ROY HILL INFRASTRUCTURE PTY LTD

Roy Hill Infrastructure Railway

Surface Water Management Plan

9 July 2010
RH1-001-BO-EN-PLN-0565 Rev F

SYNOPSIS

This Environmental Management Plan (EMP) consolidates strategies for managing and mitigating potential surface water hydrological impacts associated with the development and operation of the proposed Roy Hill to Port Hedland railway alignment.

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1 INTRODUCTION

1.1 This Document

Roy Hill Infrastructure Pty Ltd (RHI) is proposing to construct and operate a railway (the RHI Railway) and associated infrastructure to transport iron ore from the Roy Hill 1 Mine to port infrastructure at Port Hedland (Figure 1). This Environmental Management Plan (EMP) consolidates strategies for managing and mitigating potential surface water hydrological impacts associated with the development and operation of the proposed railway alignment. RHI will ensure that the management strategies and controls in this EMP are implemented as part of the Project Environmental Management System (EMS).

This EMP is based on framework EMPs from the railway referral document and an assessment of the Project environmental aspects and impacts. Throughout the Project, this EMP will be updated as necessary to ensure impact management and mitigation measures remain relevant and effective.

1.2 Purpose and Scope

This EMP defines the surface water management strategies to be applied during construction and operation of the proposed railway alignment.

The objectives relating to surface water management are to:

- Maintain the function and environmental value of watercourses and sheet flow areas;
- Maintain quantity and quality of surface water flows to the Fortescue Marsh, existing baseline water quality information will be taken into consideration when assessing surface water quality;
- Limit disturbance from clearing, excavation and construction in and around watercourses and sheet flow areas..

The key performance indicators are to:

- Maintain the quantity and quality of surface water flows downstream of the rail line, comparative to upstream flows (measured 100m in both directions from the centreline of the railway);
- Ensure that surface water runoff does not result in significantly increased offsite sediment transport or water turbidity, in comparison to upstream flows; and
- Ensure there is no loss of significant vegetation downstream of the approved disturbance corridor due to surface water quality or quantity alterations, in comparison to upstream quality and quantity (measured 100m in both directions from the centreline of the railway).

