all CHPP sediment dams. Calculations were only conducted for the sediment dams as listed in EPL 12932 condition L2.5. Refer to **Section 6** for further discussion regarding upgrades to CHPP dams.

Table 2 50-year ARI Runoff Volume CHPP Dams

Sediment Dam	Existing Dam Capacity (ML)	XP Rafts Runoff Volume (ML)	Volume in PRP Report (ML) (see Note a)	Blue Book Volume per EPA Rainfall Depth Provision (ML) (see Note b)	Design Storage Capacity Adopted (ML)
SD01	15.04	12.13	15.54	-	**15.04 (Note c)**
SD07	0.22	0.42	0.57	0.41	**0.5**
SD08	1.28	1.90	2.41	0.80	**1.28**
SD10 A (existing)	1.93	8.17	9.92	2.0	**2.0**
SD10 B (new dam)	-	-	-	8.6	**9.0 (Note d)**
SD12 A (existing)	0.90	1.10	1.45	-	**0.8 (Note e)**
SD12 B (new dam)	-	-	-	-	**1.7 (Note e)**
SD14	**-**	12.30	12.5	6.46	**6.5 (Note f)**

Notes

a - These results were determined by GSS Environmental and presented in the Arkhill Engineers PRP review for the CHPP[1], and are based on 50yr ARI 24hour duration events.

b - Revised EPA provision requires minimum capacity of 44mm rainfall depth over consecutive 5 day period.

c - Denotes that SD01 will spill into SD12. SD12 will be upgraded to cater for 0.5ML shortfall in SD01. Blue Book calculations are not applicable for this dam as it contains contaminated water.

d - Existing SD10 catchment is to be split, with new SD10 (B) dam to be constructed. See discussion in Section 6.

e - Denotes that SD12 A and SD12 B are to be interlinked. Combined capacity of both dams is 0.8ML (existing SD12A capacity) + 1.7ML (new SD12 B) = 2.5ML. This exceeds the 1.45ML required + 0.5ML (shortfall from SD01). See discussion in Section 6.

f - Capacity of dam is lower then previous estimates, as catchment area reduced following construction of upstream clean water diversion bund. See discussions in Section 6.

Table 3 50-year ARI Peak Flowrate CHPP Catchments

Sediment Dam	Critical Storm (mins)	50-year ARI Peak Flow (m^3/s)
SD01	120	0.84
SD07	120	0.05
SD08	120	0.19
SD10	120	0.62
SD12	60 or 120	0.12
SD14	120	1.57

5.5.2 OC1 Dam Capacities

Calculations were undertaken by AE to assess the minimum storage requirements for OC1 sediment dams compared with existing capacity. Existing capacity of all OC1 dams was provided by MCO to assist with this review. **Table 4** shows capacity requirements for the OC1 sediment dams located below the environmental bund. These dams all overflow directly off site ultimately reporting to the Goulburn River. The environmental bund include contoured banks and separate subcatchment areas that are currently being rehabilitated, and report to the various sediment dams below the bund.

The OC1-1 to OC1-5 dams, and the Workshop Dam capacities were determined in accordance with the Blue Book for the 44mm rainfall depth over 5 consecutive day provision as revised by the EPA in EPL12932. Copy of Blue Book[2] calculations are shown in **Appendix F** for all OC1 sediment dams.

OC1-6 dam comprises a much larger catchment area than the other smaller sediment control dams at OC1. This catchment includes a large portion of the mine emplacement area of OC1, and would have a higher proportion of sediment buildup reporting to this dam then the other OC1 sediment dams OC1-1 to OC1-5, considering the lower degree of revegetation present in the respective catchments. This dam also would report to the Goulburn river following overflow. A RAFTS model was prepared to analyse the containment volume required for this dam only, as a secondary check of capacity against the Blue Book calculation. Refer to **Section 6** for further discussion regarding upgrades to CHPP dams.

Table 4 50-year ARI Runoff Volume OC1 Dam

Sediment Dam	Existing Dam Capacity (ML)	XP Rafts Runoff Volume (ML) (see Note a)	Blue Book Volume per EPA Rainfall Depth Provision (ML) (see Note b)	Design Storage Capacity Adopted (ML)
OC1-1	5.0	-	4.09	**5.0**
OC1-2	5.7	-	2.25	**5.7**
OC1-3	4.0	-	3.95	**4.0**
OC1-4	1.4	-	1.16	**1.4**
OC1-5	2.4	-	1.47	**2.4**
OC1-6	12.1	51.9	35.0	**52.0**
OC1-9	7.0 (note c)	-	1.7	**7.0**
Workshop Dam	3.2	-	1.1	**3.2**

Notes

a - Based on 50year 24hour duration storm.
b - Revised EPA provision requires minimum capacity of 44mm rainfall depth over consecutive 5 day period.
c - Dam capacity is estimate only.

5.5.3 Bora Creek Flood Extents

The results of the hydraulic modelling undertaken for the Bora Creek are summarised below. It is highlighted that the result following assume there is no backwater effects from the Goulburn River during flooding, which is considered reasonable as the floor level of Bora Creek is significantly elevated above the floor level of the Goulburn River. The Goulburn River was not considered in the analysis of Bora Creek.

