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Weld Range Iron Ore Project

Surface Water Management Plan

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

TERMS AND ABBREVIATIONS GLOSSARY

ARI	Average Recurrence Intervals
AR&R	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
CSP	Corrugated Steel Pipe
DoW	Department of Water
EMP	Environmental Management Plan
SMC	Sinosteel Midwest Corporation
SWMP	Surface Water Management Plan

1.0 *INTRODUCTION*

Western Australia's economy is heavily dependent on mineral resource projects and its future growth and development rely on the continued viability of resource development projects. The Weld Range Iron Ore Project will provide financial and social benefits for the area through employment, infrastructure and flow-on effect to the non-mining sector.

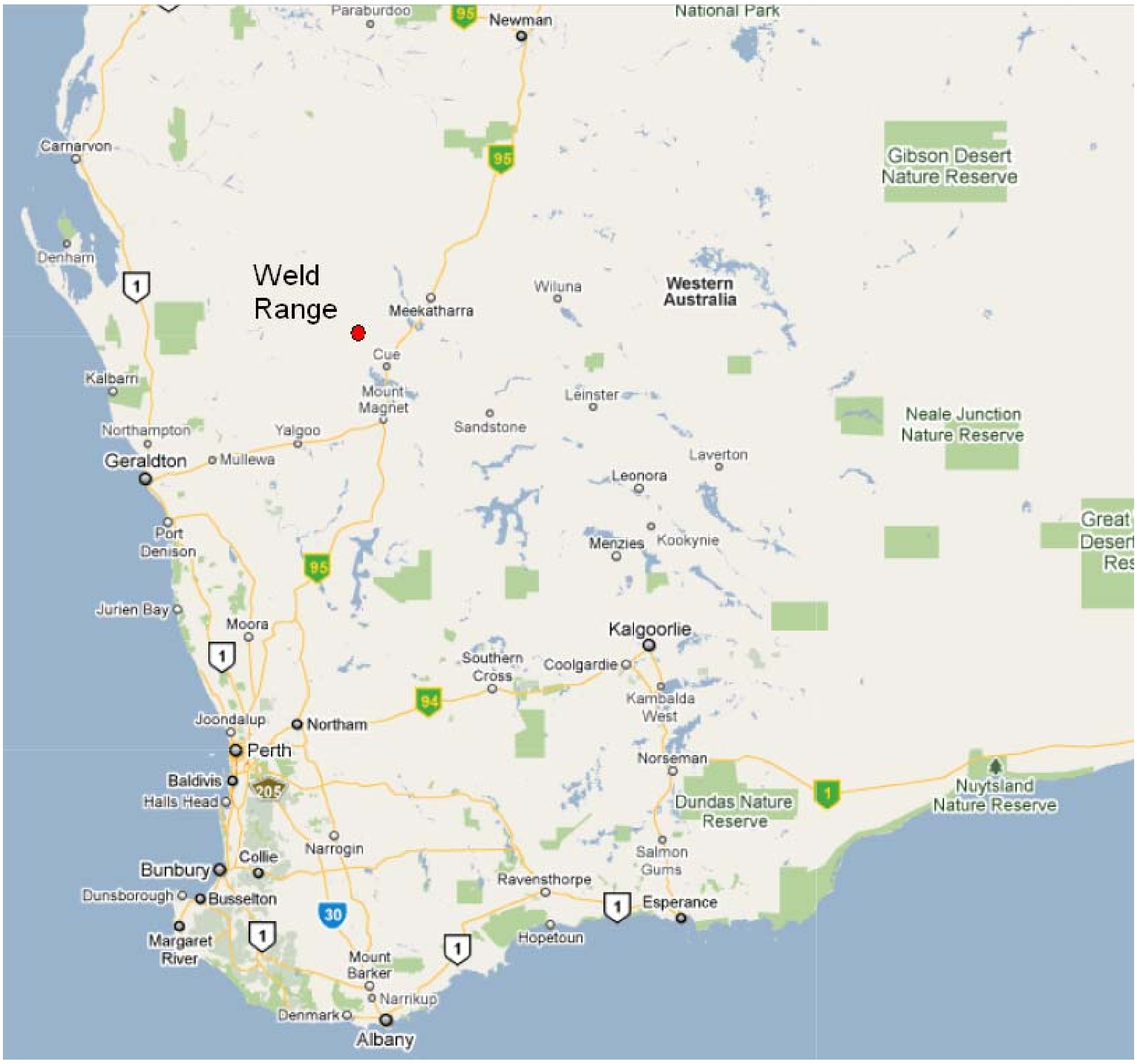

Figure 1.1 Location Map

Sinosteel Midwest Corporation Ltd (SMC) is an incorporated entity set up to conduct mineral exploration, engineering, environmental and economic studies into the feasibility to mine Weld Range 60km NW of Cue.

The Weld Range Iron Ore Project (the Project) is a direct shipping iron ore project with high grade outcrops over a 60 km strike length. SMC is targeting to export 15 million tonnes per annum (Mtpa) of iron ore over a 15 year period, however, the Weld Range PER covers the first 11 years of planned operations. Any additional extension to this will be subject to a separate formal assessment. To implement this project, major infrastructure will be designed, installed and constructed immediately, with production scheduled for 2014, and decommissioning in 2024.