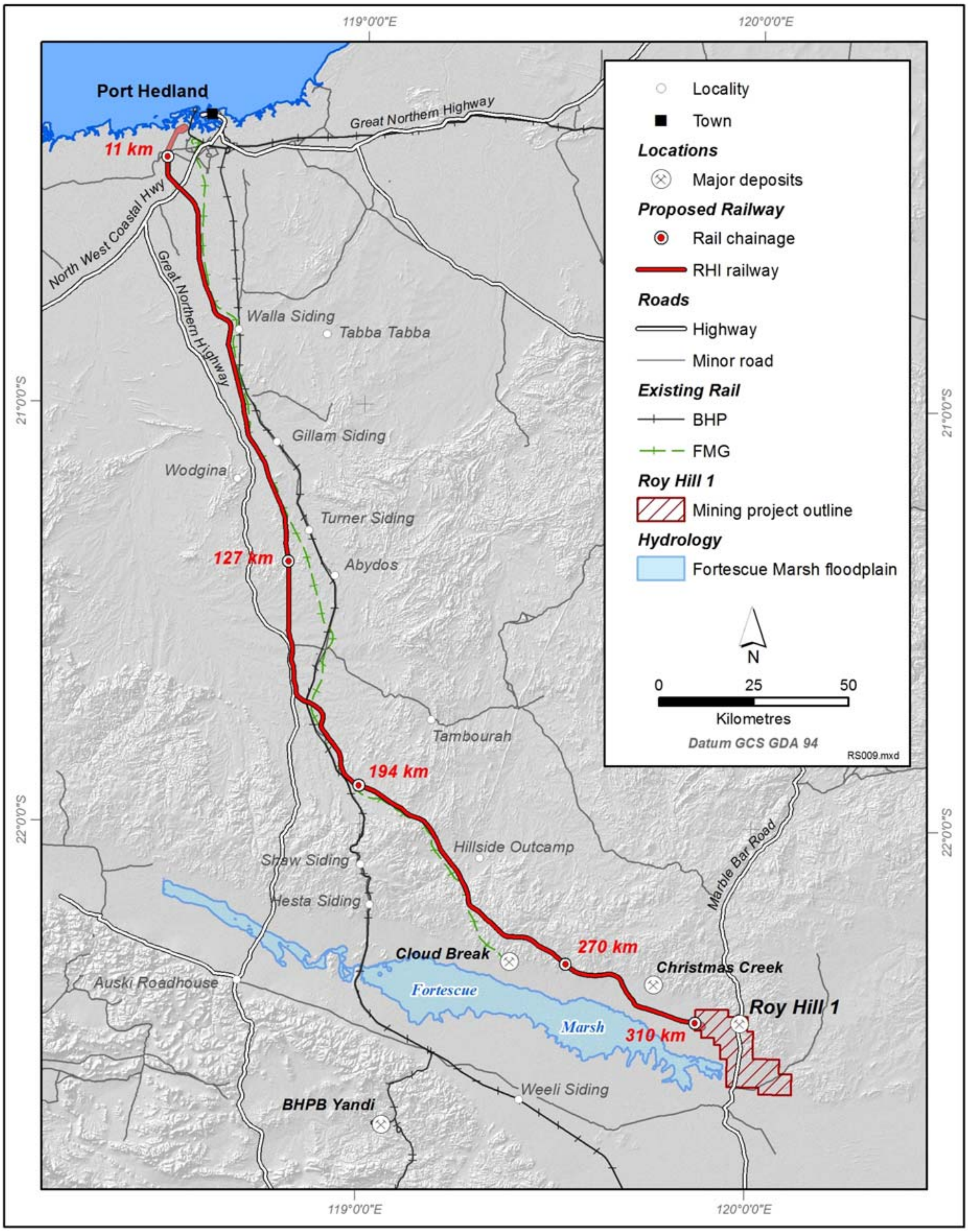

Figure 1: Roy Hill Infrastructure Railway Location Map

1.3 Relevant Legislation

- *Rights in Water and Irrigation (RIWI) Act 1914 (WA)*
- *Wildlife Conservation Act 1950* (WA)
- *Dangerous Goods Safety Act 2004* (WA)
- *Environmental Protection Act 1986* (WA)
- *Environmental Protection (Unauthorised Discharge) Regulations 2004 (WA)*

1.4 Definitions and Abbreviations

Table 1 - Definitions and Abbreviations

Abbreviation	Description
AHD	Australian Height Datum
ARI	Average Recurrence Internal
EMP	Environmental Management Plan
EMS	Environmental Management System
ESA	Environmentally Sensitive Area
RHI	Roy Hill Infrastructure Pty Ltd

2 HYDROLOGY

The location of the RHI Railway in relation to major surface water features is depicted in Figure 2.

2.1 Port Hedland area catchment

The first approximately 25km of the proposed route passes through the Port Hedland area catchment, where several creeks drain to the coast between the Turner River catchment and the De Grey River catchment. From west to east, these are South West Creek, South Creek, Beebingarra Creek, Petermarer Creek and Tabba Creek (Aquaterra Consulting 2004). The proposed RHI Railway will be aligned parallel to and away from the main surface drainages of this catchment.

Flooding of low-lying areas is common at the mouths of the major rivers on the Port Hedland coast, due to the low topography on the coastal dunes and the potentially high peak flows. RHI has committed to undertaking a flood study analysis of the proposed route before the railway is constructed.

2.2 Turner River and Yule River catchments

The proposed RHI Railway passes through the Turner River and Yule River catchments and crosses several major rivers and creeks including Turner River East, Turner River West, Coonarrie Creek and upper portions of the Yule River.

All drainage channels are ephemeral, responding only to major rainfall events. The drainage lines in these catchments support eucalypt woodland on their banks and floodplains, and have alluvial gravel/sand beds that may become mobile during flood events (Aquaterra Consulting 2004).

For the purpose of conducting a flood study analysis, records are available from gauging stations on the Yule and Turner rivers. MRWA has estimated the average recurrence interval of the 1975 Yule River flood event to be 80 years. Based on this assumption, the general extreme value (GEV) distribution appears to best represent the flow/recurrence relationship. The 100-year average recurrence interval discharge was estimated to be 19,002m³/s.

2.3 Upper Shaw River catchment

The proposed RHI Railway intersects a small portion of the southwest corner of the Upper Shaw River catchment, and runs perpendicular to the surface water direction. The proposed railway route crosses upper drainage lines of the Western Shaw River, which discharges north to the coast.

2.4 Upper Fortescue River catchment

The proposed route then crosses the Chichester Range and runs along the lower slopes of the Chichester Plateau through the Upper Fortescue River catchment to the north of the Fortescue Marsh. The natural drainage features along this route include creeks, floodplains and sheetflow areas.

The proposed RHI Railway is perpendicular to the surface water flow direction along this section and crosses several small creeks including Goman Creek, Sandy Creek and Christmas Creek, all of which drain south to the Fortescue Marsh. The largest is Christmas Creek, which has a catchment area of 250km^2 (Aquaterra Consulting 2005).

