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Appendix A7

Acid Sulphate Soils Management Plan

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

The Outer Harbour Development will involve the construction and operation of terrestrial and marine infrastructure for the handling and export of iron ore. This section describes the proposed terrestrial and marine components, as well as the supporting structures and systems. An overview of the project's location, layout and footprint is shown in **Figure 1.1**.

Terrestrial development will include:

- rail connections and spur from the existing BHP Billiton Iron Ore mainline to proposed stockyards at Boodarie;
- rail loops at Boodarie;
- stockyards at Boodarie; and
- an infrastructure corridor (including conveyors, access roadway and utilities) from the stockyards to the proposed marine jetty.
- Marine development will include:
- an abutment, jetty and wharf;
- mooring and associated mooring dolphins;
- transfer station and deck;
- associated transfer stations, ore conveyors and shiploaders;
- dredging for berth pockets, basins and channels; and
- navigation aids.

This project description is based on the engineering investigation and design completed to date (January 2011) and incorporates alternatives and or options which are still being considered. As BHP Billiton Iron Ore continues with detailed engineering and design prior to construction the alternatives will be evaluated.

The Outer Harbour Development will provide an export capacity of approximately 240 Mtpa of iron ore. This will be established in four stages, with incremental expansions brought on line to reach the maximum capacity. Expansion stages will occur through four separate modules, each with a nominal capacity of up to 60 Mtpa. Regulatory approvals are being sought for the infrastructure required to deliver the total capacity of 240 Mtpa.

The staging of the four stages and their terrestrial and marine components, are summarised in **Table 1.1**.

Table 1.1 – Outer Harbour Development Staging

	Outer Harbour Development Project Staging			
	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
Nominal Capacity (cumulative)	60 Mtpa	120 Mtpa	180 Mtpa	240 Mtpa
Landside Components				
Car Dumper	1	1	1	1
Stockyard	1	1	1	1
Stacker	1	1	1	1
Reclaimer	1	1	1	1
Lump Re-screening Plant	Shared, construct Stage 1		Shared, construct Stage 3	
Re-screened Fines Stockyard	Shared, construct Stage 1		Shared, construct Stage 3	
Rail Loop	1	1	1	1
Rail Spur	Single track		Duplicate Western Spur	
Marine Components				
Loading Berths	2	2	2	2
Shiploader	1	1	1	1
Berth Pockets	4	-	4	-
Link Channel	1		-	-
Swing/Departure Basin	1	1	2	
Departure Channel	-	1	-	-
Tug Access Channel	1			

Figure 1.1 – Project Overview

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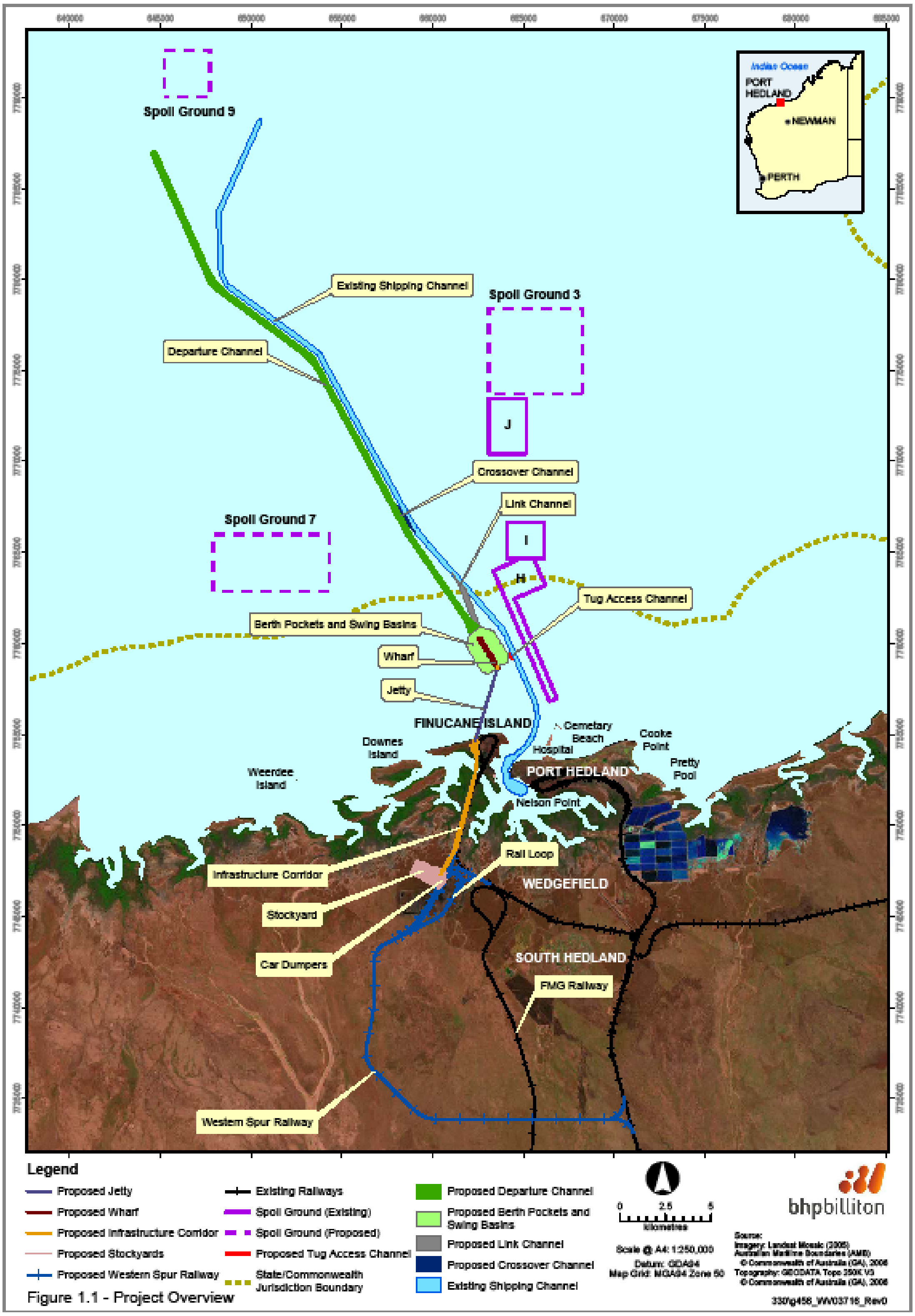

2 OBJECTIVES AND SCOPE

2.1 OBJECTIVES

The EPA's stated objective relevant to soils and landforms is 'to maintain the integrity, ecological functions and environmental values of the soils and landform'. The specific objective for acid sulphate soils (ASS) is that potentially acid sulphate soil (PASS) disturbing activities are avoided or managed to avoid harm to the surrounding environment (DEC 2009).