There are a number of potentially significant environment impacts expected as a result of the Project. As a result, environment management plans for the significant factors have been developed as a primary method of controlling, managing and monitoring these known and expected environmental impacts. The management plans and elements of the Project's Environmental Management System (EMS) that will be used to achieve the environmental objectives, targets and commitments of the Project and the application of mitigation measures.

It is a primary objective that all environmental impacts during operation of the Project are avoided or minimised as far as reasonably practicable; consistent with the principles of environmental protection. Environmental impacts will also be evident during construction of the Project infrastructure and the objectives and management practices within these plans will also apply to these construction activities.

Compliance with commitments outlines in this document will be internally audited by SMC and subject to external audits by the relevant regulatory agencies, including the Department of Environment and Conservation (DEC) and the Department of Mines and Petroleum (DMP).

This Surface Water Management Plan (SWMP) consolidates strategies for managing and mitigating potential surface water impacts associated with the construction and operation of the project.

1.1 Purpose and Scope

The purpose and scope of this surface water management plan is to:

- *Develop a SWMP for the Weld Range site to address the following:*
    - Potential impacts of project on surface water flows and flow regimes (quantity and quality).
    - Potential impacts associated with hydrocarbon spills and contamination;
    - Present appropriate management measures to minimise these potential impacts; and
    - Present monitoring requirements.

This SWMP provides a general description of surface water management measures that will implemented during the life of the project.

The SWMP will not address surface water impacts associated with:

- *Acid rock drainage; and*
- *Dust suppression (waste dumps, stock piles, access and haul roads).*

1.2 Potential Environmental Impacts

A number of potential environmental impacts associated with surface water, have been identified and will be discussed later in this report. Table 1.1 displays the potential impacts and their association with the different aspects of the Project.

Table 1.1 Potential Impacts Associated with the Development and Operation of the Project.

Aspect	**Impacts**	**Location in Management Plan**
Development of Mine Pits and Mine Infrastructure	Interruption of flow regime, inundation of upstream areas and water starvation of downstream vegetation. Erosion and sedimentation impacts associated with diversion channels.	4.1.1
Road and Rail Infrastructure	Interruption of flow regime. Impacts associated with culvert waterway crossings such as scouring, sedimentation and erosion occur due to changes in flow rates and paths.	4.1.2
Ground Disturbance	Interruption of flow regime, requiring diversion drains around disturbance areas. Erosion and sedimentation impacts associated with diversion channels. Ground disturbance results in high suspended sediment loads in runoff. This introduces the need for sedimentation ponds.	4.1.3
Storing and Handling of Hydrocarbons	Contamination risk if hydrocarbon management plans are not followed or as a result of an incidental spill.	4.1.4

1.3 Relevant Legislation

The relevant legislation and guidelines applicable to the development of this SWMP include (but is not limited to):

- *Rights in Water and Irrigation Act 1914*
- *DoW Water Quality Protection Guidelines (2000)*
- *Wildlife Conservation Act 1950*

2.0 *HYDROLOGY*

2.1 Climate

The Weld Range is located in a region classified as semi-arid, with low annual rainfall, hot dry summers and mild, cool winters. The typical rainfall pattern for the Weld Range has been derived from rainfall data recorded by the Bureau of Meteorology (BoM) at Meekatharra Airport (007045). The mean monthly rainfall is presented in Figure 2.1. While the average annual rainfall at Meekatharra Airport is 236 mm, the highest daily rainfall records show an event of 123 mm. The majority of rainfall occurs in the summer months associated with thunderstorms and tropical depressions moving from the north. Rainfall events in these months are usually intense and can result in significant flooding. Winter rainfall is normally from cold fronts moving northwards from depressions in the Southern Ocean. Winter rainfall is normally less intense and therefore is less likely to result in significant flooding.

Evaporation in this region is very high and significantly exceeds annual rainfall. The mean annual pan evaporation from records at Meekatharra Airport is 3,560 mm. Evaporation rates are higher in summer than they are in winter, with a mean monthly pan evaporation of 502 mm in January compared with only 114mm in June.