2.5 Fortescue Marsh

The Fortescue Marsh is an extensive, intermittent wetland, bound by the Chichester Range to the north and the Hamersley Range to the south. The Marsh occupies an area of approximately 1,000 km2 when in flood (Department of Environment, Heritage, Water and the Arts (DEHWA) 2008). Previous studies have established that the Marsh is predominantly a surface water fed feature, rather than ground water fed, on the basis that water levels in the uppermost (alluvium) aquifer within the surrounding plain are below the bed of the Marsh and the marsh water is hyper saline (Environ Australia Pty Ltd 2005).

Published topographical mapping indicates that bed levels in the Fortescue Marsh is between 400m and 405m above AHD and that the maximum 100 year ARI flood levels in the Marsh would be no more than 409.3m AHD (MWH, 2010). There is only a small section of the railway alignment (less than 20km) which is located in areas where ground elevation is less than 410.0m AHD. As the minimum rail embankment level is expected to be 411.0m AHD in the Fortescue Marsh area, the risk of overtopping as a result of water levels in the Marsh is considered low.

At its closest point the southern boundary of the 2km environmental approval corridor is approximately 2.5km from Geoscience Australia’s boundary of the Marsh. Impacts on this area are expected to be low.

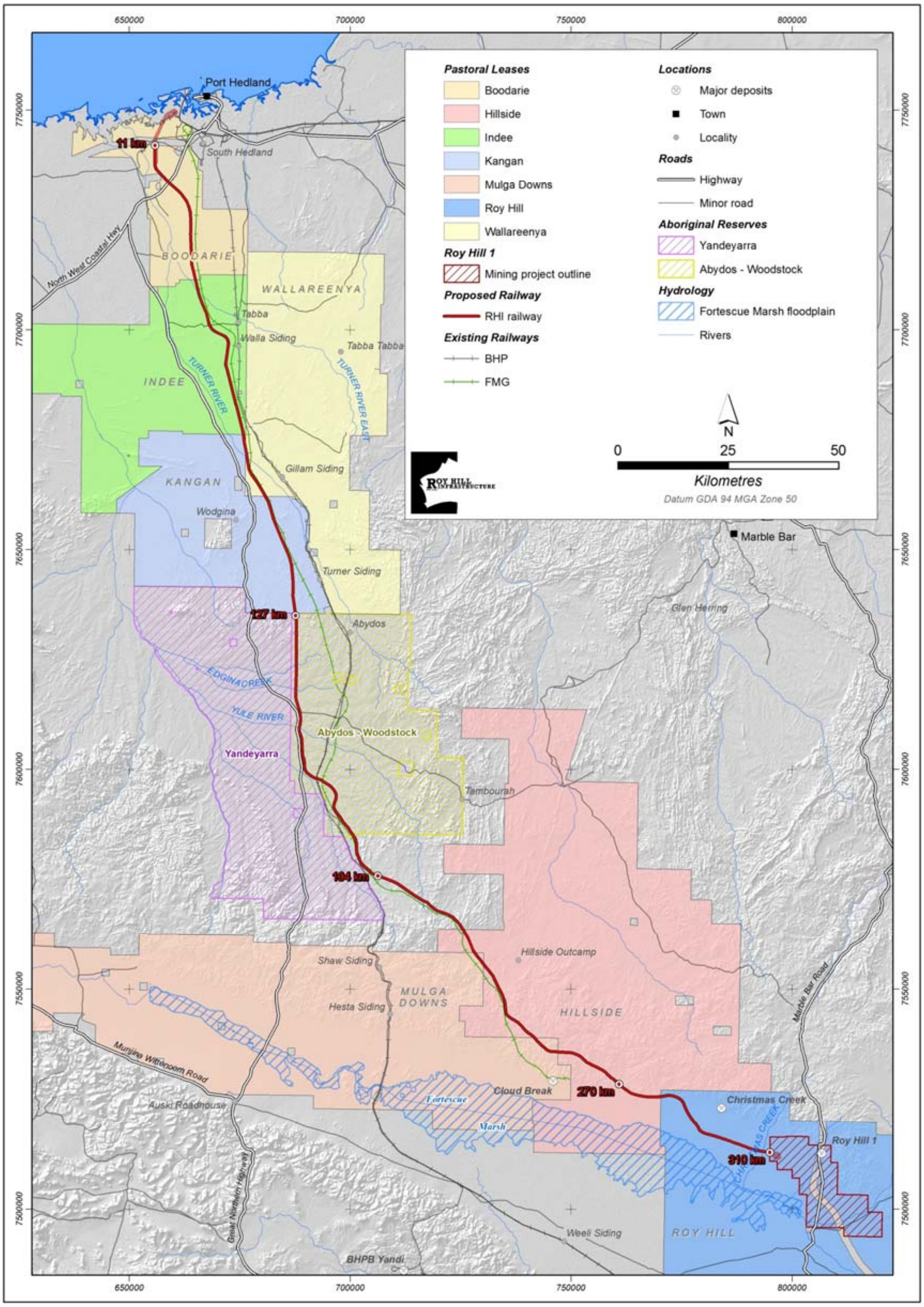

Figure 2: Proposed RHI railway, pastoral leases and major surface water features

2.6 Sheet Flow Areas and Dependent Vegetation

Mulga communities occur in banded patterns across gentles slopes. The distinctive vegetation pattern is comprised of bands or groves of *Acacia anerua* trees of about 30% canopy cover and an intergrove area of grass or forb-land (Anderson & Hodgkinson 1997).