The objectives of the Acid Sulphate Soil Management Plan (ASSMP) are to minimise the risk to the environment resulting from Acid Sulphate Soils (ASS) by:

- defining areas of Potential Acid Sulphate Soils (PASS);
- providing an operational methodology to reduce the potential risks to the environment due to the disturbance of PASS and/or Actual Acid Sulphate Soils (AASS) material during construction works; and
- documenting monitoring and contingency methods for implementation during construction works.

2.2 SCOPE OF THE ASSMP

This Acid Sulphate Soil Management Plan is applicable to the terrestrial elements of the Outer Harbour Development (as outlined in **Section 1.1** and shown on **Figure 1.1**), which are hereinafter referred to as the 'proposed development'.

To achieve the objectives, the scope of work consisted of:

- review of previously completed reports to summarise the extent of PASS (where information is available) within the proposed development;
- development of the onshore management measures (to minimise PASS impacts);
- development of environmental compliance monitoring and reporting requirements;
- outline potential contingency measures; and
- outline requirements for the ASS closure report.

2.3 STANDARDS AND GUIDELINES

Acid Sulphate soils are regulated under the *Contaminated Sites Act 2003* and the *Environmental Protection Act 1986.* Applicable guidelines for the management of PASS include:

- Western Australia Planning Commission (WAPC). January 2009. *Acid Sulfate Soils Planning Bulletin No. 64* (WAPC 2009a);
- WAPC. January 2009. *Acid Sulfate Soils Planning Guidelines* (WAPC 2009b);
- Department of Environment and Conservation (DEC). November 2003. *Contaminated Sites Management Series: Assessment Levels for Soil, Sediment and Water, Draft for Public Comment, Version 3,* (DEC 2003);
- Acid Sulphate Soils Management Series Guidelines including:
  - DEC. January 2009. *Draft Treatment and management of soils and water in acid sulphate soil landscapes. Acid Sulfate Soils Guideline Series*. (DEC 2009a);
  - Department of Environment and Conservation (DEC). May 2009. *Identification and Investigation of Acid Sulfate Soils. Acid Sulfate Soils Guideline Series*. (DEC 2009b); and
- Agricultural and Resources Management Council of Australia and New Zealand (ARMCANZ) and Australian and New Zealand Environment and Conservation Council (ANZECC). January 2000. *National Strategy for the Management of Coastal Acid Sulfate Soils* (ANZECC / ARMCANZ 2000).

3 ENVIRONMENTAL SETTINGS

The Outer Harbour Development is located at Port Hedland, WA. Port Hedland is one of the major towns and one of three ports operating in the Pilbara region. The portion of the Outer Harbour Development, to which this ASSMP is applicable includes the terrestrial portion extending from Finucane Island southwards onto the mainland to Boodarie as shown on **Figure 1.1**.

3.1 PREVIOUSLY COMPLETED REPORTS

Two ASS reports have previously been completed for BHP Billiton Iron Ore for the proposed development or the immediate surrounds:

- SKM, February 2009 *Draft Port Hedland Outer Harbour Development Acid Sulphate Soil Investigation along the Infrastructure Corridor to Finucane Island* (SKM 2009a); and
- SKM, June 2009, *Port Hedland Outer Harbour Development Preliminary Acid Sulphate Soil Investigation* (SKM 2009b).

Several maps identifying the risk of the presence of ASS in Western Australia have been developed by the Department of Environment and Conservation. The acid sulphate soils map for Port Hedland indicates that the proposed development extends through a zone where there is a 'high to moderate risk of ASS occurring within 3 m of the natural soil surface' (refer to **Figure 3.1**). The *Acid Sulphate Soils Guidelines Series*, (DEC 2009a and DEC 2009b) states that there are several land features which indicate ASS:

- coastal alluvial valleys;
- wetland dependant vegetation, such as reeds and paper barks;
- areas where the dominant vegetation is tolerant of salt, acid and/or water logging conditions;
- areas known to contain peat or a build up of organic material;
- waterlogged conditions or a high water table; and
- presence of some pale grey sands or iron cemented organic rich sands (coffee rock).

More than one of these indicators were observed during site inspection or identified during the desktop review of readily available data for Outer Harbour Development.

The area this ASSMP relates to has been subdivided into two zones (Zone 1 and Zone 2) for ease of description based on the proposed development. The two zones are shown on **Figure 3.1** and comprise of:

- Zone 1 – Infrastructure corridor and Finucane Island transfer station; and
- Zone 2 – Stockyards and Rail Loop.

Figure 3.1 – Acid Sulphate Soils Risk Map

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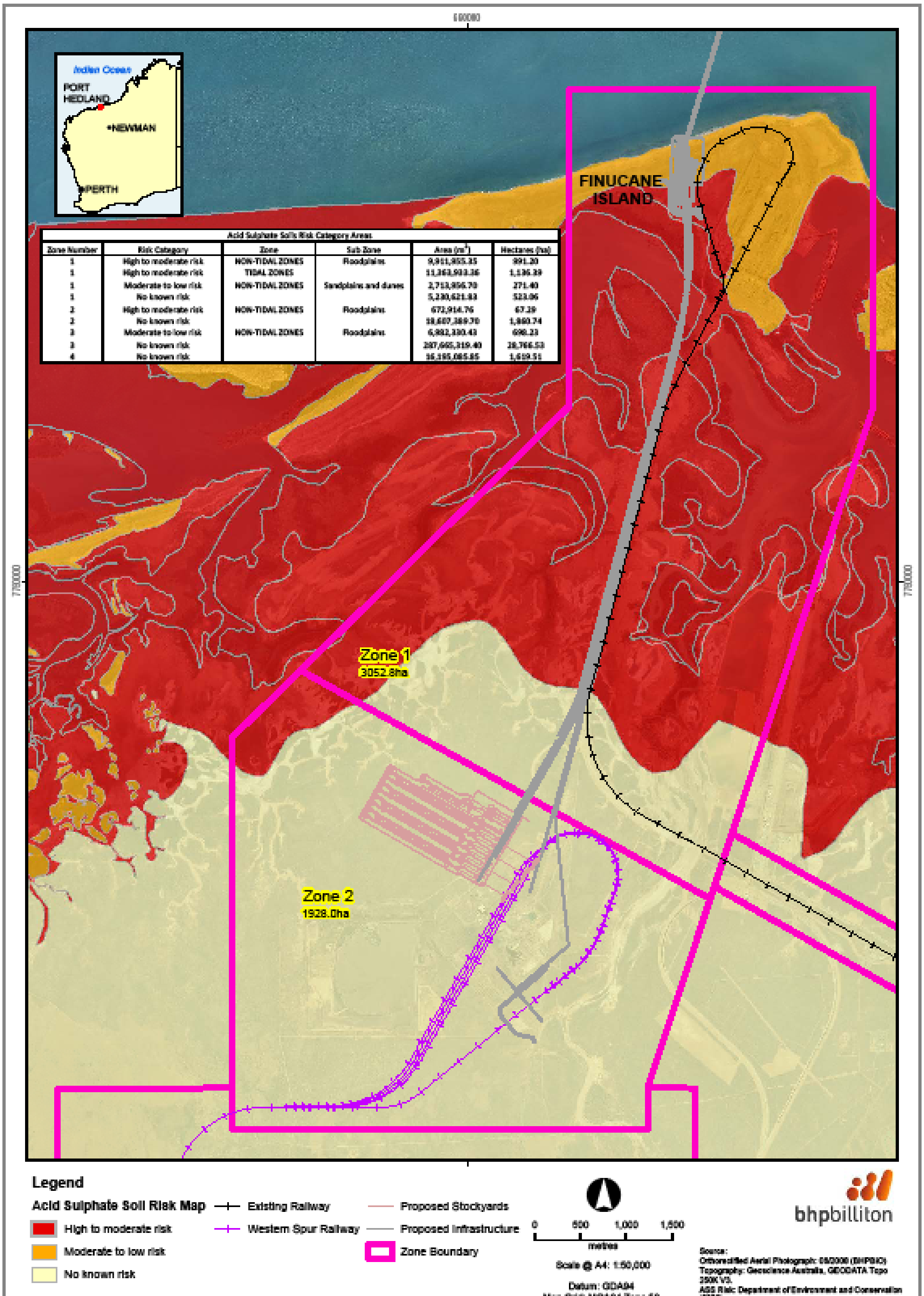

