July 2014

GOVERNMENT OF WESTERN AUSTRALIA

NEW PERTH STADIUM

Project Environmental Management Plan

REPORT

Report Number. 117643077-036-R-Rev1

Distribution:

1 Electronic Copy - Public Transport Authority
1 Electronic Copy - Department of Treasury Strategic Projects
1 Electronic Copy - Golder Associates Pty Ltd

Golder Associates

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Overview

This New Perth Stadium Environmental Management Plan (Project EMP) has been prepared for the new Perth Stadium project (the Project) as part of an Environmental Management Strategy to guide the Department of Treasury Strategic Projects (SP) in establishing and maintaining controls to manage potential environmental and social impacts during the Project.

This document is to be read in consultation with the Construction Environmental Management Framework (CEMF), the Operational Environmental Management Framework (OEMF) and the New Perth Stadium Section 38 Referral Supporting document which provides the following:

- A description of the Preconstruction Site Works (PCS Works), Stadium Construction Works (Stadium Works) and Operations
- A description of each Environmental Management Plan (EMP) document that comprises the Environmental Management Strategy of the Project
- SP's and the future Stadium Governance Body's Environmental Objectives and Environmental Commitments for the Project
- The Environmental Commitments for the Project for the Lead Contractor(s) and Stadium Governance body
- A description of the Project's existing environment and results of specialist studies undertaken.

1.2 Project EMP Scope

The Project is to design, construct, operate and maintain a new Perth Stadium (the Stadium) contained within a "Sports Precinct" located at Burswood Peninsula, Western Australia. The "Sports Precinct", referred to throughout this document, is described in the New Perth Stadium Master Plan (Strategic Projects, 2012) as including:

- A 60 000 seat Stadium with an east-west orientated pitch measuring 165 m × 130 m. The Stadium will incorporate an external elevated plaza up to 30 m wide.
- An upgraded Belmont Park rail station with dual access to transport up to 28 000 patrons within an hour after an event. The upgraded facility will include rail forecourts to allow queuing.
- An on-street bus hub facility.
- A pedestrian bridge linking the Sports Precinct with Nelson Avenue in East Perth.
- A parkland for community sports and temporary car parking on event days north of the Stadium.
- An underpass under Victoria Park Drive.
- The retention of the existing Swan River-connected lake (the River-fed Lake) as major feature of the Sports Precinct.
- Footpaths/cycle networks linking the Stadium with Windan Bridge and East Perth train station.
- The supply of additional water, power and gas utilities to service the Stadium. Sources are available in the vicinity and are generally aligned along Victoria Park Drive.

For planning purposes the Project is to be delivered in three parts:

- **Part 1**: the construction of the Stadium and associated Sports Precinct. This will be undertaken in two phases:
  - Construction Phase, which includes:
    - Preconstruction Site Works (PCS Works) - The objective of the PCS Works is to prepare some parts of the site in advance of the main construction contract so that long term ground movements in those designated areas are within prescribed limits and to facilitate timely construction of the Stadium and associated works. This will necessitate ground treatment such as surcharge, dynamic compaction and/or stone columns so that upon completion of the PCS Works, construction of the Stadium can commence without undue delay caused by site preparation works.
    - Stadium Construction Works (Stadium Works) - Includes the construction of the Stadium, its plaza and associated infrastructure on the PCS Works site and will necessitate the use of deep piles to support the Stadium structure. Construction of surrounding infrastructure, such as pedestrian access ways, roads, bridges, services and site rehabilitation will also be undertaken during the Stadium Works.
  - Operating Phase: the commissioning of the internal fit-out of the Stadium facilities will be undertaken and ongoing environmental monitoring of the site and management of site facilities will continue during this phase.
- **Part 2**: the construction of the transport infrastructure including the rail realignment, road upgrades to Victoria Park Drive and the Belmont Park Train Station upgrades.
- **Part 3:** the construction of the new pedestrian bridge over the Swan River, including bus and pedestrian facilities at Gloucester Park.