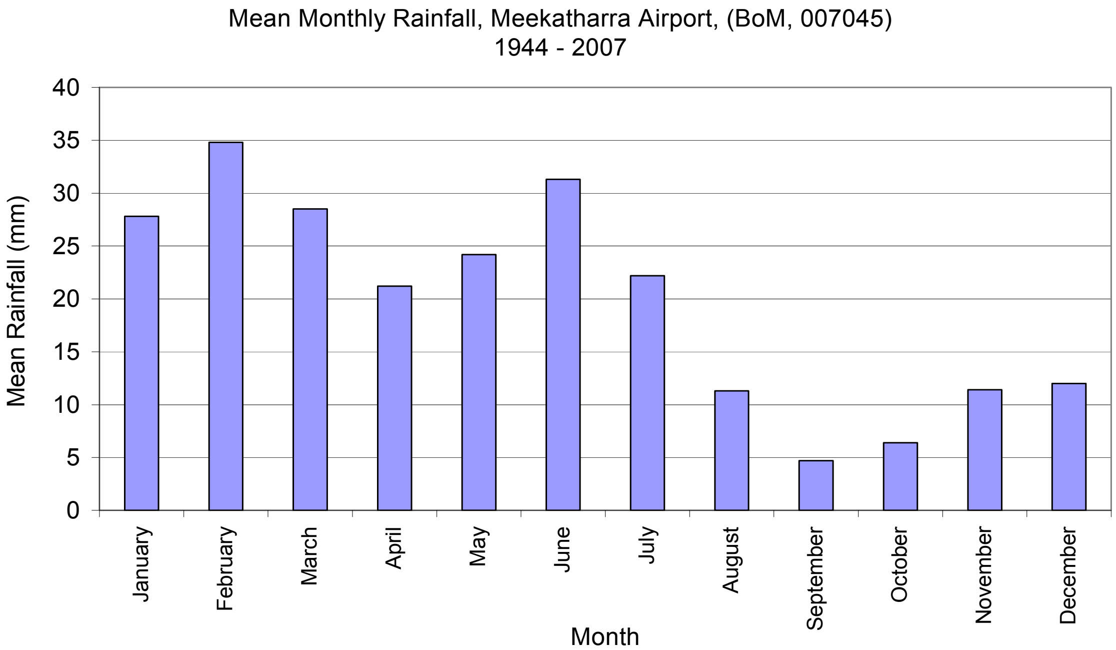

Figure 2.1 Mean Monthly Rainfall recorded at Meekatharra Airport (007045), 1944 to 2007

Design rainfall intensity, frequency and duration (IFD) data was derived for the Weld Range using the methods described in AR&R Vol.1 (Engineers Australia, 2001). The basic intensities, skewness and frequency factors for the site were obtained from AR&R Volume 2 (Engineers Australia, 1987). AusIFD Version 2.0 (Engineers Australia, 2001) software was used to compute the design IFD curves which are presented Figure 2.2. Rainfall intensities for selected durations and average recurrence intervals (ARI) were used to determine the peak design flows in creeks and drainage lines adjacent to the mine infrastructure.

A significant rainfall event caused flooding at Weld Range between the 6th and 8th of February 2008. Rainfall data collected at Meekatharra Airport showed that 90.4mm fell over the three day period (48.4, 7.4, 34.6mm respectively). The three day total lies between the 5 and 10-year ARI design event totals. The one day total of 48.4mm lies between the 2 and 5-year ARI design events.

A smaller rainfall event caused minor flooding at Weld Range between December 9 and 12, 2007. Approximately 16mm fell over this period, which is less than a 1-year ARI design event.

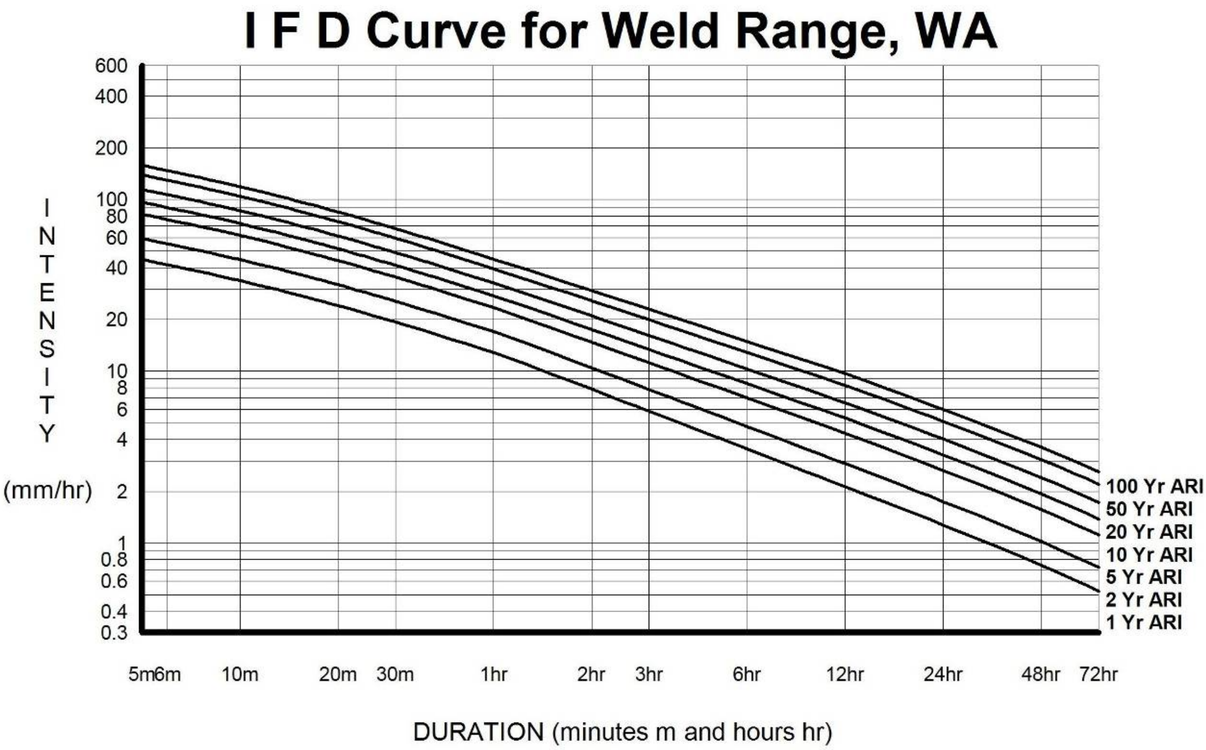

Figure 2.2 Intensity-Frequency-Duration (IFD) curves for Weld Range, WA.