Figure 3.1 - Acid Sulphate Soil Risk Map

4 ASSESSMENT OF ACID SULPHATE SOILS CONDITIONS

This section includes an overview of the general environmental setting as well as a summary of the acid sulphate soil investigations undertaken both within and nearby to the proposed development.

4.1 PORT HEDLAND REGION

4.1.1 Topography, Geology and Soils

The Port Hedland area consists of flat sandy lowlands, with broad areas of bare coastal mudflats, intertidal mudflats and tidal creeks, and a significantly altered open harbour at Port Hedland.

The Port Hedland area is located on the Holocene, Bossut Formation, a body of unconsolidated sedimentary soils described as sandy calcarenite, oolite and calcilutite, which outcrops discontinuously near the coast. These dune, beach ridge, beach and offshore bar deposits are predominantly marine, with the exception of the barrier dune system which is of Aeolian origin.

Finucane Island and the conveyor system occurs in the Littoral Land System unit, which is characterised by bare coastal mudflats with mangroves present on the seaward fringes, with samphire flats, sandy islands, coastal dunes and beaches (DoA 2004).

Topography

The coastal areas within Zone 1 are generally flat with gently sloping beaches, numerous headlands, and many offshore islands (SKM 2009b). The topography of Finucane Island ranges from 1 m to 20 m above sea level, with berms along the north shore. The mainland area within Zone 1 ranges from 1m to 15 m above sea level.

Zone 2 is situated on a coastal plane, which is generally flat, low lying and ranges between 1m and 20 m above sea level.

Geology

The coastal areas are primarily composed of saline muds and marine sands. Most of the soils within the project area were formed by quaternary deposits and comprise of the units described below:

- intertidal mudflat deposits consisting of calcareous clay, silt and sand and mangrove swamp deposits that fringe numerous tidal creeks; and
- calcareous sand, silt and clay of supra-tidal flats which separate the intertidal deposits from non-marine sediments further inland.

Inland soils frequently include patches of hard, red alkaline earths and Pindan soils.

The general geology of the site is presented in **Figure 4.1**.

Figure 4.1 – Site Geology with Infrastructure Layout

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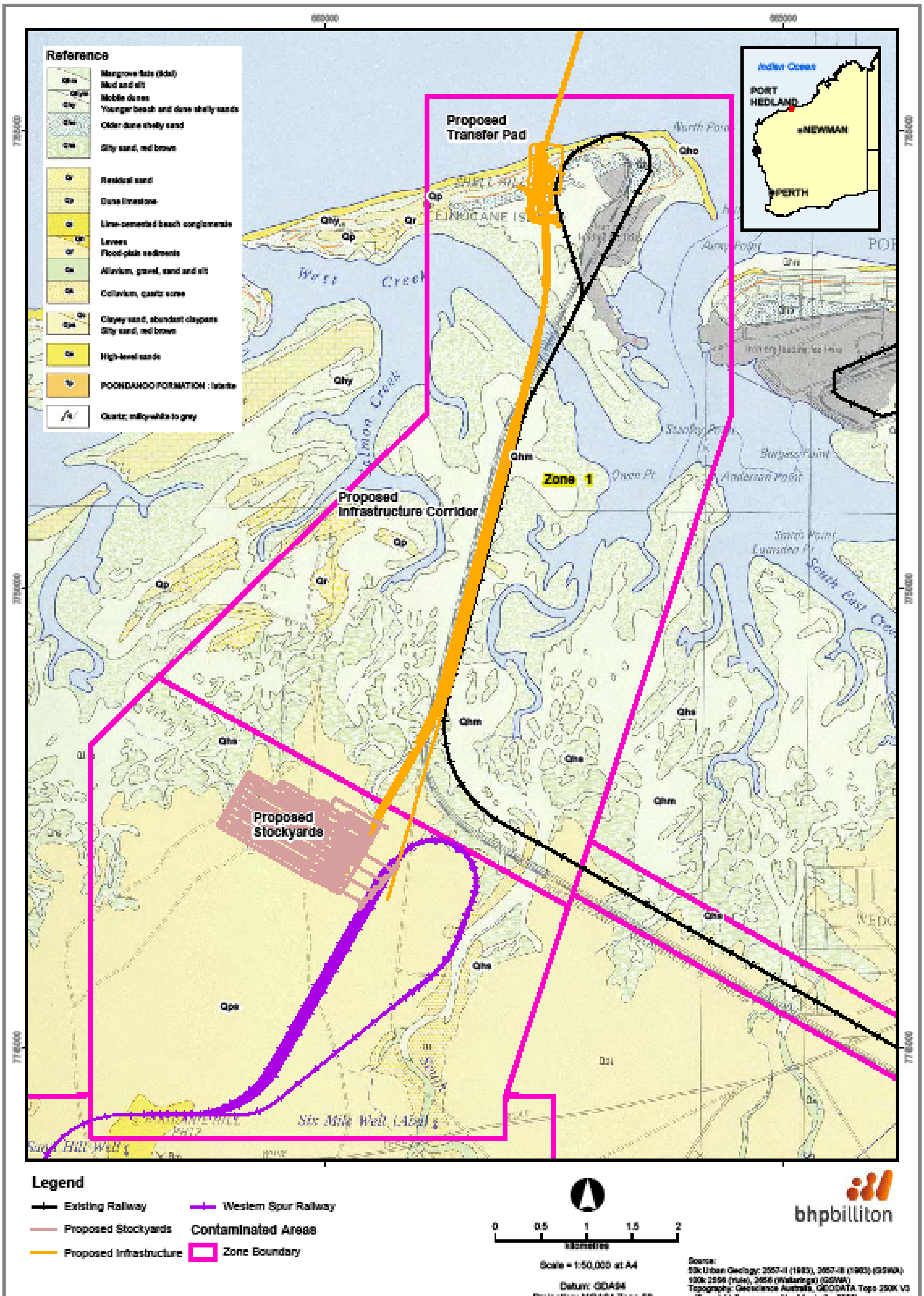


Figure 4.1 - Site Geology with Infrastructure Layout

4.2 HYDROGEOLOGY

Generally, groundwater occurrences are associated with sand and gravel units within the alluvium, augmented by weathered basement and/or calcrete. The regional granite terrain comprises medium to coarse grained biotite granodiorite with common pegmatite veining. Groundwater is mostly associated with fracturing and intrusions of pegmatite and/or dolerite rocks.