Delivery of the Project, including Parts 1, 2 and 3, has potential environmental and social impacts and has required referral to the Environmental Protection Authority (EPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (EP Act). Referral applications have been lodged for Parts 1, 2 and 3, with the EPA determining that the proposals did not require formal assessment. Delivery of the two phases within Part 1 of the Project is required by 2018. This requires that the PCS Works commence by mid-2013 to allow Stadium Works of the Stadium to commence in 2014, facilitating completion by 2018.

The scope of this Project EMP concerns both the Construction Phase (PCS Works and Stadium Works) and Operating Phase of Part 1 of the Project. It focuses on the development of the Sports Precinct including the:

- Stadium and its plaza
- Bus hub
- Pedestrian access ways and the Stadium ring road
- Parklands.

This Project EMP excludes the following components which are discussed in separate documentation:

- Swan River pedestrian bridge
- Train station
- Rail realignment
- Road upgrades to Victoria Park Drive.

Figure 1 outlines the conceptual Master Plan.

Golder Associates

CLIENT Public Transport Authority
DOCUMENT 117643077-036-R-Rev1
DATE 23 Jul 2014
COMPILED GGW/SL/ADV
APPROVED IYK

0 100 200 300 400
metres

SCALE (at A4) 1:10,000

NOTES
Coordinate System: PCG94

LEGEND
Project area
Claisebrook site
Concept design (Oct 2012)

New Perth Stadium Project EMP

PROJECT LAYOUT

FIGURE 3

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R36\117643077-036-R-F003-Rev1.mxd

1.3 Objective

This Project EMP has been drafted by Golder Associates Pty Ltd (Golder) in consultation with SP based on the findings of the Detailed Site Investigation (DSI) and the content of the Environmental Management Frameworks (EMFs). This Project EMP is the overarching document in the Environmental Management Strategy for the Project and its objective is to describe the Project's:

- Existing environment
- Environmental issues
- Environmental and social receptors
- Potential environmental and social impacts
- Project roles and responsibilities
- Standards, guidelines and legislation
- Limits and targets
- Environmental management measures
- Monitoring procedures
- Incident management
- Training
- Auditing procedures
- Reporting procedures
- Environmental management document review procedures.

This Project EMP is to be implemented by every Lead Contractor and subcontractor working on site. References in this Project EMP to the Lead Contractor(s) being responsible for certain tasks also extend to subcontractors where engaged by the Lead Contractor(s). This document will be revised and finalised in consultation with the relevant regulatory agencies and final approval of the Project EMP by SP will be required before any form of work begins on site.

1.4 Project Location and History

The Project will be located on the northern nine holes of the Burswood Park Golf Course and the State Tennis Centre located on the Burswood Peninsula in Perth Western Australia, as shown in Figure 2. The Project area is shown in Figure 3 and highlighted by the solid red border and will be referred to as the "Project area" throughout this document. The Project area is bounded by the Swan River to the west; the Graham Farmer Freeway to the north and east; and the remainder of the Burswood Park Golf Course to the south.

Included within the Project area are the Sports Precinct, which includes the Stadium structure, bus hub, pedestrian access ways and other associated infrastructure. The pedestrian bridge, train station and road upgrades are, for the most part, contained outside the Project area and are discussed in separate documentation.

The environmental Preliminary Site Investigation (PSI) (Golder, 2012a) conducted in accordance with the Department of Environment and Conservation ((DEC) now Department of Environment Regulation (DER)) Contaminated Sites Management Series Guidelines has identified that the Project area is historically the location of a waste disposal site. It is considered that the Project area has been impacted as a result of previous use as a landfill facility. Further, leachate and ground gas may have generated over time and be contained beneath the ground surface. An environmental Detailed Site Investigation (DSI) has been completed in accordance with the DER Contaminated Sites Management Series Guidelines (Golder, 2013b). The DSI reported elevated concentrations of contaminants in soil, groundwater, sediment and surface water, as well as concentrations of ground gases (methane and carbon dioxide). Soil and groundwater contaminant concentrations and ground gases will require management during construction works, with more details and proposed management measures outlined in the relevant sections of this management plan and in the Contaminated Site Management Plan (CSMP) (Golder 2013a). The DSI also summarises the Project Conceptual Site Model (CSM), which has been developed to summarise our understanding of the site based on the site history, field observations and laboratory results from the contamination investigation and to provide a platform for future investigations. The CSM identifies humans and the environment as the potential receptors. The CSM includes Acid Sulfate Soils, ground gases, Swan River sediment and water quality based on the outcomes of the DSI and the data obtained to date.