The analysis of Bora Creek considered two (2) cases as follows:

- Existing model of the infrastructure for Bora Creek; and
- Proposed model following future upgrades (including enlargement of dams, and construction of new diversion bund for Bora Creek to prevent clean water surface runoff entering the Rail Loop.

Existing peak flood levels immediately upstream of Ulan Road during the 50-year ARI and 100-year ARI events are 413.1 m AHD and 414.0 m AHD. The corresponding peak flood levels for the proposed creek re-alignment condition is 412.7 m AHD and 413.7 m AHD. The long section profile of peak water levels along Bora Creek is shown in **Appendix C**. The flood extents corresponding to the existing creek and the proposed new earth diversion bund design during the 50-year ARI and 100-year ARI are shown in **Appendix D** (see sketch drawings SK3445-007 and SK3445-008).

The most notable differences between the predicted flood extents occur immediately upstream of Ulan Road where a backwater is created due to the capacity of the downstream culvert pipes being exceeded. The crest level of Ulan Road is sufficiently high that overtopping would not occur under existing and proposed design conditions for both the 50-year and 100-year ARI rainfall events.

Under the proposed creek re-alignment conditions, the flood extents within the rail loop would be greatly reduced as a consequence of increased storage in Cockies Dam and SD08, and the diversion of clean catchment runoff from northern sub-catchments (CC1, CC2 and CC3) around the rail loop. The flood extents along the length of the proposed earth bund are typically 15 to 20 metres wide and up to 30 metres at some locations. The difference between the 50-year and 100-year ARI flood extents are small (typically 3 metres or less) due to the steepness of the terrain and design profile of the bund. Approximately 250 metres downstream of the rail loop embankment, the relatively confined flows near the downstream end of the bund spread out and join with Bora Creek. At this location (approximately north of the ETD) the flood extent is approximately 60 metres.

The predicted flood extents confirm that the height of the embankment between Bora Creek and the Stage 1 CHPP facilities is adequate for up to the 100-year ARI.

The bank levels of sediment dams closest to Bora Creek (i.e. SD01, SD02, SD12 and the ETD) are sufficiently elevated such that flooding from the creek does not spill back into the dams. For the proposed creek diversion scenario, the peak flood extents immediately upstream of Ulan Road during the 50-year and 100-year ARI events are marginally less than the equivalent flood level predicted for the existing creek alignment condition (~40 cm and 30 cm respectively) due to the enlargement of Cockies Dam.

6. FUTURE WATER MANAGEMENT STRATEGY

6.1 General

The following section of this report discusses the proposed future water management strategy for the CHPP and OC1 facilities.

An overview of the various dam facilities including specific upgrade measures are discussed.

6.2 CHPP Facilities

6.2.1 Sediment Dam - SD01

The existing SD01 dam has constraints on all four sides of the current location that do not permit enlargement of this facility. Further the dam is lined, making deepening of the dam a high risk option with regard to ensuring the dam remains sealed.

It is proposed that the existing capacity of 15.04ML be maintained. A total of 15.54ML capacity is required for containment of the 50year – 24hour duration rainfall event, leaving a 0.5ML shortfall in capacity. SD01 has an overflow link however to SD12, and as such it is proposed that the shortfall in SD01 be allowed for in the upgrade of SD12.

There are no further works planned for this dam.

6.2.2 Sediment Dam - SD02

The current capacity of SD02 is deemed adequate for the 50year – 24hour duration design rainfall event. No additional works are planned for this dam.

6.2.3 Sediment Dams - SD03, SD04, SD05 and SD06

The current capacity of SD03, SD04, SD05 and SD06 is deemed adequate for the 44mm – 5 day rainfall depth required by the EPA (see **Section 5** and calculations in **Appendix E**).

These dams are to remain in temporary use only until such time as the unsuitable stockpile area is removed as part of the Bora Creek diversion works, and the area are effectively rehabilitated. Following successful rehabilitation, the dams will be decommissioned and filled in.

No additional works are planned for these dams other than they will be locally regraded to remove the present scour problems occurring to the batter faces.

Following rainfall, dewatering to an upgraded Cockies Dam shall be undertaken as soon as possible.

6.2.4 Sediment Dam - SD07

The current capacity of SD07 is deemed inadequate for the 44mm – 5 day rainfall depth required by the EPA (see **Section 4** and calculations in **Appendix E**).

The dam is to be upgraded as generally shown on SK3445-010 in **Appendix D**.

Following rainfall, dewatering to an upgraded Cockies Dam shall be undertaken as soon as possible.

6.2.5 Sediment Dam - SD08

The current capacity of SD08 is deemed adequate for the 44mm – 5 day rainfall depth required by the EPA (see **Section 4** and calculations in **Appendix E**).

No additional works are planned for these dams other than they will be locally regraded to remove the present scour problems occurring to the batter faces.

Following rainfall, dewatering to an upgraded Cockies Dam shall be undertaken as soon as possible.

6.2.6 Sediment Dam - SD09

As SD09 primarily is a clean water catchment, there is no intention to upgrade this facility.

The existing dam will remain as a first flush facility to cater for any coarse sediment and for local runoff from the current MCM Main Administration Area.

6.2.7 Sediment Dam - SD10

The existing SD10 site is located directly under overhead electrical services, and is adjacent to the Ulan-Wollar railway easement.