2.2 Topography

The topography of the Project area is dominated by the Weld Range, which runs in a southwest-northeast direction and ranges in elevation from 460 mAHD to 730 mAHD. The Madoonga and

Beebyn tenements form part of the Weld Range. The slope of the ground surface in the Weld Range catchments generally varies from 5% to 90%; however, the land immediately north of the Weld Range is relatively flat with the ground surface generally sloping at between 0.1% and 1%. There are some clearly delineated drainage channels within the Weld Range itself; however, the land to the north has few well defined channels and is characterised by numerous mud flats and salt pans. There is a significant salt pan in a depression immediately north of the Madoonga tenement. The available topographic data indicates a minimum elevation of 482.7 mAHD in this salt pan.

2.3 Watercourse Analysis

The Weld Range site contains a number of watercourses of varying sizes, vegetation types and soil types, which were identified during a site visit to the Weld Range between the 15th and 17th of January 2008 (Appendix A). The sites identified ranged from a shallow depth of 0.3 m to a maximum depth of 1.2 m, and widths from 3 m to larger than 500 m. The bed conditions of the watercourses were mainly comprised of coarse sand, rocks and cobbles, while the banks are comprised of silty sand which is easily eroded. In the upper sections of the Beebyn and Madoonga catchments the watercourses were deep and narrow, while in the lower sections of the catchments they became wide and shallow. The majority of the watercourses had moderate to dense vegetation levels with the banks being lined with Mulga.

2.4 Significant Water Features

There have been two water features that have been identified as significant areas, the Madoonga "Food Bowl Area" and the Beebyn water course. The "Food Bowl" is located at the base of the Madoonga catchment area, in a topographic depression. This area is seasonally inundated during significant rainfall events, and is a common feeding site and waterhole for many fauna in the area. The Beebyn watercourse is also a major watercourse in the area, draining a significant catchment area to the south through Beebyn Gap. It is important that both sites remain unaffected by the project.

The quantity and quality of streamflow in both water courses should be similar to the pre-development conditions, to minimize the impacts associated with The Project. This may involve the introduction of drainage infrastructure, flow impediments and water quality treatment sites.

3.0 *IDIOSOMA NIGRUM*

The *idiosoma nigrum,* trapdoor spider, has been identified as protected species that will be affected with the construction and operation of the Project. A survey conducted by *ecologia* Environment in 2010 covered 76 hectares of the Weld Range and found all burrows within the boundaries of the drainage lines of the watercourses and underneath *Acacia* vegetation. The majority of the populations have been located on the south side of the ridge, with a population being found in the flat drainage lines south of the Beebyn ridge rather than on the ridge itself. The location of the populations in respect to the mine infrastructure can be found in Appendix B. The proposed site location of the project impacts six sub-populations of *I. nigrum* representing 9% of the population with the effect of mining predicted to, directly and indirectly impact 12% of the overall population (*ecologia* Environment 2010). The SWMP will aim to reduce the impact surface water alterations have on the ecosystems to maintain the abundance, diversity and geographic distribution of the *I, nigrum* species. This will be achieved by maintaining natural flow regimes and water qualities in all watercourses and drainage lines.

4.0 *SURFACE WATER MANAGEMENT*

The potential impacts on surface water and surface water dependent ecosystems, that are associated with this Project include:

- *the modification and interruption of the existing hydrological regime;*
- *increased erosion, scouring and sedimentation;*
- *inundation of upstream vegetation and water starvation of downstream vegetation; and*
- *discharge of hydrocarbons and contamination events.*

The following sections describe these impacts in more detail and present appropriate mitigation measures to manage these impacts.

4.1 Management Plans

4.1.1 Development of Project Infrastructure

The Beebyn and Madoonga mine site infrastructure has been located outside the estimated 100-year ARI design flood extents of the main creeks. Flood protection measures are required to protect the site infrastructure, waste dumps and mine pits from inundation caused by sheet flow and localised flooding of waterways. Mine infrastructure has the potential to affect the existing surface water drainage features, including rivers, creeks and floodplains.

Stormwater runoff around the mine pit and waste dumps, and all associated mine infrastructure needs to be managed to avoid excessive scour, erosion and sediment transport. Mining operations should be managed so natural depressions in and around these areas are drained to prevent ponding following rainfall events.

Mine pits located in positions obstructing existing surface water regimes will have diversion channels and earth bunds installed to prevent the intrusion of water into the mine, while attempting to maintain similar flow and quality water conditions. Unattended to, this may cause the inundation of upstream vegetation and the starvation of downstream vegetation. Earth bunds will prevent the water entering the mine site, preventing the water from continuing to flow downstream. The diversion channels will then aim to redirect the water around the infrastructure and back to the original water regime as soon as possible, providing habitats downstream with similar water conditions to their original conditions.