The banded patterns, shown in Figure 3, are thought to be dependent on sheet flow from the intergrove areas immediately upslope of each band and on the high infiltration of water flowing overland into the soil of the band of mulga. Surface water carries nutrients and litter matter which creates fertile patches of land in mulga groves. Water flow is then concentrated and distributed around the plants, which act as obstructions to surface water flows across the slopes (Anderson & Hodgkinson, 1997). Grove and intergrove mulga communities are mainly concentrated on the lower flanks of the Chichester and Hamersley Ranges adjacent to the Fortescue Marshes.

The proposed railway alignment crosses areas of sheet flow on which stands of Mulga depend for survival. Grove/intergrove Mulga communities are susceptible to subtle changes in surface water distribution patterns and are dependent on sheet flow, rather than channel flow.

Muller Consulting (2005) found that water discharge from culverts in lower sloping areas spread more than in areas with steeper slopes. Muller Consulting thus surmised that rail infrastructure in the Mulga flats will potentially have a lower drainage impact than infrastructure positioned upslope as it would be easier to re-establish sheet flow in these flat areas.

Figure 3: Typical banded mulga patterns near the Fortescue Marsh

3 SURFACE WATER MANAGEMENT

Surface water related impacts that could potentially arise from the construction and operation of the proposed railway alignment include:

- Changes to flooding characteristics;
- Scouring, erosion and siltation of drainage channels; and
- Inundation of upstream areas and water starvation of downstream areas.

Surface water contamination as a result of hydrocarbon spillage is another potential source of adverse environmental impact, particularly during construction. The typically intense rainfall and flooding patterns, however, are likely to preclude construction near waterways during the wet season, thereby reducing any risk of hydrocarbon contamination. Hydrocarbon management plans and spill response procedures will nevertheless be developed.

The following subsections describe the potential surface water related impacts arising from the construction and operation of the railway, and the consequent management and mitigation measures to be implemented.

3.1 Development of Linear Infrastructure

Flood protection culverts (engineering culverts) will be installed along the railway embankment at the significant creek crossings and at the smaller drainage channels.

The railway embankment and associated excavations for borrow pits will tend to interrupt transverse surface drainage and will require special treatment to maintain down-gradient water quality and flow regimes. The linear configuration of the rail formation and associated access road (approximately 7m and 10m wide respectively) has the potential to create areas of up-gradient pooled water and down-gradient drainage shadows. Up-gradient ponding against the embankment could jeopardise its structural integrity, while down-gradient shadowing would compromise sheet flow dependent vegetation.

Ponding and shadowing will be prevented by installing a combination of engineering and environmental culverts. Engineering culverts are typically large diameter pipes (>600mm) designed for a specific flow rate. These will be placed at creek crossings where formation height is greatest and at other defined flow lines. Environmental culverts are typically smaller than engineering culverts and will be placed at depressions where ponding is likely to occur and within areas of sheet flow. Environmental culverts will be installed at intervals of between 50-100m in response to local hydrological conditions, and would include discharge controls to re-establish down-gradient sheet flow and limit the risk of erosion.

Sections of the railway alignment pass through areas of sheet flow dependent Mulga communities. Installation of environmental culverts along the rail embankment will be used to maintain the sheet flow within these areas and to the Fortescue Marsh. Environmental culverts will be spaced with the objective of re-establishing sheet flows within 50m down-gradient of the rail formation, thereby limiting potential impact on the sheet flow dependent mulga communities and the Fortescue Marsh.

Drainage management controls to be incorporated into the railway design to minimise the risk of upgradient ponding and the extent of down-gradient drainage shadows are further discussed in Section 0.

Management strategies to mitigate the potential impacts of the linear alignment of the proposed railway are summarised below.