The CSM will be subject to review and revision as further information becomes available, and is illustrated in Figure 4 below.

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-036-R-Rev1
DATE	23 Jul 2014
COMPILED	GGW/SL
APPROVED	IYK

0 100 200 300 400
metres

SCALE (at A4) 1:10,000

NOTES
Coordinate System: PCG94

LEGEND
Project area

New Perth Stadium Project EMP

REGIONAL LOCATION

FIGURE 2

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R36\117643077-036-R-F002-Rev1.mxd

NOTES

Coordinate System: N/A

COPYRIGHT

Master Plan Concept provided by client

0 30 60 90 120 150
metres

SCALE (at A3) 1:4,000

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	127643056-037-R-Rev1
DATE	23 Jul 2014
COMPILED	MS/SAR
APPROVED	IYK

New Perth Stadium Project EMP

MASTER PLAN

FIGURE 1

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R36\117643077-036-R-F001-Rev1.mxd

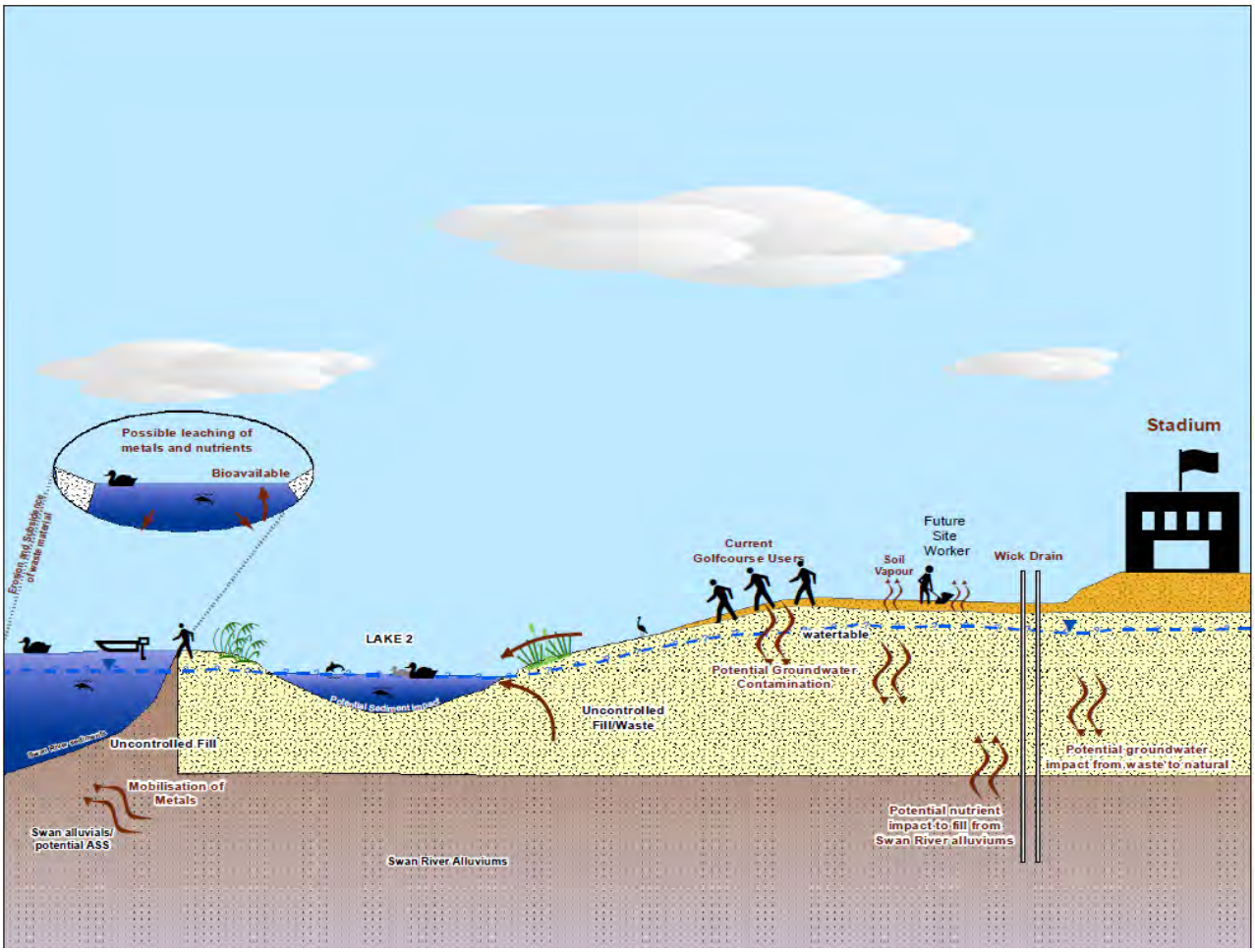


Figure 4: Project Conceptual Site Model

2.0 PROJECT SCOPE

2.1 Preconstruction Site Works

The PCS Works are necessary to prepare the site for construction and in particular, to treat the underlying ground conditions which currently give rise to differential settlement across the site. The main components of the PCS Works are site preparation and ground improvement.

2.1.1 Site Preparation

The site preparation works have been identified as those that do not require specific ground improvement:

- Fencing the site.
- Providing access into the site and hard standing areas.
- Altering existing golf course services (e.g. reticulation) so that any existing, remaining vegetation can be maintained.
- Removing and storing trees/logs for rehabilitation, if required.
- Draining the existing irrigation lake (the Irrigation Lake on Figure 3).

- Undertaking general earthworks including shaping and contouring existing landscape to specific levels. The Stadium itself and other infrastructure within the Sports Precinct need to be above the 100 year flood level which the Department of Water has estimated at Reduced Levels (RL) 3.2 m Australian Height Datum (AHD). A topographical survey of the site indicates that much of the existing landscape is already above this level but some ground work involving shaping and contouring of the land will be required to attain a level of RL 3.5 m AHD across the Stadium site. All flood level considerations will be made with reference to *Potential Impacts of Climate Change on the Swan and Canning Rivers* (Swan River Trust, 2007).