Waste rock dumps are located in areas where there is a potential impact to water qualities before they enter water dependent ecosystems. Management and mitigation plans will be developed to ensure that the flow regimes will be restored and water quality will be maintained. Diversion channels will be installed, with the aim of preventing water entering the waste dumps, while being restored to the original flow path within a short distance after the waste dump area. The perimeter of the waste rock dumps will be bordered by diversion channels and earth bunds to prevent the runoff from the dumps travelling downstream. The diversion channels will collect runoff and contaminant flows, diverting them to sedimentation ponds for treatment.

A protected spider species is locally found on the south side of the Weld Range and also on the plains to the south of the proposed Beebyn waste rock dump. Analysis will be conducted to ensure that mine infrastructure will not impact the protected spider species that inhibit the area. This will be done, by ensuring that diversion channels and sedimentation ponds do not impact vegetation in the area by changing water regimes or conditions.

Table 4.1 Development of Mine Infrastructure

Development of Mine Infrastructure	
Objective	Restore surface water flow regimes and minimise the change in water conditions
Key Performance Indicators	• *Maintain the flow regime of the surface water, which will be identified by the vegetation and creek outlines* • *No loss of significant vegetation beyond the approved disturbance zone due to changes in water conditions upstream or downstream* • *No discernible change in surface water quality.*
Management Strategies	• *An Erosion Management Plan will be developed for the site to guide mitigation of the risks associated with erosion and increased sedimentation. The plan will meet the requirements outlined in the DoW Water Quality Protection Guidelines (2000).* • *Installation of diversion channels to alter the path of the surface water, preventing the water from entering disturbance zones, hence maintaining similar water conditions to preconstruction times.* • *The placement of earth bunds will prevent water entering and exiting disturbance zones, reducing the risk of high sediment loads occurring downstream.* • *The creation of sedimentation ponds to remove sediments and contaminants before release will ensure waste rock dumps have limited effect on the environment.* • *Diversion drains will be designed to divert runoff from undisturbed areas with a freeboard allowance of 0.5m. The drains located around mine site infrastructure and waste dump drainage will be able to capture and divert 10-year ARI design flood events, while mine pit diversions will capture and divert the*

Development of Mine Infrastructure	
	100-year ARI design flood events.
Monitoring	• *Baseline data will be obtained when surface water flows occur. Parameters monitored will be ph, EC and TDS.* • *Monthly testing of surface water flows will be conducted within the Weld Range project area of the above parameters when possible ** • *There is minimal surface water flows within the project area. The nearest named creeks, Madoonga and Beebyn Creek will be the focus of monitoring.*

4.1.2 Road Infrastructure

The construction of access and haul roads has the potential to modify and interrupt the existing hydrological regime impacting both upstream and downstream conditions. The roads will be built connecting all areas of the mine site, crossing across a number of surface water flow areas. Culverts will be implemented at all sites identified as part of the water flow regime, with the aim of continuing flow paths and maintaining water conditions. The introduction of the culverts will prevent pooling and inundation of upstream areas and the water starvation of downstream vegetation. Culverts have the potential impacts of scouring and increasing erosion rates, which will be prevented through the use of riprap pads. Riprap pads are used to reduce flow rates through culverts and re-distribute water as it exits preventing scouring.

Table 4.2 Construction of Access and Haul Roads

Construction of Access and Haul Roads	
Objective	Maintain natural drainage paths, while minimising scouring and erosion
Key Performance Indicators	• *No loss of significant vegetation beyond the approved disturbance zone, both upstream and downstream* • *No evidence of pooling in areas upstream of the roads* • *No water shadows or evidence of scouring and erosion downstream of the installed culverts*
Management Strategies	• *An Erosion Management Plan will be developed for the site to guide mitigation of the risks associated with erosion and increased sedimentation. The plan will meet the requirements outlined in the DoW Water Quality Protection Guidelines (2000).* • *Culvert location and design have been identified in a*

Construction of Access and Haul Roads	
	prefeasibility study undertaken by Worley Parsons to accommodate a 10-year ARI design flood event these locations are based on the PER access track and haul road locations. Culvert Locations for the proposed changes will be identified when the Section 45C Response to submission documentation is approved by the EPA. The design will remain as detailed by Worley Parsons. Culverts will be installed in identified drainage areas where creeks and drainage lines cross road and rail infrastructure, with the aim of maintaining flow paths. • *Riprap pads will be installed at culverts identified as experiencing flow rates that will be prone to scouring.*

4.1.3 Ground Disturbance Activities

Ground disturbance activities associated the construction of mine, road and rail infrastructure have the potential to cause erosion and disruption of water regimes resulting in increased sediment transport during flow events. The effect of ground disturbance activities will be reduced through rehabilitation and planned clearing. Rehabilitation of the land will ensure the land remains stable, reducing erosion. Planned clearing will ensure only land that is necessary to be disturbed is and plans will be in place to restore water regimes. The timing of construction will also help reduce erosion, construction should occur during dry periods of the year.