Table 2 - Development of Linear Infrastructure

Development of Linear Infrastructure	
Objective	Maintain natural drainage patterns and minimise the extent of drainage shadows.
Key Performance Indicators	• Maintain the quantity and quality of surface water flows downstream of the rail line, comparative to upstream flows (measured 100m in both directions from the centreline of the railway). • No loss of significant vegetation downstream of the approved disturbance corridor due to surface water quality or quantity alterations, in comparison to upstream quality and quantity (measured 100m in both directions from the centreline of the railway)
Management Strategies	• An initial desk top study, based on analysis of aerial photography and topographic information, will be undertaken to locate optimal positions for environmental culverts to be installed in sheet flow areas. Results from the desk-top study will be verified (and revised as necessary) based on hydrological modelling and field verification surveys, as appropriate. • Install and maintain drainage controls. • Culverts design will incorporate ecological water requirements for sensitive areas, particularly mulga communities and the Fortescue Marsh. • Install environmental culverts, at appropriate intervals (50-100m) in sheet flow areas and in areas adjacent to the Fortescue Marsh, to maintain continuity of flows across the rail formation and associated access road. • Within areas of sheet flow dependent mulga communities, environmental culverts will be installed at intervals of between 50-100m in response to local hydrological conditions, and will include discharge controls to re-establish down-gradient sheet flow and limit the risk of erosion. • Riprap pads will be used where environmental culverts are installed to slow the rate of flow, prevent scouring and re-distribute the floodwaters to environmentally sensitive ecosystems, including mulga communities.

Development of Linear Infrastructure	
	• The results of vegetation, flora and fauna biological surveys will be incorporated into engineering design prior to design finalisation. • The locations of environmental culverts and other drainage control measures in sensitive environments will be reassessed and amended (if required) prior to construction. This is based on a visual in-field assessment of the vegetation, soils, drainage and fauna movement patterns in the vicinity of each culvert site.

3.2 Construction and Maintenance of Access Road

A graded road (formation width approximately 7m to 10m) will be constructed along the entire length of the railway alignment to provide access for maintenance and ongoing works.

Regular grading of roads typically results in the formation of loose earth windrows along the road verges. Sheet flow could potentially mobilise sediments from windrows formed along the access road and redistribute the sediments down-gradient, increasing the sediment load in runoff, or blocking culverts along the railway corridor if the road is up-gradient of the railway.

The management strategies identified in Section 3.1 will also apply to construction of the access road.

Table 3 - Construction and Maintenance of Access Road

Construction and Maintenance of Access Road	
Objective	Minimise erosion and mobilisation of sediment in natural watercourses.
Key Performance Indicators	• Surface water runoff does not result in significantly increased offsite sediment transport or water turbidity.
Management Strategies	• The access road will be installed down-gradient of the railway line (in the vicinity of the Fortescue Marsh) to prevent the impact of sheet flow on windrows and the mobilisation of sediments. • The access road will be constructed down-gradient of culvert crossings, to prevent erosion. • The vertical alignment of the road will be lowered in areas containing culverts crossings to prevent up-gradient water ponding. • The road formation will incorporate erosion controls in all sections of the route subject to seasonal inundation. • Annual and event-based inspections and maintenance will be carried out to ensure the effectiveness of surface drainage and erosion protection structures within areas containing down-gradient sheet flow dependent mulga communities.

3.3 Ground Disturbance Activities

Ground disturbance, including clearing associated with the construction of the railway and associated access road, has the potential to disturb existing surface water flows and sediment regimes.

Table 4 - Ground Disturbance Activities

Ground Disturbance Activities	
Objective	No significant erosion is caused by ground disturbance activities.
Key Performance Indicators	• Surface water runoff does not result in significantly increased offsite sediment transport or water turbidity.
Management Strategies	• Develop a permit-based ground disturbance procedure to ensure best practice. • Clearly define areas to be cleared in the vicinity of watercourses, drainage lines and sheet flow areas. Supervise clearing operations to ensure clearing is confined to the defined areas. • Progressively rehabilitate temporarily disturbed areas • Erosion control measures will be maintained until vegetation cover is restored and can stabilise soils. • In areas that will remain cleared for the operational phase of the Project, culverts, levees and other drainage management controls will be used to maintain the natural drainage patterns.

3.4 Storage and Handling of Hydrocarbons

The storage and handling of hydrocarbon products represents the most likely source of potential contamination associated with the Project. As indicated above, however, the typically intense rainfall and flooding patterns within the project area are likely to preclude construction near waterways during the wet season, thereby reducing this risk.

Table 5 - Storage and Handling of Hydrocarbons

Storage and Handling of Hydrocarbons	
Objective	Minimise the risk of hydrocarbon spillage during all facets of Project construction and operation.
Key Performance Indicators	• Number and magnitude of hydrocarbon spills.
Management Strategies	• Develop and implement hydrocarbon management and handling procedures.