The current capacity of the existing SD10 is inadequate for the entire catchment area reporting to it. Means for upgrading the existing dam are limited, and as such AE have investigated the option for constructing a new dam below the OC1 ROM Station directly south of the CHPP and current SD10 site. The existing SD10 catchment area shall be split as follows:

- Existing dam labelled as SD10 (A) in lower catchment portion.
    - The dam capacity would be slightly enlarged to 2.0ML;
    - Catchment area currently 9.2ha is reduced to 2.0ha, following splitting of catchment into upper and lower areas;
    - This dam will collect surface runoff from areas downstream of Ulan Wollar road; and
    - In emergency cases the dam would overflow to SD01.
- New dam labelled as SD10 (B) in upper catchment portion.
    - The dam capacity would be 9.0ML;
    - Catchment area to be nominally 7.2ha;
    - This will collect surface runoff from OC1 ROM areas upstream of Ulan Wollar Road;
    - In emergency cases, the dam would overflow to SD10 (A) through existing culverts under the public road;
    - The existing shotcrete lined drain falling away to the north from the Sizing Station will need to be realigned into the new SD10(B) facility, and be relined; and
    - Relocation of buried electrical services may be required in this area. No allowance has been made for this in the attached budget cost estimates.
- Refer to SK3445-012 in **Appendix D** for a drawing overview of the proposed setup.

6.2.8 Sediment Dam - SD11

SD11 is located in a clean water catchment, and the dam is intended to be decommissioned.

It is proposed that the dam will be filled using surplus excavation material from the upgraded Cockies Dam facility, with the surface area rehabilitated.

A natural swale will be formed in the surface to allow conveyance of surface runoff from the upstream clean water catchment following rainfall.

6.2.9 Sediment Dam - SD12

The current capacity of SD12 is understood to be 0.8 ML. Capacity required to contain the 50yr 24hour event is 1.45 ML. So there is presently a 0.65 ML shortfall in SD12. In addition to this, an extra 0.5 ML is required to be added to the SD12 upgrade to cater for the shortfall in capacity in SD01.

A new dam is proposed to be installed adjacent to the present SD12 facility with a capacity of 1.7ML which exceeds the 1.15 ML capacity required. See SK3445-013 in **Appendix D** for concept design details.

6.2.10 Sediment Dam - SD14

The catchment area for SD14 comprises predominantly clean surface water runoff from undisturbed areas on both the northern and southern sides of the rail loop. Refer to **Figures 2.1 and 2.2** in **Appendix A** for overview of the current SD14 catchment areas.

It is proposed that the capacity required for this dam be upgraded to 6.5ML.

This upgrade accommodates collection of surface runoff from the rail loop section and the upstream catchment on the southern side of the Ulan-Wollar rail line only, as the surface runoff from the northern catchment will be diverted by a new clean water diversion bund into Wilpinjong Creek (bypassing SD14). See SK3445-006 and SK3445-014 in **Appendix D** for concept design details.

The new dam will be built up along the current inlet drain into the present SD14 dam.

Material excavated to construct the dam will be used to construct the new clean water diversion bund.

6.2.11 Emergency Tailings Dam

There are no plans to upgrade the existing Emergency Tailings Dam (ETD).

6.2.12 Existing CHPP Process Dam

There are no alterations planned for the future operation of the existing CHPP Process Dam, other than it will be labelled as CHPP Process Dam No. 1. This dam will remain as the principal water supply to the CHPP.

The current capacity of this dam is nominally 123ML with Top of Bank Level for this dam is nominally RL432.80.

As this dam is considered to be critical infrastructure to the MCM CHPP complex, the minimum design case considered for rainfall surge protection was deemed to be the 100year AEP rainfall event. The hydrology study has found that approximately 4.7ML of surge capacity is needed to contain rainfall falling into the dam during a 100year AEP rainfall event. In addition to this, the dam should have at least 0.50m freeboard.

On this basis, it is recommended that this dam be set with a maximum operating level of RL432.00, to ensure the 100year design event surge capacity is contained, with adequate freeboard provided. The dam will have 103ML capacity to this level.

6.2.13 Existing CHPP Clean Water Dam

The existing CHPP clean water dam is proposed to be used in future for holding surplus dirty water. The dam will become CHPP Process Dam No. 2. Key features of this facility determined by AE in previous investigations are as follows:

- Dam crest level – RL434.30 nominal
- Maximum surge capacity level for rainfall – RL 433.80 (recommended)
- Recommended Maximum Operating Level - RL 433.50 (recommended)
- Capacity at Maximum Operating Level - 69 Megalitres.

These details were included in the PRP report by AE[1].

Considering that this dam is now proposed to be used to store surplus dirty water from the CHPP dirty water dams SD01, SD02, SD10, SD12 and the ETD, the maximum operating level needs to be lowered. If a 50year – 24hour rainfall event was to occur at the CHPP, the total quantity of water required to be contained from these dams is 42.3ML.

Based on this, the following is recommended:

- That the dam not hold greater than 26.7ML of water at any time other than when the dams are being dewatered following rainfall.
- Further reduce Maximum Operating Level of this dam to RL 430.70, or lower.