Table 4.3 Ground Disturbance Activities

Ground Disturbance Activities	
Objective	Maintain natural water regimes and to minimise erosion
Key Performance Indicators	• *Erosion is not evident in areas of construction* • *No evidence of flow regime change*
Management Strategies	• *An Erosion Management Plan will be developed for the site to guide mitigation of the risks associated with erosion and increased sedimentation. The plan will meet the requirements outlined in the DoW Water Quality Protection Guidelines (2000).* • *The construction process will involve only clearing identified areas, preventing the disturbance of land outside the defined area.* • *Ensuring the rehabilitation processes occurs to sites affected by the ground disturbance.* • *Where practical, construction and ground disturbance activities*

Ground Disturbance Activities	
	in areas of potential water flow should be scheduled for dry periods. • *Cleared vegetation and topsoil will be stored away from watercourses (*ecologia *Environment 2010).* • *Land clearing close to watercourses will occur as close to construction dates in order to minimise erosion and sedimentation risks (*ecologia *Environment 2010).*

4.1.4 Storage and Handling of Hydrocarbons

There is potential for hydrocarbons to be released into the environment due to the storage, handling and transport of hydrocarbons occurring on site. If contamination occurs it can impact on vegetated areas, pools and other sensitive ecological areas downs stream if the contaminant enters a watercourse. The locations of fuel handling areas will be outside of floodplains and be bunded to capture any spills for remediation. Areas outside the bunded areas where spills occur will be remediated to avoid contamination of ground and surface water.

Table 4.4 Storage and Handling of Hydrocarbons

Storage and Handling of Hydrocarbons	
Objective	Minimise the risk of hydrocarbon spillage during construction and operations of the project.
Key Performance Indicators	• *Number and magnitude of hydrocarbon spills*
Management Strategies	• *Develop and implement a hydrocarbon management plan and handling procedures. All chemicals stored on site will be stored in accordance to dangerous goods regulations, while management plans will meet the requirements outlined in the DoW Water Quality Protection Guidelines (2000).* • *Establish a fuel handling area bunded to capture any spills for remediation and located outside the flood area. Bunded area is designed for a combined volume from runoff from a 20 year ARI 72 hour duration design flood event and 110% of the tank contents in accordance with to the DoW Water Quality Protection Guidelines (2000).* • *Equip vehicles with spill recovery equipment* • *Locate hydrocarbon storage and vehicles/machinery away from surface drainage features* • *Storm water runoff from workshop pavements, fuel unloading*

Storage and Handling of Hydrocarbons	
	*and storage areas and from vehicle washdown areas will be directed to grit and oil interceptors to remove pollutants prior to discharge of the water (*ecologia *Environment 2010).* • *Washing vehicles and equipment will only occur in appropriate and designated wash-down bays (*ecologia *Environment 2010).* • *Equipment maintenance and fuel handling areas, where there is significant risk of hydrocarbon spillage, shall be bunded and all runoff directed to grit and oil interceptors prior to discharge of treated water to the environment; and* • *Oil interceptors will require regular monitoring and maintenance to maintain their performance, particularly during the wet season. Trapped materials that are removed from interceptors will be transported to an appropriate site for safe disposal.*

4.1.5 Monitoring and Maintenance of Drainage Controls

The effectiveness of drainage controls such as culverts are dependent on ongoing monitoring and maintenance. The infrastructure can be affected by sediment loading and other materials which may block or reduce the effectiveness of the controls. Periodic maintenance ensures that drainage controls remain efficient reducing the negative potential effects of runoff events.

Table 4.5 Monitoring and Maintenance of Drainage Controls

Monitoring and Maintenance of Drainage Controls	
Objective	Maintain ongoing effectiveness of drainage controls through periodic monitoring and maintenance, while also identifying opportunities for improvements.
Key Performance Indicators	• *No evidence of blockages of culverts, i.e. pooling or obstructions.* • *Structural integrity of drainage controls remains.*
Management Strategies	• *Visual inspections of drainage control infrastructure prior to periods of expected rainfall and after significant rainfall events.* • *Reporting of visual inspections to ensure that drainage controls are still fulfilling their requirements. This will also identify areas required for change allowing for a more effective drainage system.* • *Maintenance of drainage structures, based on the results of visual inspections.* • *Based on reporting, research will be undertaken into the effectiveness of controls and potential improvements that could*

Monitoring and Maintenance of Drainage Controls	
	be incorporated.

4.2 Design of Drainage Management Controls

Culverts, scour protection and riprap aprons will be used to reduce the impact of the project, by attempting to resume flow regimes surrounding the operation area.

4.2.1 Culverts

Engineering culverts have been identified as a requirement for road infrastructure in the aim of allowing from regimes to continue under road and rail infrastructure. Culverts will be placed at all sites identified as major-creek crossings based on topographic maps.

Culvert location and design have been identified in a prefeasibility study undertaken by Worley Parsons to accommodate a 10-year ARI design flood event these locations are based on the PER access track and haul road locations. Culvert Locations for the proposed changes will be identified when the Section 45C Response to submission documentation is approved by the EPA. The design will remain as detailed by Worley Parsons.

4.2.2 Scour Protection

Scour protection blankets of rock or another material will be used to stabilise steeper culverts and channels to prevent scour and erosion.

4.2.3 Riprap Rock Aprons

Aprons of rock riprap will be placed at the outlet of culverts to slow flow rates down as water passes through the culvert. The riprap aprons will prevent erosion and spread the flow in an attempt to restore flow regimes.