Generally bores located along the alluvial plain south of Port Hedland draw groundwater from alluvial sediments or calcrete horizons. These bores are mostly shallow (less than 50 m depth) with modest to low yields, i.e. less than 500 m^3/d, and near surface ground water levels. Recorded salinities vary from 400-8,000 mg/L total dissolved solids (TDS).

4.3 HYDROLOGY

The hydrology of the site is dominated by the permeable sandy surface soils which can support infiltration rates greater than most of the high rainfall intensities experienced during storm events. The proximity of the shallow groundwater near to the ground surface (<1 m) in some areas of the Outer Harbour Development is indicative of water logging and flooding during significant rain events.

For Zone 1, a tidal marine shoreline with mangroves is the nearest surface water feature to the site. From information gathered from Site Contamination Preliminary *Site Investigation, Boodarie Iron Plant, Port Hedland,* (Golder Associates Pty Ltd, 2006), major surface drainage features for Zone 2 are ephemeral Turner River and South West Creek. The Turner River is 7 km west of the decommissioned Boodarie Hot Briquetted Iron (HBI) plant site, whilst South West Creek runs about 0.7 km to the east of the decommissioned Boodarie HBI plant site in a south to north direction prior to discharging into the Headland Harbour. Surface water flow is to the north-east towards estuaries along the coast and locally towards the South West Creek, which is located to the east of the plant.

4.4 DESKTOP REVIEW SUMMARY

Zone 1 has been identified as being in an area with ***moderate to high risk of ASS occurring in the top 3 m of natural soil surface*** (refer **Figure 3.1**). The southern portion of this zone is located in an area which has ***no known risk of ASS*** occurring.

Low lying and undisturbed mangrove or intertidal areas are assumed to pose a higher risk of ASS or PASS occurrence. The risk from ASS is associated with ground disturbance activities and only areas where excavations are to take place into undisturbed natural ground will require investigation, in line with DEC guidelines (DEC 2009b). The risk of disturbance of ASS for the proposed development in Zone 1 is considered to be high for localised areas.

Zone 2 contains mostly areas where ***no known risk of ASS*** occurring (within the top 3 m below natural soil surface or deeper. A small area of '*moderate to high risk of ASS occurring in the top 3 m of natural soil surface'* exists in the north-west corner of this zone. The risk of disturbance of ASS, for the proposed development, in Zone 2 is considered to be moderate since deep excavations (25 m deep) are planned and the area is located nearby to an area with high risk ASS occurrence. Further desktop review information is contained in SKM (2009b)

4.5 SITE ASS INVESTIGATION

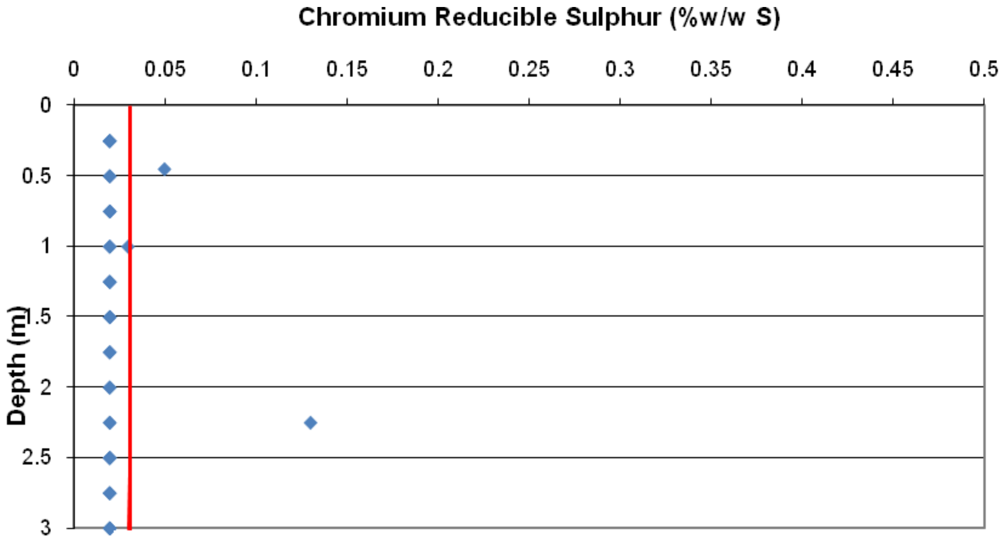
4.5.1 Outer Harbour Development Infrastructure Corridor

An ASS field sampling investigation (ASSI) was undertaken along a 5.5 km section of the infrastructure corridor 3 km south of Finucane Island. The investigation of the infrastructure corridor was limited to this section due to constraints imposed by site access and underground services. Chemical analyses were conducted on core sub-samples using the ASS Chromium Reducible Sulphur (S_{CR}) method. The results of the investigation can be found in SKM (2009a).

A total of 108 samples were 'field' tested as part of the Investigation. The 'field' testing consisted of submission of soil samples to the laboratory with a soil water (pre oxidation) and soil hydroxide (post oxidation) paste prepared with the pH measured for each paste. There were a variety of different reactions ranging from slight to extreme, with pH changes ranging from -1.1 (BH5 - 2.5 m) to 3.2 (BH8 – 2.0 m). The DEC Guidelines discuss assessment of a measured drop in pH following oxidation with peroxide. The lower the oxidised pH and the greater this drop from the unoxidised pH, the greater the potential of occurrence of PASS.

Of the 108 samples 'field' tested, 35 were analysed for PASS using the S_{CR} method. The sulphur (% w/w S) concentrations exceeding the DEC action criteria of 0.03 % w/w S are shown in **Figure 4.2**.

Figure 4.2 – PASS Distribution along a Section of the Proposed Infrastructure Corridor



The red line on Figure 4.1 represents the DEC action criteria of 0.03% w/w Sulphur

There were a number of results with concentrations less than the limit of reporting (LOR) of 0.02 % w/w S. These points are overlaid in the 0.02 column suggesting fewer than 35 samples were analysed. However, this is not the case.

No AASS was identified in any of the samples analysed across the investigation area. **Figure 4.2** depicts the vertical distribution of PASS reported for all boreholes. Two of the 35 samples (6%) returned concentrations exceeding the DEC action criteria of 0.03 % w/w S. Both of these samples were collected from the same borehole (BH1). Borehole logs of BH1 indicate the PASS was encountered in unconsolidated sediments at depths of less than 3 m below ground surface (bgs).