- In effect, this will enable MCO to contain surface runoff from two consecutive 50year -24hour rainfall events, with the existing dirty water dams SD01, SD02, SD10, SD12 and the ETD initially filling, then each being dewatered to the CHPP Process Dam No. 2 until empty, then being able to fill again for the next rainfall event.

6.2.14 Cockies Dam

6.2.14.1 Overview of Existing Setup

Cockies Dam is presently a small dam that has a reasonably large clean water catchment reporting to it from the southern range area above the CHPP. This water traverses across Ulan – Wollar Public Road, through the services easement, and a section of the rail loop and Ulan – Wollar railway line, before it is diverted into Cockies Dam. The purpose of the dam is to capture and contain sediment laden surface runoff from disturbed areas particularly located within the confines of the rail loop.

The existing dam has a current capacity of 2ML when full. Without any consideration for diversion of the upstream clean water catchment areas, the dam capacity would need to be upgraded to 50ML capacity to contain runoff from a 50year ARI rainfall event.

6.2.14.2 Proposed Setup

It is proposed that the upstream undisturbed catchment to the south of Cockies Dam above the rail loop, be diverted into the existing clean water diversion drain that passes between the CHPP Building and the Rail Loop. Refer to drawings SK3445-025 and SK3445-026 in **Appendix D** showing the proposed diversion drain and flow routes into Bora Creek. This in effect reduces the catchment area for Cockies Dam from 46.6ha to 19.2ha.

The diversion drain shown on SK3445-025 is to be partially cut into natural ground areas on the southern side of the rail loop with a new embankment bund to be formed on the low side of the drain. The drain will feed runoff to an existing 5-cell box culvert (nominally 900mm wide x 600mm deep) that is located directly south of the CHPP Building. The existing culvert capacity is considered adequate to convey the peak flow of a 50year ARI rainfall event, with headwater level at top of bank level of the railway.

The existing drain that passes between the CHPP Building and the Rail Loop will be upgraded with the low side embankment bund to be raised as conceptually defined on SK3445-026. The drain will have sufficient capacity to convey the 50year peak flow with 0.5m freeboard.

By incorporating the upstream clean water diversions drain in the future upgrade works, the proposal for Cockies Dam is now as follows:

- Dam crest level – RL 430.50 nominal
- Spillway level – RL 429.50 (recommended)
- Capacity - 33 Megalitres (reduced from 50ML previously determined).
- See drawing SK3445-005 and SK3445-007 for concept details of the Cockies Dam upgrade in **Appendix D**.
- 17ML Capacity is required to contain 44mm – 5 day rainfall depth for the Cockies Dam catchment of 19.2ha. See calculations in **Appendix E**.
- 16ML capacity is available for transfer of water from other sediment dams SD03 to SD06 (temporary storage allowance), SD07, SD08 and SD14 ready for discharge.
- Cockies Dam to be setup as the future licensed discharge point for the CHPP, with proposed maximum discharge of 10ML/day into Bora Creek as discussed in **Section 3**.
- All water from SD03, SD04, SD05, SD06, SD07, SD08 and SD14 should be dewatered back to Cockies Dam following rainfall, where it can be discharged under license if the water quality meets the EPL12932, or it can be transferred into the Process Dams.
- Cockies Dam shall be operated empty so that it has adequate capacity to contain future rainfall. If the dam is left full or part full, this will put the sediment dams SD03, SD04, SD05, SD06, SD07, SD08 and SD14 under pressure to contain rainfall, and could lead to unlicensed overflows from these facilities, as the transfer of water to Cockies Dam may be limited.
- The dam construction will include an embankment and excavation for the dam impoundment. The excavated material will required stockpiling to a permanent site adjacent to the CHPP Process Dam No. 1 (on downstream side of Cockies Dam).

- Surface Runoff from the new spoil stockpile will be directed back into Cockies Dam. Exposed surface areas will be revegetated.
- Access to Cockies Dam embankment will be possible via a new access road link built between the southern end of Cockies Dam embankment, and the north west corner of the CHPP Process Dam No. 1 embankment.
- This proposal enables all spoil material to be disposed within the CHPP complex, and significantly reduces project costs due to reduction in haulage costs to OC1.

6.2.14.3 Licensed Discharge to Bora Creek

Licensed discharges from Cockies Dam will flow into Bora Creek through the existing triple cell corrugated steel pipe culverts located under the rail loop on the departure side of the train loadout bin. Key points to note are as follows:

- The existing basin immediately on the discharge outlet of the triple cell culvert will be upgraded with all existing bank erosion repaired. The existing basin will be free-draining into Bora Creek;
- The flows of up to 10ML/day from Cockies Dam equate to an average flowrate of 115L/s. It is not anticipated that maximum discharge rates from Cockies Dam would exceed 150L/s (total up to 10ML/day maximum discharge would be maintained). Final discharge flow rates shall be confirmed in detail design; and
- Bora Creek has adequate capacity to convey the discharge from Cockies Dam. The hydrology modelling for Bora Creek in existing and future forms shows the 50year and 100year flowrates are significantly greater compared with the likely discharge from Cockies Dam. Flow comparisons are as follows:
  - 50year ARI Peak Flow in Bora Creek – 34.62m^3/s.
  - 100year ARI Peak Flow in Bora Creek – 41.88m^3/s.
- A sample of cross sections of Bora Creek are shown using 1D HECRAS modelling results in **Appendix C**. Additional sample cross sections were prepared and are shown in drawings SK3445-027 and SK3445-028, taken at random points along Bora Creek (refer to **Appendix D**). Key points to note are as follows:
  - Base width of drain is highly variable along the creek alignment;
  - The geometry of the natural creek formation varies from triangular to trapezoidal shape and vice versa;
  - Side batters of the creek vary from steep batters of 1V:1H to flat sloped surfaces;
  - The bedslope of the creek varies from 0.5% to nominally 5% in random locations along the creek alignment;
  - Calculations were undertaken to determine estimated flow depth for flowrates of 115L/s and 150L/s discharge flowrates from Cockies Dam;
  - Variable surface roughness parameters ranging from using Mannings n values of 0.040 to 0.080 were used to assess the sensitivity of the flow depth and velocity in the creek;
  - Variable bedslopes from 0.5% grade to 5.0% grade were found from assessment of the laser survey of the creek. These variable bedslopes were checked in calculations to assess the sensitivity of the flow depth and velocity in the creek;
  - Refer to **Appendix H** for copies of sample calculations for the 115L/s and 150L/s flow cases;
  - In summarising results, the flow velocity varies from 0.4m/s for 0.5% bedslopes to 1.2m/s for 5.0% bedslopes. Generally velocities are below 0.6m/s when bedslopes are 1.0% grade or flatter;
  - Subject to final inspection and detail design, local placement of rock protection and rock check dams may be advantageous to bare soil areas within the Bora Creek formation, where bedslopes exceed 1.0% gradient, particular where soils are identified as being highly dispersive and erodible; and
  - Where necessary, rock protection would likely only need to be placed up to a local vertical height of 0.5m above base level, as the maximum estimated flow depth does not typically exceed 0.35m based on calculations at sample locations of Bora Creek.

- A real-time monitoring system is proposed to be installed at Cockies Dam that will monitor and record the water quality, and ensure that water quality trends comply with EPL12932 before discharge occurs from the dam.

6.3 Bora Creek Diversion

As outlined in **Section 5** it is proposed that Bora Creek be realigned to bypass around the northern edge of the rail loop following construction of a new Clean Water Diversion Bund No. 1, rather than through the rail loop as per the present arrangement. Concept details for the proposed Diversion Bund No. 1 are shown in concept drawing SK3445-004 in **Appendix D**.

The construction of the new clean water diversion bund will be constructed using material from the unsuitable stockpiles area on the north side of the CHPP rail loop departure area.

6.4 SD14 Dam Clean Water Catchment Diversion

It is proposed that the upstream catchment north of SD14 be diverted to bypass around the northern edge of SD14 dam following construction of a new Clean Water Diversion Bund No. 2. Concept details for the proposed Diversion Bund No. 2 are shown in concept drawing SK3445-006 in **Appendix D**. Diversion Bund No. 2 will terminate on the downstream side of SD14, with all surface runoff from the northern clean water catchment feeding into the upmost reaches of Wilpinjong Creek.

The construction of the new clean water diversion bund will be constructed using material from the unsuitable stockpiles area on the north side of the CHPP rail loop departure area. The upstream end of Diversion Bund No. 2 will tie into the start of Diversion Bund No. 1 that conveys surface runoff into Bora Creek.

6.5 Unsuitable Stockpiles

AE have investigated means of removing the two (2) existing Unsuitable Material Stockpiles located on the north side of the CHPP rail loop departure area.

Previous works estimated the Unsuitable Stockpiles have approximately 131,000m3 of material. The stockpiles have minimal vegetation coverage, and create a large maintenance problem for the CHPP following rainfall, resulting in the need for frequent dewatering and cleanup of the current sediment dams SD03, SD04, SD05 and SD06.

The EPA have outlined in correspondence to MCO their preference that these stockpiles be removed.

AE have investigated the following:

- Unsuitable stockpile 1 (northern Bora Creek end stockpile) is estimated to contain 56,450m3 of material in this stockpile.
- Unsuitable stockpile 2 (southern Wilpinjong Creek end stockpile) is estimated to contain the remaining quantity of 74,550m3 of material in this stockpile.
- Unsuitable stockpile 1 will be fully removed, with all material excavated used to construct the new clean water diversion bund for Bora Creek, as shown in concept sketch SK3445-004 (refer to **Appendix D**).
- Unsuitable stockpile 2 will be regraded, with batters flattened to 1V:10H, with 8,305m3 of material moved to construct the clean water diversion bund for Bora Creek, as shown in concept sketches SK3445-006 and SK3445-022 (refer to **Appendix D**).
- The final landform of unsuitable stockpiles 1 and 2 will be regraded as shown in concept sketch drawing SK3445-021 (refer to **Appendix D**).
- Following removal and flattening of the unsuitable stockpiles, the entire area needs to be rehabilitated including replacing surface areas with conditioned topsoil to improve nutrient content and revegetation, hydromulching and seeding.
- The sediment dams SD03, SD04, SD05 and SD06 will need to remain for temporary short term sediment collection until the area is adequately revegetated.