Storage and Handling of Hydrocarbons	
	- Establish dedicated hydrocarbon storage and refuelling sites that have adequate containment measures. - Locate hydrocarbon storage and refuelling sites a minimum of 100m from surface drainage features and sheet flow areas. - Equip all hydrocarbon storage, refuelling sites, and vehicles transporting bulk diesel (or other hydrocarbon products) with spill recovery equipment.

3.5 Monitoring and Maintenance of Drainage Controls

The operational effectiveness of the drainage controls is dependent on ongoing maintenance. Culverts can become blocked by sediment and other material if not adequately maintained and contour drains are susceptible to trampling from stock.

Table 6 - Maintenance of Drainage Controls

Maintenance of Drainage Controls	
Objective	Ensure the on-going effectiveness of drainage controls and identify opportunities for improvement.
Key Performance Indicators	- Maintain the quantity and quality of surface water flows downstream of the rail line, comparative to upstream flows (measured 100m in both directions from the centreline of the railway);
Management Strategies	- Visual monitoring of drainage controls will be undertaken prior to the onset of the wet season and following significant rainfall events. - Drainage structures will be inspected to identify whether down-gradient sheet flows are being maintained, and any occurrence of up-gradient surface ponding at culvert inverts. - Remedial maintenance of drainage structures will be undertaken as required based on outcomes from the regular inspections. - Results of remedial maintenance undertaken, will be reported annually to provide an ongoing assessment of surface water flow in sheet flow areas of the rail alignment - Annual and event-based inspections and maintenance will be completed to maintain the effectiveness of the installed works at redistributing flows to the downstream Mulga communities - Monitoring for impacts on sheet flow dependent mulga communities will be completed and remedial actions as required will be

Maintenance of Drainage Controls	
	implemented to manage any identified adverse impacts.

3.6 Design of Drainage Management Controls

A combination of culverts, scour protection, riprap rock aprons, contour drains and interceptor embankments (guide banks) will be used, as appropriate, to manage the potential impact on sheet flow dependent mulga communities and other sensitive ecosystems.

Design specifications, including the size of environmental culverts, nature and extent of scour protection, design and materials used for riprap rock aprons, dimensions of interceptor embankments and contour drains will be developed once the final alignment is chosen. Specific locations of the drainage management controls will also be selected at this time and will be based on hydrological studies and a visual assessment of the route.

Muller Consulting (2005) has assessed the performance of surface flow redistribution structures in the Pilbara through field trials to determine the most effective methods for preventing distribution shadow effects. The trials investigated the use of interceptor embankments and contour drains to redistribute sheet flow after it passes through a culvert and included an evaluation of the optimum material for interceptor embankments for spread and permeability.

The recommendations from this assessment will guide drainage design and management. Drainage structures will be regularly inspected and maintained to ensure their functional effectiveness during construction and operation of the railway.

The following drainage management controls will be used to maintain the natural drainage and sedimentation patterns.

3.6.1 Culverts

Engineering culverts will be installed at all major creek crossings and will be located as required based on topographic survey data and visual in-field assessments. The engineering culverts will be designed to accommodate flows up to the 20-year average recurrence interval flood.

Environmental culverts will be used to re-establish sheet flow within 50m down-gradient of the formation in areas containing sheet flow dependent mulga communities. They will range from approximately 300mm to 600mm in diameter and will be installed at intervals of 50-100m in environmentally sensitive areas to maintain continuity of flows across the railway.

3.6.2 Riprap rock aprons

Aprons of rock riprap will be installed at all engineering and environmental culvert inlets and outlets as a design standard. The rock aprons act to reduce the energy of inflows and discharge lowering the risk of scour at culvert inlets and outlets. The aprons also slow, and laterally spread, flows at the culvert outlets, reducing drainage shadows. Schematics showing the function of the rip rock aprons are shown in Figure 4 and Figure 5.

3.6.3 Interceptor Embankments (Guide Banks)

Interceptor embankments (guide banks) will be installed at culvert inverts in areas where sheet flow is promoted along the toe of the rail embankment, due to the surface gradient. This will help to reduce culvert bypass and concentration of runoff flows at the incised creek lines. Schematics showing the function of the interceptor embankments are shown in Figure 4 and Figure 5.