4.3 Design Standards

The following hydrological design standards were adopted for design of flood mitigation and surface water management measures;

- *10 year Average Recurrence Interval (ARI) for the design of diversion drains around mine site infrastructure, haul road culverts and floodways, waste dump drainage and sedimentation ponds;*
- *100 year ARI for the design of diversion drains and bunds around mine pits;*
- *Sedimentation pond design standards are as follows:*

- o Sedimentation pond dimensions to be sufficient to drop out of suspension sediment particles down to 75 µm (fine sand/silt) during the critical 10 year ARI flood event;
- o A nominal 0.5 m storage depth is allowed for sediment accumulation in the sedimentation ponds before clean out is required;
- o Sedimentation ponds area designed with a 5 m minimum width emergency spillway (overflow weir) to protect the pond embankments from overtopping flows exceeding the 10 year ARI design capacity Weir capacity is based on the 100 year ARI flood event;
- o Sedimentation pond depth and spillway capacity sufficient to retain at least 0.3 m freeboard to embankment crest during 100 year ARI flood events;
- o Overflow weir crest level to be at least 0.5 m above the estimated 100 year ARI flood levels in the adjacent waterway or floodplain; and
- o Each sedimentation pond shall be capable of being drained (if water quality is acceptable) within two days after the design storm event, leaving it ready for the next storm.

4.3.1 Diversion Drains and Waste Dump Drainage

Diversion drains have been designed to divert runoff from undisturbed areas around or though the mining operations where possible, with an allowance for 0.5 m freeboard. Diversion drains around mine site infrastructure and waste dump drainage have been designed to capture and divert the 10 year ARI design flood event, while mine pit diversions have been designed to capture and divert the 100-year ARI design flood event.

The depths and widths of diversion channels will vary between sites. All drains are to be either trapezoidal or v-shaped and constructed with side slopes nominally 1v:3h. Excavated material shall be placed alongside and down gradient of the drains and compacted to form an isolating bund with 1:3 side slopes. Rock aprons shall be installed at the downstream end of diversions to reduce scour and erosion. A concept design for flood diversions and waste dump drainage is provided in Figure 4.1.

Any portions of the Madoonga waste dump drainage located within the 100-year ARI flood risk area (Appendix D) will require safety bunds constructed down gradient of the drains and at a level appropriate to maintain a minimum 0.5 m freeboard above floodwaters. Safety bunds may require scour protection.

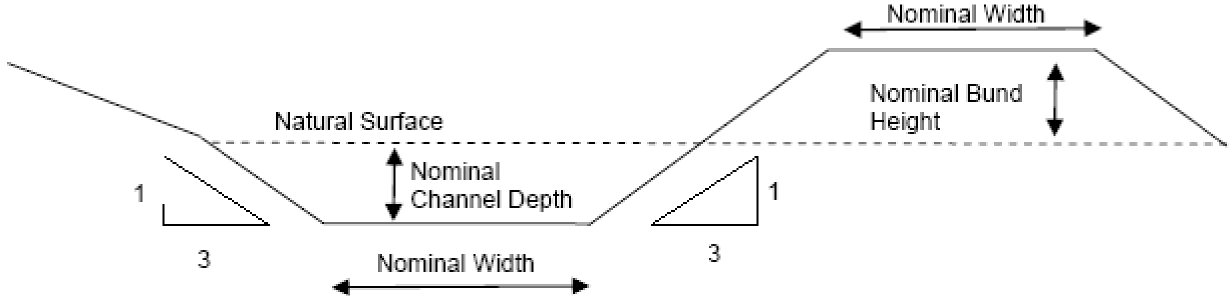

Figure 4.1 Typical Drain and Bund Cross-section

4.3.2 Sedimentation Ponds

Surface water runoff from waste dumps will be managed during mining operations to reduce suspended sediment loads prior to discharge to existing ephemeral watercourses. During the course of mining operations, waste dumps will progressively develop and grow in size, covering increasing areas until the final design levels are reached. Stormwater runoff from waste dump areas will be directed to sedimentation ponds using diversion drains, bunds and existing natural drainage lines. To ensure all runoff from waste dump areas is captured and treated at all stages of development, sedimentation ponds have been located in natural drainage lines on the ultimate boundary of the waste dump layout. Natural depressions and storage areas have been used where possible, to minimise the volume of earthworks required. As the majority of suspended sediments are generated during waste dump development, sedimentation ponds have been sized to ensure they can treat the maximum peak flows expected throughout all stages of development, not just on completion.

Surface water which collects in mine pits during significant rainfall events will be pumped out using sump pumps. The pumped discharge will pass into sump pump sedimentation ponds to capture suspended sediment prior to discharge to existing ephemeral watercourses.

Waste dump sedimentation ponds were designed to drop out of suspension sediment particles greater than or equal to 75µm (fine sand/silt) during the critical 10 year ARI storm event. Sump pump sedimentation ponds were sized the same way, by assuming the following sump pump flow rates provided by SRK Consulting;

- *Two 150 L/s sump pumps at Madoonga;*
- *One 100 L/s pump at the smaller pit at Beebyn, and two 100 L/s pumps in the larger pit;*
- *Flows are based on runoff generated from the 50-year ARI design rainfall event; and*
- *Water accumulated in each pit is removed in one week.*

A 5 m minimum crest width weir is incorporated into the design to carry overtopping flows from the 100 year ARI flood event, while maintaining at least 0.3 m freeboard. A rock apron is also required at each weir outlet to minimise scour during overtopping events. The locations of each sedimentation pond are also shown in Appendix D.