6.6 OC1 Facilities

6.6.1 Sediment Dams – OC1-1, OC-2, OC-3, OC-4 and OC1-5

The current capacity of Open Cut sediment dams OC1-1, OC1-2, OC1-3, OC1-4 and OC1-5 is deemed adequate for the 44mm – 5 day rainfall depth required by the EPA (see **Section 5** and calculations in **Appendix E**).

No additional works are planned for these dams other than local pipe distribution infrastructure will be relocated so that all dewatering from these dams is to pumped to Sediment Dam OC1-6 rather than the 200ML Dam as per present arrangements.

Dewatering from each of these sediment dam facilities to OC1-6 shall be undertaken as soon as possible following rainfall to ensure containment without unlicensed discharges.

6.6.2 Sediment Dam – OC1-6

6.6.2.1 Overview of Existing Setup

OC1-6 Dam has a reasonably large catchment area reporting to it from the OC1 emplacement area. The water from this catchment traverses the spoil dump areas of OC1, before it is passes down a steep graded rock lined drop structure into OC1-6 Dam. The purpose of the dam is to capture and contain sediment laden surface runoff from these disturbed areas without discharging directly into the downstream Goulburn River system.

The existing dam has a current capacity of 12.1ML when full. Without any consideration for diversion of the emplacement areas, the dam capacity would need to be upgraded to 52ML capacity to contain runoff from a 50year ARI rainfall event.

6.6.2.2 Proposed Setup

Sediment Dam OC1-6 is proposed to be used in future as the licensed discharge point for OC1. The maximum daily discharge proposed from this facility is 10ML/day. The present discharge point which exists at OC1-7 dam will need to be relocated to OC1-6 dam.

The capacity of OC1-6 will be upgraded to 52ML capacity as part of the upgrade. The dam will receive pumped water from OC1-1, OC1-2, OC1-3, OC1-4, OC1-5 and the Workshop Dam. The dam may also receive pumped water from clean water cutoff dams located upstream of mining areas such as Strip 6 dam.

See drawing SK3445-023 in **Appendix D** for concept details of the proposed upgrade.

6.6.2.3 Licensed Discharge to Goulburn River

Licensed discharges from OC1-6 Dam will flow through a series of open drains and culvert structures prior to entering the Goulburn River.

Key points to note are as follows:

- Flows of up to 10ML/day from OC1-6 Dam equate to an average flowrate of 115L/s. It is not anticipated that maximum discharge rates from OC1-6 Dam would exceed 150L/s (total up to 10ML/day maximum discharge would be maintained). Final discharge flow rates shall be confirmed in detail design; and;
- The drawing SK3445-023 also shows the flow route of discharge from the dam feeding to the Goulburn River;
- Flow from OC1-6 discharge passes overland towards the open swale along Ulan Road;
- Flow travels along the open swale for ~500 metres before reaching the culvert beneath Ulan Road;
- Flow passes under Ulan Road. MCO previously engaged Barnson Engineers to carry out hydraulic checks of the culverts immediately downstream of OC1-7 dam to determine flow capacity of these pipe installations. Of these culverts, the only culvert which overflow from OC1-6 will pass through is Culvert 3 under Ulan Road, as labelled in **Appendix G** attached.

- Copies of the drainage calculations for Culvert 3 are attached in **Appendix G** with capacity estimated at 22.5m^3/s which significantly exceeds the maximum discharge likely from OC1-6;
- Flow appears to pass into a surface water storage. As this dam is located on UCML land, it has not been able to be inspected.
- The drain travels towards another open channel situated at the toe of the rail loop embankment;
- Travel along the open swale for ~250 metres before reaching a series of culverts beneath the Rail Loop and colliery area. AE understand that these culverts typically comprise large multi-cell Corrugated Steel Pipe (CSP) construction. The capacity of these culverts will easily convey the discharge from OC1-6 Dam;
- Discharge to Goulburn River is approximately 1.8km downstream of OC1-6 Dam;
- Along the flow path, dry-weather flows would be subject to seepage and evaporation from open channels and surface water storages. Depending on the capacity and water level in the unnamed surface storage immediately north of Ulan Road, overflows may be entirely captured and/or significantly attenuated before reaching the Goulburn River;
- The discharge water quality from the unnamed storage will be influenced by the initial quality of water in the storage, its treatment effectiveness (capacity to remove suspected solids and other pollutants) and the quality of surface water generated by other surfaces (e.g. Ulan Road, surrounding paddocks and other upstream catchments) during wet weather conditions; and
- A real-time monitoring system is proposed to be installed at OC1-6 that will monitor and record the water quality in OC1-6, and ensure that water quality trends comply with EPL12932 before discharge occurs from the dam.

6.6.3 Sediment Dam – OC1-7

Open Cut sediment dam OC1-7 is primarily used for transfer of dirty water from active mining areas and the 200ML Holding Dam to OC1-10 and ultimately to the CHPP to meet processing water user demands.

The dam currently is a licensed discharge point under the EPL12932, however the dam is used as part of the network for transfer of dirty water around the mine site, and hence the water quality from the dam is not deemed suitable for discharge. As such, MCO propose to move the licensed discharge point from OC1-7 to OC1-6.

There is no provision for future upgrade of OC1-7 other than potentially introducing capacity increases necessary as part of distribution of onsite dirty water.