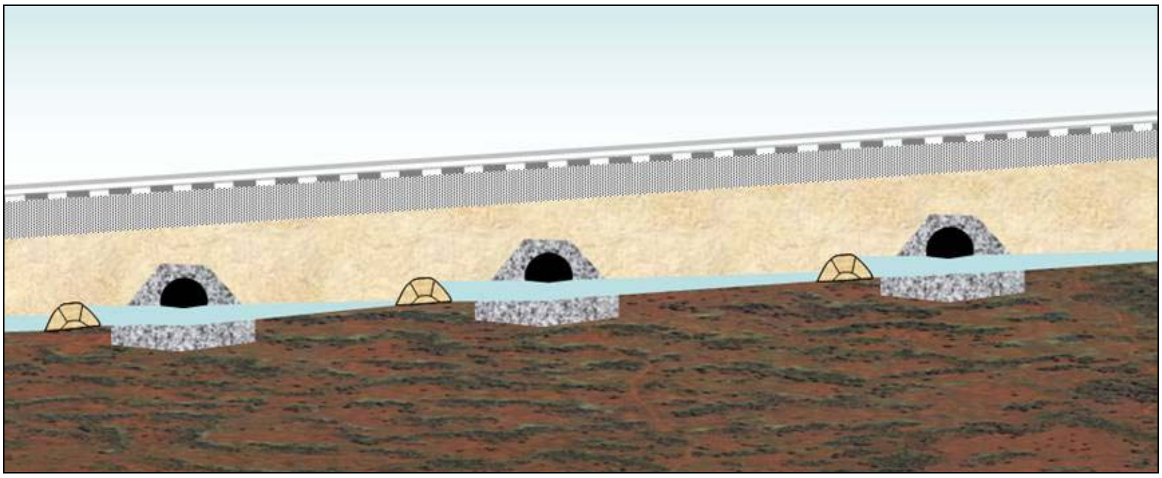

Figure 4: Schematic (elevation view) showing function of rip rock aprons and guide banks to assist with the redistribution of culvert flows.

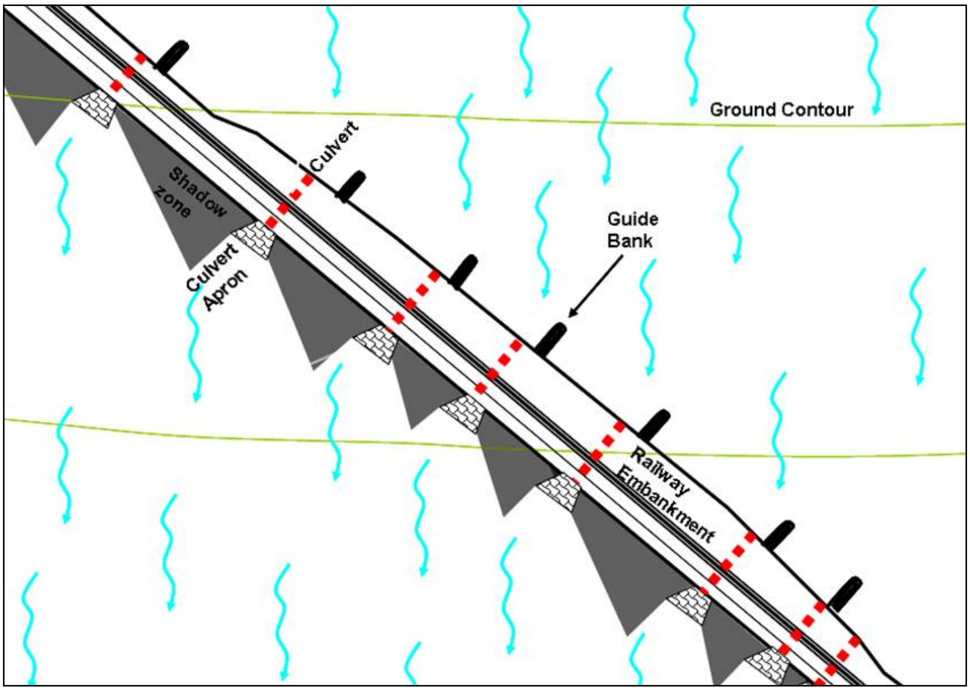

Figure 5: Schematic (plan view) showing function of rip rock aprons and guide banks to assist with the redistribution of culvert flows.

3.6.4 Contour Drains

Contour drains may be used to distribute sheet flow uniformly in areas that contain Mulga communities, and other sensitive ecosystems, immediately down gradient of the railway formation. Drains will be constructed along the contour, as near as practicable to the formation to spread the water. Figure 6 provides a schematic representation of the function of the contour drains.

If the drains retain water, they may attract cattle, and therefore be susceptible to trampling and erosion. Drains will therefore be maintained accordingly to prevent sediment accumulation and erosion.

Contour drains should only be installed at the outlet of environmental culverts, in areas where rock aprons alone are determined to not be sufficient to redistribute flows to down-gradient sheet flow dependent Mulga communities and other sensitive ecosystems.