This intrusive investigation indicates that ASS, in contrast to the risk mapping, are generally not present in the top 3 m along the majority of the area investigated. BH1 was the only borehole (of nine boreholes drilled) that encountered PASS, with the levels slightly exceeding the DEC action criteria. The sample location and the concentrations exceeding the DEC action criteria are shown on **Figure 4.3**.

To the north of the investigation area the depositional environment is different. Due to soft sediments, water logging and site access constraints samples could not be collected from this area.

4.6 ASS INVESTIGATIONS – SUMMARY

Based on the results of the investigations detailed above, excavations along the proposed infrastructure corridor are likely to encounter PASS material. Borehole BH1 is located on the edge of a creek to the south of the investigation area. As PASS was encountered at this location, there is potential for material in or near these tidally influenced areas further south to contain PASS.

Although soils to the north of the investigation area (nearer to and on Finucane Island itself) were not assessed by the investigations discussed in this section, they are considered likely to contain PASS due to topography, geology and soil types in the area.

Figure 4.3 – Soil Samples Exceeding the DEC Action Criteria

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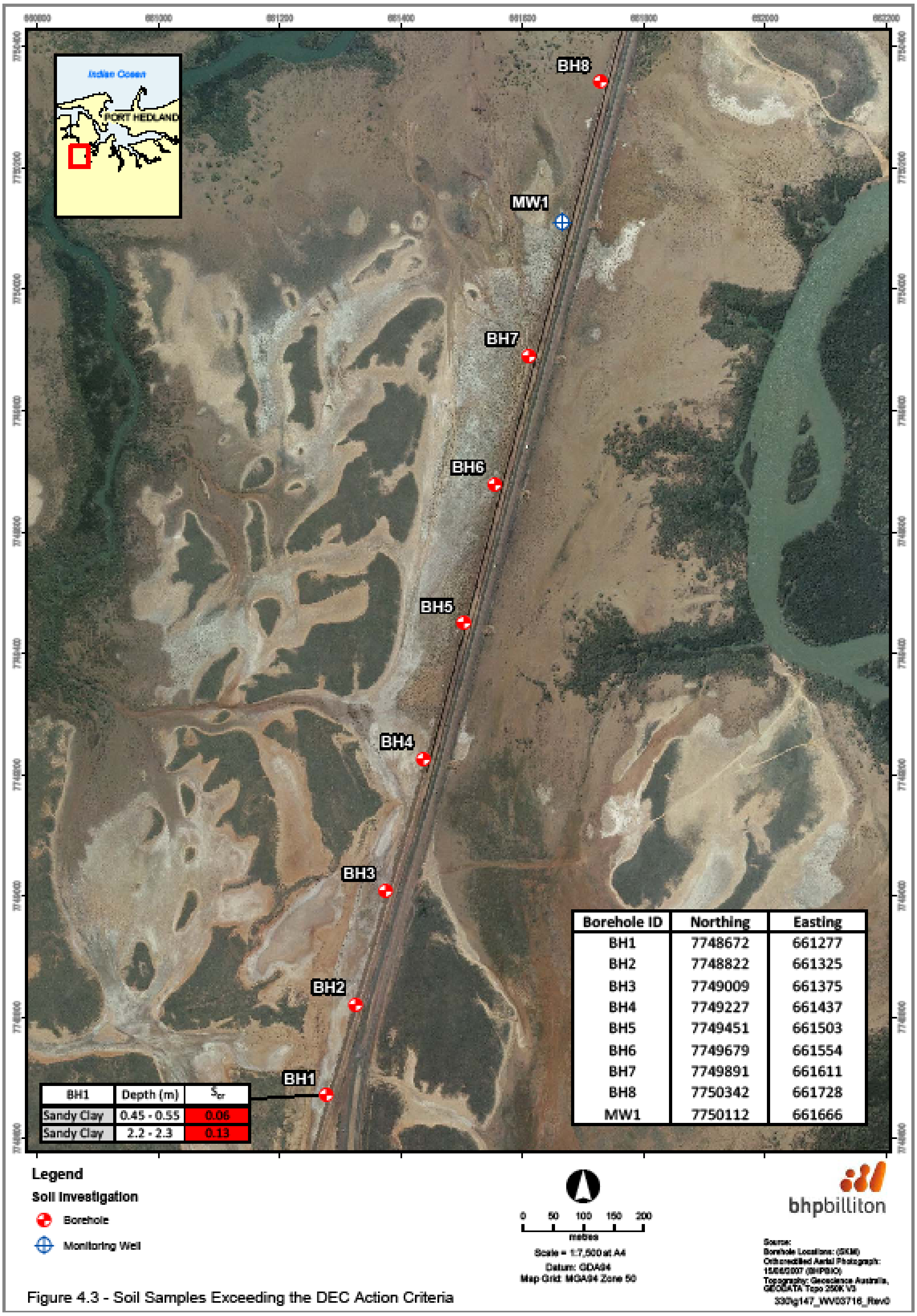

Figure 4.3 - Soil Samples Exceeding the DEC Action Criteria

4.7 EXPECTED OCCURRENCE OF ASS WITHIN THE PROPOSED DEVELOPMENT

ASS are likely to be encountered within the following areas of the proposed development:

- Finucane Island – soil material excavated during construction of the Finucane Island transfer station. Additionally, material excavated between the proposed transfer station and the West Creek crossing.
- West Creek crossing – any soil material excavated as part of the construction of the West Creek crossing.
- Infrastructure Corridor – excavation of soil material along the proposed infrastructure corridor from the West Creek crossing to the Boodarie Stockyards. The likely extent of ASS will vary along this linear corridor with increased likelihood in close proximity to creeks or areas subject to inundation.
- Stockyards – excavation of soil material for construction purposes. Disturbance of ASS in this area is generally considered a low risk and is likely only related to material excavated in close proximity to the groundwater table (likely greater than 3 m bgs).
- Car Dumpers – unconsolidated soil material excavated in close proximity and beneath the groundwater table. Additionally, as dewatering is likely in this area and is likely to occur for an extended period (on the order of 15 months), there is potential for oxidation of *in situ* PASS. The dewatering discharge may require treatment if PASS exists within the dewatering area of influence. Lastly, there is potential for impact on groundwater quality (following completion of dewatering activities) should PASS material be encountered, within the area of dewatering influence, and allowed to oxidise.

5 POTENTIAL IMPACTS

Oxidation of PASS material can result in generation of AASS. The generation of AASS can result in the release of sulphuric acid and iron into the soil and groundwater. This in turn can release aluminium, nutrients and heavy metals (particularly arsenic) stored within the soil matrix. Once mobilised in this way, the acid, metals and nutrients can seep into waterways, killing fish, other aquatic organisms and vegetation and can degrade concrete, steel pipes and structures to the point of failure. Additionally low levels of impact include reduced hatching, decline in growth rates, skin and health impacts for aquatic life.