The sedimentation ponds will be constructed to meet the following design criteria;

- *Sedimentation ponds located on relatively flat terrain shall be designed for balanced cut to fill.*
- *Excavated material shall be placed and compacted to form isolating bunds with 1v:3h side slopes and 3 m wide crest;*
- *Excavated material should be used for construction of sedimentation pond bunds where suitable;*
- *Sedimentation pond liners will be 1.5 mm thick underlain by a geotextile filter and constructed in accordance with the manufacturers specifications; and*
- *Sedimentation pond rock aprons will be constructed using rock filled gabion mattresses underlain by a geotextile filter to prevent scour of fine material.*

Waste dumps and sedimentation ponds have been located generally outside of the estimated 100-year ARI flood zone. Sedimentation ponds located within this zone will need to be constructed to a finished crest level above the estimated 100-year ARI flood level. Scour protection will be required to prevent erosion during extreme flood events and will also require the minimum weir elevation to be set at least 0.5m above the estimated 100-year ARI flood level in the adjacent watercourse. A nominal storage depth of 0.5m has been allowed for sediment accumulation before clean out is required. Sediment levels should be monitored following all significant flood events. Any significant depth of sediment accumulation should be removed on a regular basis.

Sedimentation ponds will be designed to be capable of being drained in approximately two days duration after the storm event, in preparation for the next storm. Low flow outlets with control valves installed 0.5m above the base level and/or submersible pumps may be installed to facilitate drainage of the ponds.

All sedimentation ponds will require regular monitoring and maintenance to maintain their performance during the wet season. Fine sediments removed from sedimentation ponds will need to be deposited to an appropriate location and backfilled to prevent further erosion and migration during rainfall events.

Table 4.6 Monitoring and Maintenance of Sediment Basins

Monitoring and Maintenance of Sediment basins	
Objective	Maintain ongoing effectiveness of sediment basins through periodic monitoring and maintenance, while also identifying opportunities for improvements. Reduce the potential for unauthorised release of sediment from the site.
Key Performance Indicators	• *Clean stormwater diverted around the areas.* • *Structural integrity of sediment basins remains.*
Management Strategies	• *Visual inspections of sediment basins prior to periods of expected rainfall and after significant rainfall events.* • *Reporting of visual inspections to ensure that sediment basins are still fulfilling their requirements. This will also identify areas required for change allowing for a more effective drainage system.* • *Maintenance of sediment basins, based on the results of visual inspections.* • *Sediment removed from sediment basins will be disposed of appropriately to ensure it does not cause pollution.*
Monitoring	• *Visually inspect erosion and sediment controls during (if safe and practical) and as soon as is safe and practical after rainfall events that cause or are likely to cause a discharge from the sediment basins, to assess the condition and effectiveness of mitigation measures.* • *Visually inspect erosion and sediment controls on a daily basis (if safe and practical) during extended rain events (rain events that are continuous or frequently intermittent for periods greater than 24 hours, e.g. 10 mm/day).* • *Visually inspect surface water management features on a two-weekly basis during periods without rain events.* • *To the extent practical, collect water quality samples from each sediment basin from which a discharge occurs and analyse the samples for pH and turbidity daily during discharge (overflow) due to storm events.*

4.3.3 Haul Road Culverts and Floodways

Culvert crossings and floodways have been designed to accommodate the 10-year ARI design flood event at locations where creeks and drainage lines cross the haul road alignment. Low level floodways are proposed to minimise the store of water behind the road embankment, thereby minimising the period of inundation and reducing access restrictions following flood events. The locations of all culvert crossings and floodways are depicted in Drawing 13923- DW-0100-CI-0008 (Appendix E).

Nominal culvert design details, to be considered further at the detailed design phase, are provided as follows;

- *Culverts shall be constructed using corrugated steel pipe (CSP). CSPs should be galvanised and wrapped in a waterproof membrane for added corrosion protection against backfill soils. The membrane should be Nylex XL45, or similar;*
- *Culvert crossings without floodways shall be designed with allowance for a minimum 0.6m freeboard to top of formation under minor design flow conditions;*
- *The road design shall include cement stabilisation at floodways to reduce scour;*
- *Maximum ratio of headwater depth to culvert height/diameter shall be 1.5 for the minor design flood condition;*
- *For the 10-year ARI design flow, pipe full average velocity shall be no greater than 3.0m/sec; and*
- *Cement stabilised backfill shall be used for CSP culvert installations. Minimum thickness should be 0.4 m cover from top of culvert pipe to top of formation.*

The haul road should be elevated at least 1.0m above natural ground level in areas prone to flooding. The access road between Haul Road and Camp Site will require rock protection to prevent erosion, especially along diversion DD06.

5.0 *REFERENCES*

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Appendix A Watercourse Locations

Appendix B Spider Locations

Appendix C Flood Map

Appendix D Site Infrastructure Map