2.1.2 Ground Treatment

Some areas of the site will require the design and construction of ground improvement in order to meet specific long-term ground movement environmental conditions. It will be necessary to carry out ground improvement to control the ground movements that would otherwise occur due to past and future loading of the refuse layer, the underlying river mud and the paleochannel which traverses the site.

Those areas identified for the design and construction of ground improvement works include the:

- Pitch
- Artificial irrigation lake beneath the Stadium site
- Pedestrian assembly areas
- Northern parkland/public open space
- Peninsula Bus Station.

2.1.3 Ground Improvement Methods Considered

A commentary on potential ground improvement methods is included in Golder (2012b). The improvement methods considered during the conceptual design study for the areas are outlined below.

2.1.3.1 Compaction of Uncontrolled Fill

Dynamic or Impact Compaction

Dynamic or impact compaction would be used to compact the uncontrolled fill material and cause collapse of items such as hollow waste within the fill. A variety of methods of compaction can be used; however, for the purpose of this report, dynamic compaction is assumed.

Dynamic compaction typically consists of a large weight (approximately 12 to 20 t) that is lifted (generally 10 m to 40 m) and dropped onto the ground repetitively and repeated on a grid pattern. This equipment could treat material up to about 15 m to 20 m deep.

2.1.3.2 Treatment of Swan River Alluvium Surcharge plus Wick Drains

Surcharging consists of placement of fill to a higher level than final finished surface level, such that the applied loading exceeds the in-service loading. Following adequate time to allow for consolidation settlement of the weak ground below the fill to occur, the excess surcharge fill is removed down to the finished level.

Surcharge plus wick drains have been adopted for the purposes of this report.