The potential impact on groundwater due to dewatering activities include change in pH of soil and water, changes to water quality and changes to the hydraulic regime.

PASS oxidation can result in medium to long-term changes in soil chemistry. Changes in soil chemistry may affect the water quality of tidally influenced areas located at the site, resulting in reduced biodiversity and potentially death of flora and vegetation.

In addition to environmental impacts there is a risk of land sterilisation and deterioration of existing infrastructure should the soil become acidic.

Where there is a potential to disturb ASS, as mapped in the Acid Sulphate Soil Investigation, the works will require the implementation of the controls detailed in this plan. Whilst the following information relates to the specific activities, all the activities that disturb potential ASS will be assessed for acid generating potential and treated accordingly.

Any activities that have potential to lower the water table may enhance the oxidation of sediments. Where the excavation is below the water table and into PASS material, drawdown of the water table may expose PASS material. This can result in the oxidation of PASS and acid generation.

Project elements will be designed to minimise excavations where practicable. However, as described in **Section 1**, excavations and dewatering will be required and do have potential to intercept ASS.

6 MANAGEMENT ACTION PLAN

Based on the PASS assessments completed to date (discussed in **Section 4**) and potential impacts identified in **Section 5**, the management action plan is outlined in **Section 6.1**. Further, prior to any excavation on site in Zone 1 (as shown on **Figure 3.1**), a representative surface and sub surface soil sampling and analysis program will be undertaken to characterise the material to be excavated.

6.1 MANAGEMENT OF ASS MATERIAL

There is a high ASS risk from PASS material, to the north of the area assessed in the ASSI (including Finucane Island) with a lower risk of PASS material in the area of the proposed Stockyard and Car Dumpers. Further investigations, to be undertaken prior to construction, are to be carried out in these areas, to assess the extent of PASS. A preliminary sampling plan has been included in **Appendix A** with the sampling methodology and proposed depths included in the table in **Appendix A.**

In order to verify the nature of the disturbed or excavated material during construction, material will be sampled and tested for ASS by carrying out confirmatory laboratory testing by NATA approved methods (such as S_{CR} suite or Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) suite) as required. A summary of the potential Acid Sulphate Soils management actions is included in **Table 6.1**.

Table 6.1 – Management Action Plan Summary

Disposal Options	Action Plan	Environmental Monitoring and Management Methods	Frequency and Monitoring Parameters
Segregation of Excavated Soil	Soils excavated during the development will be managed in accordance with DEC Guidelines.	Field screening of soil material for pH and total titratable acidity (TTA). Laboratory analysis will be undertaken to identify if AASS has been generated. Should laboratory tests indicate AASS, contingency measures will be instigated. Validation samples will be collected from excavated acid sulphate soils to determine adequate treatment rates. Post treatment samples will be collected to confirm adequate treatment prior to reuse or disposal.	Field screening will be conducted at a rate of two samples per 100 m^3 for volumes up to 1,000 m^3 with a reduced sampling rate of one sample per 100 m^3 for volumes up to 3,000 m^3 ,one sample per 200 m^3 for volumes up to 10,000 m^3 and a sample rate of one sample per 400 m^3 for volumes greater than 10,000 m^3 S_{CR} or SPOCAS suites of analyses will be conducted on a weekly basis (if required) on selective samples of solid material at a rate of one sample per 200 m^3 for volumes up to 1,000 m^3 with a reduced sampling rate of one sample per 400 m^3 for volumes up to 3,000 m^3 ,one sample per 800 m^3 for volumes up to 10,000 m^3 and a sample rate of one sample per 1,600 m^3 for volumes greater than 10,000 m^3 Samples to be collected in accordance with the relevant DEC Guidelines.
Dewatering Discharge Generated During Construction	All dewatering discharge will be discharged in accordance with DEC Guidelines.	Groundwater extracted during dewatering will be monitored for water quality. Groundwater monitoring will be undertaken during construction activities according to regulatory guidelines. Undertake surface water monitoring in compliance with the DoW and DEC. DEC specified water quality parameters[1] will be monitored and compared to action criteria.Should action criteria be exceeded, contingency measures will be instigated.	TTA, pH monitored regularly to ensure ph>6 and TTA <40 mg/L. Should these parameters be exceeded monitoring frequency will be increased and samples submitted for laboratory analysis as required. Where acid sulphate soils are identified groundwater will be monitored prior to construction, on a monthly basis during construction.

[1] *DEC specified water quality parameters include total acidity, total alkalinity, sulphate, chloride, dissolved metals (aluminium, arsenic, chromium, cadmium, iron, manganese, nickel, selenium and zinc), total aluminium, total iron, ammoniacal nitrogen, total nitrogen, total dissolved solids, total phosphorus and filterable reactive phosphorus. Field measurements for pH, electrical conductivity, dissolved oxygen, temperature and redox potential.*

6.2 REPORTING REQUIREMENTS

Scope and frequency of reporting relative to ASS management will be by agreement with the EPA but will, as a minimum, comprise an annual report capturing the key criteria. If an incident occurs, this will need to be reported to the relevant statutory authority as per contingency measures.

6.3 CONTINGENCIES

To assist in the management of PASS/AASS present in the project area the following contingency measures will be in place to reduce the risk of harm to the surrounding environment:

- Should the soil monitoring not satisfactorily identify areas of ASS then sampling and monitoring methodology will be reviewed to improve effectiveness.
- In the case of water quality parameters, should these parameters be exceeded then monitoring frequency will be increased and samples will be submitted for laboratory analysis as required.
- Incidents or other relevant occurrences will be reported to the relevant statutory authority.

7 RESIDUAL RISK ASSESSMENT

Risk assessment is a process which determines the frequency of occurrence of an event and the probable magnitude of adverse effects. Risk identification involves identifying environmental aspects, related hazardous events, their causes and environmental impacts. Risk analysis examines the controls to prevent the environmental impact from occurring, or mitigate the severity of the impact (consequence). It also analyses the potential consequence and the likelihood of an impact of this severity occurring. Risk is the combination (or, in mathematical terms, the product) of consequence and likelihood. For further information on the risk assessment procedure utilised, refer to the Draft Public Environmental Review/ Environmental Impact Statement (PER/EIS).

A summary of the key potential impacts posed by the excavated material and due to the proposed dewatering discharge, with respect to ASS, and their associated management measures are provided in **Table 7.1**. Further, their associated severity, likelihood and residual risk is also provided in **Table 7.1**.

Potential impacts are considered to be 'known to happen, but only rarely', as defined in the BHP Billiton Risk Guidelines. Any impacts are considered to be 'moderate, short term effects but not affecting ecosystem function' as defined in the BHP Billiton guidelines. The residual risk (i.e. after the management measures proposed in the plan have been applied) has therefore been determined to be minor.