6.6.4 Sediment Dam – OC1-9

Open Cut sediment dam OC1-9 is primarily used for capturing locally disturbed areas downstream of the OC1-10 Holding Dam and OC1 ROM Pad. It is highlighted that the dam capacity used in this assessment is an estimate only, and should be verified by survey.

The dam feeds into a clean water catchment that passes through CHPP Sediment Dam SD11, before it enters Bora Creek.

The current dam capacity is estimated to be approximately 7.0ML, and is deemed adequate for the 44mm – 5 day rainfall depth required by the EPA.

Subject to confirmation of dam capacity, there is no provision for future upgrade of OC1-9 other than the dam needs to be dewatered to OC1-10 following rainfall to prevent discharge into the downstream catchment. The frequent spillage as shown in the water balance assessment in **Appendix A** is based on the dam not being dewatered following rainfall - this is not an accurate representation of the future system strategy that includes a pump link to OC1-10.

6.6.5 Sediment Dam – OC1-10

Open Cut sediment dam OC1-10 captures runoff from the OC1 ROM Pad and is primarily used for transfer of dirty water from active mining areas, the OC1 200ML Holding Dam, and OC1-7, to the CHPP Process Dam No. 1 to meet processing water user demands.

The dam currently is a licensed discharge point under the EPL12932, however the dam is used as part of the network for transfer of dirty water around the mine site, and hence the water quality from the dam is not deemed suitable for discharge. Future licensed discharges are not planned from this dam by MCO.

There is no provision for upgrade of OC1-10.

6.6.6 Workshop Sediment Dam

The Workshop sediment dam is located below the environmental bund protecting the OC1 MIA complex from Ulan Road. The dam is primarily used for capturing locally disturbed areas from the environmental bund.

The dam feeds into a clean water catchment that passes below the Ulan Airstrip before linking into the same drainage pathway as per the proposed discharge from OC1-6.

The current dam capacity of 3.2ML is deemed adequate for the 44mm – 5 day rainfall depth required by the EPA.

There is no provision for future upgrade of the Workshop Dam.

6.6.7 MIA Dam

The MIA Dam is primarily used for storing dirty water draining to it from the OC1 MIA. The MIA Dam is pumped to OC1-7 where it is then transferred ultimately to the CHPP to meet processing water user demands.

There is no provision for future upgrade of the MIA Dam.

6.6.8 200ML Holding Dam

The 200ML Holding Dam is primarily used for storing dirty water pumped to it from active mining areas. The 200ML Holding Dam is pumped to OC1-7 where it is then transferred ultimately to the CHPP to meet processing water user demands.

There is no provision for future upgrade of the 200ML Holding Dam.

6.6.9 Strip 6 Dam

Strip 6 dam is currently used to cutoff upstream clean water surface runoff from entering downstream active mining areas. Dewatering from this dam to OC1-6 may be carried out by MCO as part of licensed discharges.

There are no additional works planned for this dam.

7. RAIL LOOP REMEDIATION

7.1 Background

The CHPP Rail Loop is located east of the CHPP building, with the site positioned within a natural broad gully that slopes west into Bora Creek which is aligned in an east-west direction which feeds into the Goulburn River. The entry and exit points to the MCO rail loop feeds off the Muswellbrook to Ulan Rail Line. Local drainage from the entry and exit area feeds into the upper reaches of Wilpinjong Creek which flows to the south of SD14.

The rail loop has undergone variable degrees of erosion and scour problems to the embankment and cutting batters at the CHPP site. The rail loop requires frequent maintenance of cess drains at the toes of embankments to remove sediment and specific maintenance around drainage structures such as culverts.

An investigation of the rail loop was undertaken by Douglas Partners to assess the extent of damage prevalent to the rail loop – refer to **Appendix J**. The investigation included data review of available information for the original design of the rail loop, site inspection and logging of the rail loop and its cuttings and embankments, laboratory testing of surface samples, engineering analysis and reporting.

The erosion and scour present to the various areas was risk assessed in terms of potential for future erosion and its likely effects on both serviceability of the rail loop and ongoing maintenance.

7.2 Inspection Findings

The rail loop comprises cutting up to 8m in height which are located mainly in the northern departure areas of the rail loop and the southern approach end. Embankments are up to 6m in height on the departure side of the train loadout bin facility, however are generally less than 3m height for the majority of the length of the rail loop. Batter angles to these areas vary around the formation.

Site soils were found to comprise the following:

- Deep alluvial palaeochannel profile with slightly cemented sands;
- Soils generally 85% sand and 15% clay / silt;
- Sand is naturally erodible when exposed on batters; and
- The 15% clay and silt is dispersive.

Laboratory testing results of select samples found the following:

- Emerson class (No. 2 to 6) – indicating non-dispersive to dispersive;
- Pinhole dispersion – intermediate dispersive;
- Growability / erodability – highly dispersive; and
- Turf rootzone assessment suite undertaken, identified that the topsoil should generally be treated with lime, fertilisers and organics to improve soil fertility and potential vegetation regrowth.

The report included an erosion category scheme to assess the risk of erosion and the potential for future instability of the railway formation and batter slopes. This classification scheme then allows for setting of repair priorities for the various areas. Refer to **Appendix J** for further discussion.