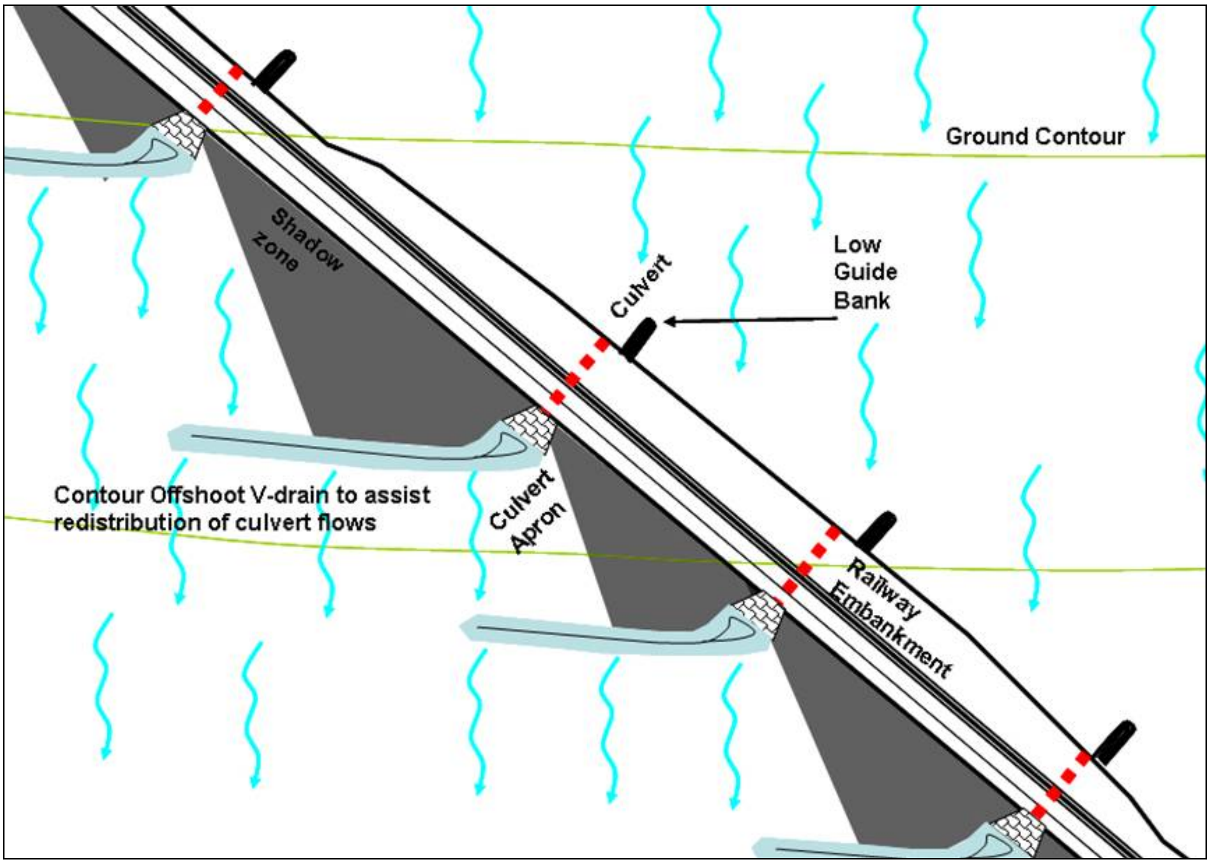

Figure 6: Schematic showing function of rip rap aprons, guide banks and contour drains to assist with the redistribution of culvert flows.

REFERENCES

Anderson, V.J. & Hodgkinson, K.C., 1997. *Grass-mediated capture of resource flows and the maintenance of banded Mulga in a semi-arid woodland* in . Australian Journal of Botany Vol. 45, 331-342.

Aquaterra Consulting 2004, *Stage A Port and North South Railway Surface Hydrology*. Report prepared for Fortescue Metals Group Limited.

Aquaterra Consulting 2005, *Pilbara Iron Ore & Infrastructure Project – Stage B Mines and East-West Railway - Surface Hydrology*. Report prepared for Fortescue Metals Group Limited.

Department for the Environment, Water, Heritage and the Arts (DEWHA), 2008. *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters Report, available online:http://www.environment.gov.au/erin/ert/epbc/index.html, accessed 24 November 2008, Commonwealth of Australia.

Environ Australia Pty Ltd, 2005. *Public Environmental Review, Pilbara Iron Ore and Infrastructure Project: E-W Railway and Mine Sites (Stage B).* Report prepared for Fortescue Metals Group Ltd.

Muller Consulting Pty Ltd, 2005. *Water Flow in Mulga Areas Adjoining Fortescue Marsh. Report of observations from field trips undertaken for Fortescue Metals Group Limited*.

MWH, 2010. *Fortescue Marsh Surface Water Impacts to Proposed Roy Hill Project Railroad Alignment.* Unpublished advice to Hancock Prospecting Pty Ltd dated 29 April 2010 (MWH reference A1242300).