Table 7.1 – Summary of Potential Impacts Relating to PASS and the associated Management Measures, Severity, Likelihood and Residual Risk

Hazard	Source of Hazard	Potential Impacts	Mitigation	Likelihood	Consequence	Residual Risk
Liquid and Waste Disposal	De-watering discharge	Discharge of acidic and/or contaminated dewatering water to marine environment from land-based excavations during construction	An Acid Sulphate Soils Management Plan (ASSMP) will be developed and implemented to manage impacts associated with de-watering discharge. Specific management measures include: Site induction/training in the monitoring and management of de-watering discharge for relevant contractors; Monitoring program to assess de-watering discharge quality prior to discharge; Treatment of de-watering discharge prior to discharge (if required).	2	2	Low
Clearing and earthworks	Stockyards Infrastructure corridor Finucane Island Infrastructure	Acidification of surface water and groundwater (including potential metal leaching and contamination) resulting from disturbance (excavation) of ASS. Health and safety implications if contact is made with acidic waters. Integrity of infrastructure could be compromised due to exposure to acidic environment.	Further detailed acid sulphate soils investigations are to be undertaken to confirm the presence of acid sulphate soils within the area proposed for the construction of the transfer pad, infrastructure corridor and car dumpers and conveyor tunnels. (refer **Appendix A**). This Management Plan will be updated with the findings from the further detailed acid sulphate soils investigation. Specific management measures could include: Site induction/training in the monitoring and management of PASS to relevant contractors; Investigation to assess the presence of/successful neutralisation of PASS; If PASS is found then appropriate management measures will be implemented as per DEC guidelines. Project design is to incorporate corrosion resistant design materials based upon field identification of acid sulphate soils, if required. If acid sulphate soils are present, excavated soil is to be treated during construction to prevent acidic fluids leaching into surface water or groundwater.	1	3	Low
Groundwater Abstraction	Dewatering during car dumper	Acidification of soils and groundwater due to disturbance of ASS.	Captured dewatered effluent during car dumper construction is to be monitored for water quality to	3	1	Low

Hazard	Source of Hazard	Potential Impacts	Mitigation	Likelihood	Consequence	Residual Risk
	construction		identify the need for treatment of acidic conditions. Undertake groundwater abstraction in accordance with the agreed DoW license.			

8 DECOMMISIONING

A Decommissioning Environmental Management Plan will be prepared by BHP Billiton Iron Ore; to be approved by the EPA prior to commencement of decommissioning of the project facilities. An Interim Rehabilitation Plan will also be developed to manage rehabilitation of areas post construction. This will include detail on the management of ASS in the project area disturbed during construction activities where required.

Closure reporting will be conducted according to DEC guidelines (DEC 2009a) covering initial closure and post-dewatering monitoring where required.

9 REFERENCES

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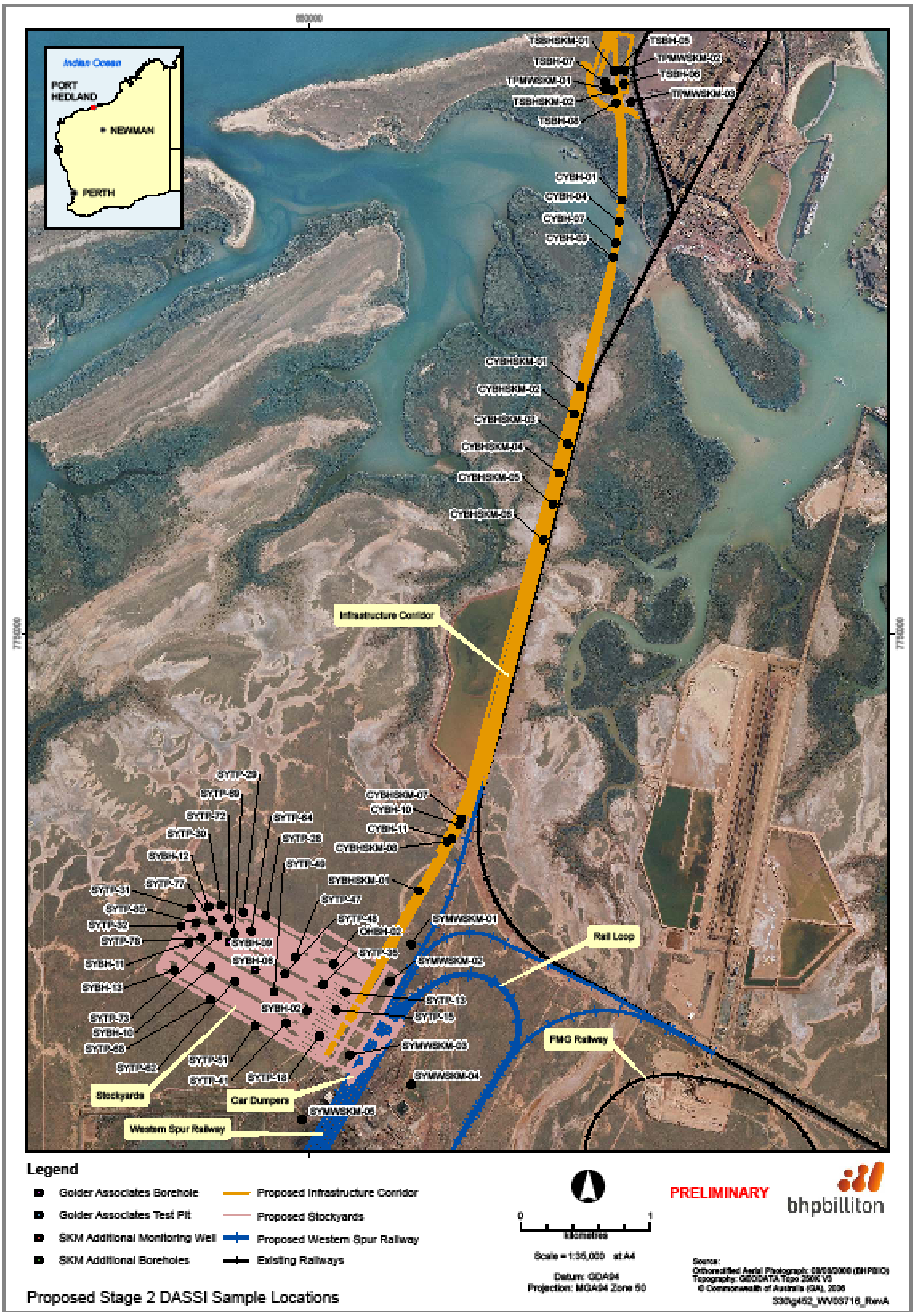
10 APPENDIX A – PROPOSED ADDITONAL ASS INVESTIGATION AREAS

Figure A1 – Proposed Stage 2 DASSI Sample Locations

[**HOLD: Preliminary figures have been copied and pasted within the chapters for information only. Final image will be updated with the correct Figure number and inserted as a PDF page at appropriate resolution and quality**]



[HOLD: This Preliminary table has been copied and pasted within the chapter for information only. Final image will be inserted as a PDF page at appropriate resolution and quality]