2.1.3.3 Stone Columns

Stone columns are vertical columns of about 1 m diameter comprised of densely compacted coarse aggregate (nominally about 50 mm size) installed on a regular grid pattern, extending through the compressible layer to increase the average strength and stiffness of the ground and possibly also provide drainage to accelerate primary consolidation settlement. The aggregate is compacted in place using a vibratory tool.

2.2 Stadium Construction Works

The Stadium Works will commence following completion of the PCS Works; however, it may occur in parallel, with the Stadium structure being the main element of the Construction Phase. The development loads associated with the Stadium structure itself are significant and will require to be supported through the use of piles which transfer these loads to stronger materials beneath the Swan River Alluvium (SRA) layer. This method involves the installation of piles (e.g. driven precast concrete piles) to a firm bearing stratum below the SRA, followed by construction of a reinforced concrete slab to span between the piles.

2.3 Operation

The Operating Phase of Part 1 of the Project involves the transition of the Stadium from construction to operation and being opened to the public. The Operating Phase will include the commissioning of the internal fit-out of the Stadium facilities and ongoing environmental management of the Sports Precinct by the Operating Phase Lead Contractor.

3.0 APPLICABLE LEGISLATION

SP is responsible for obtaining the approvals expressly stated to be its responsibility in Table 1. The Lead Contractor(s) will be responsible for identifying and obtaining all other approvals, licences and permits required to deliver each phase of the Project. Table 1 is an indicative list only, it is not exhaustive, and the Lead Contractor(s) must identify and obtain all other required approvals, licences and permits.

Table 1: Summary of Current and Potential Approval Requirements for the Project

Project Element	Legislation	Decision Making Authority	Application/approval	Responsibility
Project approval	*Environmental Protection Act 1986 (EP Act)*	Minister for the Environment (on advice from the EPA)	Section 38 Referral under Part IV of the EP Act.	Strategic Projects (SP)
Project approval to take action	*Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Commonwealth Minister for the Environment, or Department of the Environment (DoE) under delegation	EPBC Act Referral of a Proposed Action	SP
Contaminated Sites	*Contaminated Sites Act 2003*	DER	Auditors Report for Reclassification	SP
Indigenous heritage	*Aboriginal Heritage Act 1972*	Minister for Aboriginal Affairs, Department of Aboriginal Affairs	Section 18 Approval	SP
Vegetation clearing	*EP Act*	DER	Vegetation clearing permit application (if required)	SP
Project Works Plan and CEMP	*Public Works Act 1902*	Department of Treasury, Strategic Projects on behalf of Minister for Works	D and C Contract	Lead Contractor(s)
Approval to work within road reserves	*Road Traffic Code 2000/ Road Traffic Act 1974*	Main Roads Western Australia (MRWA)	Application to undertake works and a Traffic Management Plan	Lead Contractor(s)
Swan River	*Swan and Canning Rivers Management Act 2006*	Swan River Trust	Development Approval or Permits to undertake works that may interfere with Swan River bed and banks	Lead Contractor(s)
Dewatering	*Rights in Water and Irrigation Act 1914*	Department of Water (DOW)	5C Licence to Take Water	Lead Contractor(s)
Install bores	*Rights in Water and Irrigation Act 1914*	DOW	2D Licence to construct a bore	Lead Contractor(s)
Discharge groundwater to stormwater system	*Swan and Canning Rivers Management Act 2006/Regulations Rights in Water and Irrigation Act 1914*	DOW/SRT/DER	Application to discharge to stormwater system	Lead Contractor(s)
Discharge groundwater to sewer	*Metropolitan Water Supply, Sewage & Drainage Act 1909*	Water Corporation	Application to discharge to sewer	Lead Contractor(s)

Project Element	Legislation	Decision Making Authority	Application/approval	Responsibility
Noise	*Environmental Protection (Noise) Regulations 1997*	DER	Approval of a noise management plan for out of hours work	Lead Contractor(s)
Storage/transport/ handling of dangerous goods	*Dangerous Goods Safety Act 2004*	Department of Mines and Petroleum (DMP)	Application for a storage, transport and handling of dangerous goods licence	Lead Contractor(s)
Controlled waste management	*Environmental Protection (Controlled Waste) Regulations 2004*	DER	Application to transport controlled wastes	Lead Contractor(s)
Ablution facilities	*Metropolitan Water Supply, Sewage and Drainage Act 1909*	DOW	Application to temporarily discharge ablution and associated toilet facilities waste to sewer	Lead Contractor(s)