For an overview of the various category areas for cuttings around the rail loop, refer to Arkhill Engineers drawing SK3445-020 (in **Appendix D**). For an overview of the various category areas for embankments, refer to Arkhill Engineers drawing SK3445-021 (in **Appendix D**). These drawings indicate the erosion category, and nominal areas requiring repair.

7.3 Upgrade Measures

The recommended upgrade measures typically comprise the following techniques:

- Site earthworks to widen cess drains, improve falls, and flatten steep batter slopes to minimum 1V:2.5H angle or flatter as per drawing SK3445-018 and SK3445-019 in **Appendix D**;
- Cleanout of existing drains and culvert structures to enable free-drainage;
- Introduction of rip rap erosion control measures over geotextile underlay where necessary;

- Replace exposed covering with conditioned topsoil (existing material added with gypsum, lime, fertiliser and organics), combined with jutemesh reinforcement and Hydromulch and seed with the aid of watering / fertilising to promote vegetation growth;

8. DRAWINGS

Refer to **Appendix D** showing concept drawings of the various upgrade measures as discussed in this report.

9. BUDGET COSTS

Refer to **Appendix K** showing budget cost estimates for the proposed upgrade works.

10. REFERENCES

1. Arkhill Engineers, 'CHPP Water Management Plan Review', for Moolarben Coal Operations Pty Ltd, 2011.

2. Landcom, 'Soils and Construction, Volume 1 – Managing Urban Stormwater', 4th Edition, 2004.

3. Moolarben Coal, 'Water Management Plan – Version 2', 2011.

APPENDIX A

MOOLARBEN WATER BALANCE ASSESSMENT FOR STAGE 1

APPENDIX B

STAGED VOLUME DATA FOR MOOLARBEN COAL OPERATIONS DAMS

APPENDIX C

BORA CREEK FLOOD STUDY RESULTS (SAMPLE)

APPENDIX D

DRAWINGS

SKETCH NUMBER	SKETCH TITLE
SK3446-001	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE – EXISTING SURFACE CONTOUR PLAN
SK3445-004	CHPP RAIL LOOP & WATER MANAGEMENT FACILIITIES UPGRADE – CLEAN WATER DIVERSION DRAIN 1
SK3445-005	MOOLARBEN CHPP – NEW COCKIES DAM CATCHMENT UPGRADED 50ML DAM
SK3445-006	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE - CLEAN WATER DIVERSION DRAIN 2
SK3445-007	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE CONCEPT DESIGN – REVISED LOCATION
SK3445-008	MOOLARBEN CHPP – WATER MANAGEMENT UPGRADE – EXISTING BORA CREEK FLOOD PLAN
SK3445-009	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE CURRENT BATTER DISTURBED SURFACE AREAS
SK3445-010	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE - DAM SD07 CONCEPT PLAN & SECTION
SK3445-012	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE DAM SD10 CONCEPT PLAN & SECTION
SK3445-013	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE - DAM SD12 CONCEPT PLAN VIEW
SK3445-014	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE - DAM SD14 CONCEPT PLAN & SECTION
SK3445-015	CHPP RAIL LOOP & WATER MANAGEMENT FACILITIES UPGRADE - DAM SD12 TYPICAL SECTIONS
SK3445-017	MOOLARBEN STAGE 1 – CHPP WATER MANAGEMENT UPGRADES 50ML COCKIES DAM EMBANKMENT – TYPICAL SECTION
SK3445-018	CHPP RAIL LOOP STABILISATION PROJECT TYPICAL CROSS SECTION – RAIL LOOP CUTTING UPGRADE
SK3445-019	CHPP RAIL LOOP STABILISATION PROJECT TYPICAL CROSS SECTION – RAIL LOOP EMBANKMENT UPGRADE
SK3445-020	RAIL LOOP REMEDIATION PROJECT – EROSION CATEGORIES CUTTING REPAIR SURFACE AREAS & VOLUMES
SK3445-021	RAIL LOOP REMEDIATION PROJECT – EROSION CATEGORIES EMBANKMENT REPAIR SURFACE AREAS & VOLUMES
SK3445-022	MOOLARBEN COAL – CHPP COMPLEX UNSUITABLE STOCKPILE REMOVAL WORKS
SK3445-023	OPEN CUT OC1 WATER MANAGEMENT FACILITIES UPGRADE SED. DAM 6 – CONCEPT PLAN & SECTION
SK3445-025	COCKIES DAM UPSTREAM DIVERSION DRAIN PLAN & SECTIONS
SK3445-026	COCKIES DAM UPSTREAM DIVERSION BUND UPGRADE PLAN & SECTIONS
SK3445-027	BORA CREEK TYPICAL CROSS SECTIONS PLAN
SK3445-028	BORA CREEK TYPICAL CROSS SECTIONS

APPENDIX E

CHPP SEDIMENT DAM CALCULATIONS

APPENDIX F

OC1 SEDIMENT DAM CALCULATIONS

APPENDIX G

BARNSON ENGINEERS – CULVERT CALCULATIONS

APPENDIX H

BORA CREEK – LICENSED DISCHARGE FLOW RESULTS & SKETCHES

APPENDIX J

DOUGLAS PARTNERS – GEOTECHNICAL REPORT FOR RAIL LOOP REMEDIATION

APPENDIX K

BUDGET COST ESTIMATES