	Co ordinates		Purpose	Driling / sample collection details			Monitoring Well Construction Details								
Location				m bgs	Minimum Diameter (mm)	Drilling method	Class 18 slott PVC (m)	Class 18 Blank PVC (m)	End Caps	Lockable caps	Monument Covers	Sand Pack	Bentonite	Grout	Concrete
Transfer Pad (TS)															
TSBH-05	662375	7754327	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
TSBH-06	662433	7754227	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
TSBH-07	662286	7754239	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
TSBH-08	662371	7754082	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
TSBHSKM-01	662360	7754327	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
TSBHSKM-02	662349	7754176	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
TPMWSKM-01	662291	7754190	Monitoring well	6	100	PT, HF, VC or SPT with BO, c	4	4	1	1	1	2			1
TPMWSKM-02	662441	7754328	Monitoring well	6	100	PT, HF, VC or SPT with BO, c	4	4	1	1	1	2	1		1
TPMWSKM-03	662489	7754088	Monitoring well	6	100	PT, HF, VC or SPT with BO, c	4	4	1	1	1	2			1
Conveyor (CY)							-	-	-	-	-				
CYBH-01	662418	7753330	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBH-04	662394	7753168	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBH-07	662369	7753004	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBH-09	662350	7752896	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBH-10	661165	7748529	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBH-11	661106	7748417	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-01	662095	7751899	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-02	662048	7751688	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-03	661999	7751458	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-04	661937	7751231	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-05	661885	7750993	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-06	661812	7750720	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-07	661178	7748574	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
CYBHSKM-08	661071	7748398	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
Stockyard (SY)							-	-	-	-	-				
SYBH-02	659990	7747093	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYBH-06	659587	7747415	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYBH-09	659388	7747623	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYBH-10	659250	7747429	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYBH-11	659077	7747620	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYBH-12	659231	7747896	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYBH-13	658965	7747412	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYTP-13	660288	7747238	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-15	660214	7747101	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-18	660086	7746902	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-28	659671	7747827	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-29	659498	7747855	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-30	659329	7747908	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-31	659094	7747882	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-32	659016	7747744	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-35	660113	7747295	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-41	659828	7747005	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-47	659899	7747509	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-48	659818	7747378	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-49	659733	7747241	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-51	659586	7746983	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-62	659436	7747323	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-64	659556	7747706	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-68	659243	7747179	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-69	659427	7747690	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-72	659385	7747805	Soil sample collection	3	Test pit	grab	-	-	-	-	-				

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Location	Co ordinates		Purpose	Driling / sample collection details			Monitoring Well Construction Details								
				m bgs	Minimum Diameter (mm)	Drilling method	Class 18 slott PVC (m)	Class 18 Blank PVC (m)	End Caps	Lockable caps	Monument Covers	Sand Pack	Bentonite	Grout	Concrete
SYTP-73	659302	7747672	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-77	659255	7747788	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-78	659176	7747655	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYTP-80	659130	7747771	Soil sample collection	3	Test pit	grab	-	-	-	-	-				
SYBHSKM-01	660851	7748018	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				
SYMWSKM-01	660793	7747607	Monitoring Well	6	100	PT, HF, VC or SPT with BO, c	3	4	1	1	1	3	1		1
SYMWSKM-02	660630	7747321	Monitoring Well	35	150	PT, HF, VC or SPT with BO, c	33a	5a	1	1	1	0.5 m^3	1		1
SYMWSKM-03	660319	7746756	Monitoring Well	35	150	PT, HF, VC or SPT with BO, c	33a	5a	1	1	1	0.5 m^3			1
SYMWSKM-04	660793	7746528	Monitoring Well	35	150	PT, HF, VC or SPT with BO, c	33a	5a	1	1	1	0.5 m^3	1		1
SYMWSKM-05	659948	7746257	Monitoring Well	35	150	PT, HF, VC or SPT with BO, c	33a	5a	1	1	1	0.5 m^3		Possible	1
Ore Handling Plant (OH)															
OHBH-02	660194	7747459	Soil sample collection	3	100	PT, HF, VC or SPT	-	-	-	-	-				

(light green)	Golder Location test pits to be sampled
(green)	Golder Location Boreholes to be sampled
(orange)	Additional SKM sample locations

Drilling Method Key

PT	Push tube
HF	Hollow flight augurs
SPT	Standard Penetrometer Test (split spoon samples)
VC	Vibracore Sampled
BO	If diameter of the soil sample collection hole is less than 100mm then monitoring wells can be installed followed by boring out of the hole to 100mm to 150mm.
grab	Sample collection from test pits or material excavated via test pitting
P	Grout possibly required depending on ground conditions
c	Borehole to preferably be cased to ensure the borehole does not cave in (due to groundwater inflow) during construction of the monitoring well.

Monitoring Well Construction Details Key

Class 18 Slott PVC	50mm(minimum) ID, slot spacing of 4mm with slot width of 0.5mm, coarse screw threaded (so each section can be screwed together without the use of glues) and contained within plastic (to be removed during monitoring well construction). Usually comes in 3m lengths.
Class 18 Blank PVC	50mm(minimum) ID, coarse screw threaded (so each section can be screwed together without the use of glues) and contained within plastic (to be removed during monitoring well construction). Usually comes in 3m lengths.
a	Monitoring well to be constructed of 80mm diameter PVC to allow usage for dewatering. If no class 18 PVC for the 80mm boreholes then specs of the PVC (i.e. Slot width and spacing) to be provided.
Monument Covers	Steel stick up casing of a minimum of 0.5m above the ground surface
Sand Pack	Wash and graded coarse sand (for placement as the sand pack surrounding the screened section). Have assumed 20kg bags of sand (5mm graded coarse sand) for the 6m monitoring wells while a volume of sand (also 5mm graded coarse sand) has been included for the deeper wells. Also it is assumed that the boreholes are 100mm with 60mm OD PVC for the monitoring wells.
Bentonite	Bentonite pellets or chips. Assume 20kg pale or bag.
Grout	Cement bentonite grout may be required if two aquifers are encountered during drilliing.

Assumptions

The depths assume no excavations will be greater than 2m across the investigation area except for the Boodarie car dumpers.

Soil samples will be collected during drilling of the monitoring wells

Split spoon sampling techniques (or SPTs) will be used to the minimum depth outlined above.

Sufficient soil material will be available for samples collected (i.e. Not all the material is used for geotechnical purposes)

Sand volume has been calculated assuming 20kg bags of sand for the 6m deep monitoring wells while a volume of sand has been included for the 35m deep wells. Also it is assumed that the 6m deep boreholes are 100mm with 60mm OD PVC for the monitoring wells. The volume of sand for the deeper monitoring wells has been calculated assuming a 150mm diameter borehole with an 90mm OD PVC monitoring well.

Some additional allowance of PVC pipe has been included (i.e. Total slot and unslotted PVC is greater than the borehole depth) to allow for stickup and potential variation in screened interval due to depth to groundwater.

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