4.0 ENVIRONMENTAL MANAGEMENT STRATEGY

4.1 Overview

The Environmental Management Strategy for the Project (which considers both environmental and social factors) is outlined in a series of Environmental Management Plans (EMPs) which recognise the current environmental conditions of the site and specifies management and contingency measures for potential environmental impacts (which also considers social impacts). The Environmental Management Strategy is illustrated in Figure 5 and described in detail in the Environmental Management Frameworks (EMFs). The position of this Project EMP is highlighted in red text.

The series of EMFs and EMPs outlined in Figure 5 specify the Project's environmental objectives and details the environmental commitments, management and contingency measures; and monitoring procedures necessary to manage the Project's environmental impacts and meet the stated objectives.

Implementation of the Environmental Management Strategy is the responsibility of SP and the future Stadium Governance Body, with SP preparing most of the listed documents in consultation with the regulatory agencies. Implementation (including monitoring) of the EMPs by the respective Lead Contractor(s) will be overseen and enforced by SP during the Construction Phase and the Stadium Governance Body during the Operating Phase through the Contract of Award applicable to each phase of work.

Compliance monitoring and auditing of the Lead Contractor's CEMP will be the responsibility of SP. SP may seek technical advice from regulatory agencies if the Lead Contractor(s), SP or the Contaminated Sites Auditor considers sensitive receptors to be at risk of harm.

The EPA's decision to not assess the Project was primarily based on the following:

- The governance structure developed by the State Government for the Project, which provides for the following independent input:
  - The Site Conditions Working Group, which includes the DER, SRT and DOW, who will provide input into the Project EMPs.
  - The DER-accredited independent Contaminated Sites Auditor who will have ongoing involvement in the Project. The Auditor will oversee the works and has the power to stop work on site if the environmental or sensitive receptors, including the Swan River, are at risk.
- The DER, DOW and SRT's authority to manage and regulate potential impacts through relevant legislation, including the:
  - *Contaminated Sites Act 2003*
  - *Rights in Water and Irrigation Act 1914*
  - *Swan and Canning Rivers Management Act 2006.*
- The management and mitigation of the key potential environmental impacts being legally binding components of the Design and Construct contract between the State and the Lead Contractor(s).

The EPA provided the following public advice under Section 39A(7) of the EP Act for the new Perth Stadium Project:

> *The EPA's goal for the proposal is that there is no increase in impacts to groundwater and the Swan River. However, the EPA recognises that there are opportunities to improve the condition of the site and quality of groundwater seeping into the Swan River to achieve a net environmental benefit.*
>
> *It is the EPA's opinion that the potential environmental impacts of the proposal can be adequately addressed and managed by other government departments through relevant legislation and the Design and Construct contract for the project.*
>
> *The EPA understands that the State intends to revive the Metropolitan Region Scheme (MRS) over the proposal site for the construction and operation phases of the project. The SRT would then have a formal advisory role to the Western Australian Planning Commission, as the determining authority.*
>
> *The EPA recommends the following:*

- *That the Site Conditions Working Group continues its oversight throughout the preconstruction, construction and operation phases of the project*
- *That the Department of Treasury, Strategic Projects and the Lead Contractor(s) prepare management plans to the satisfaction of the agencies on the Site Conditions Working Group and the Contaminated Sites Auditor, prior to approval by the Department of Treasury, Strategic Projects, and*
- *The MRS should be revived for the construction and subsequent phases of the proposal.*

The EPA recommendations will be implemented by SP through the continuation and involvement of the Site Conditions Working Group, the preparation of Project EMPs in liaison with the regulatory agencies and Contaminated Site Auditor within the Site Conditions Working Group and the initiation of the MRS revivification prior to Stadium Construction.

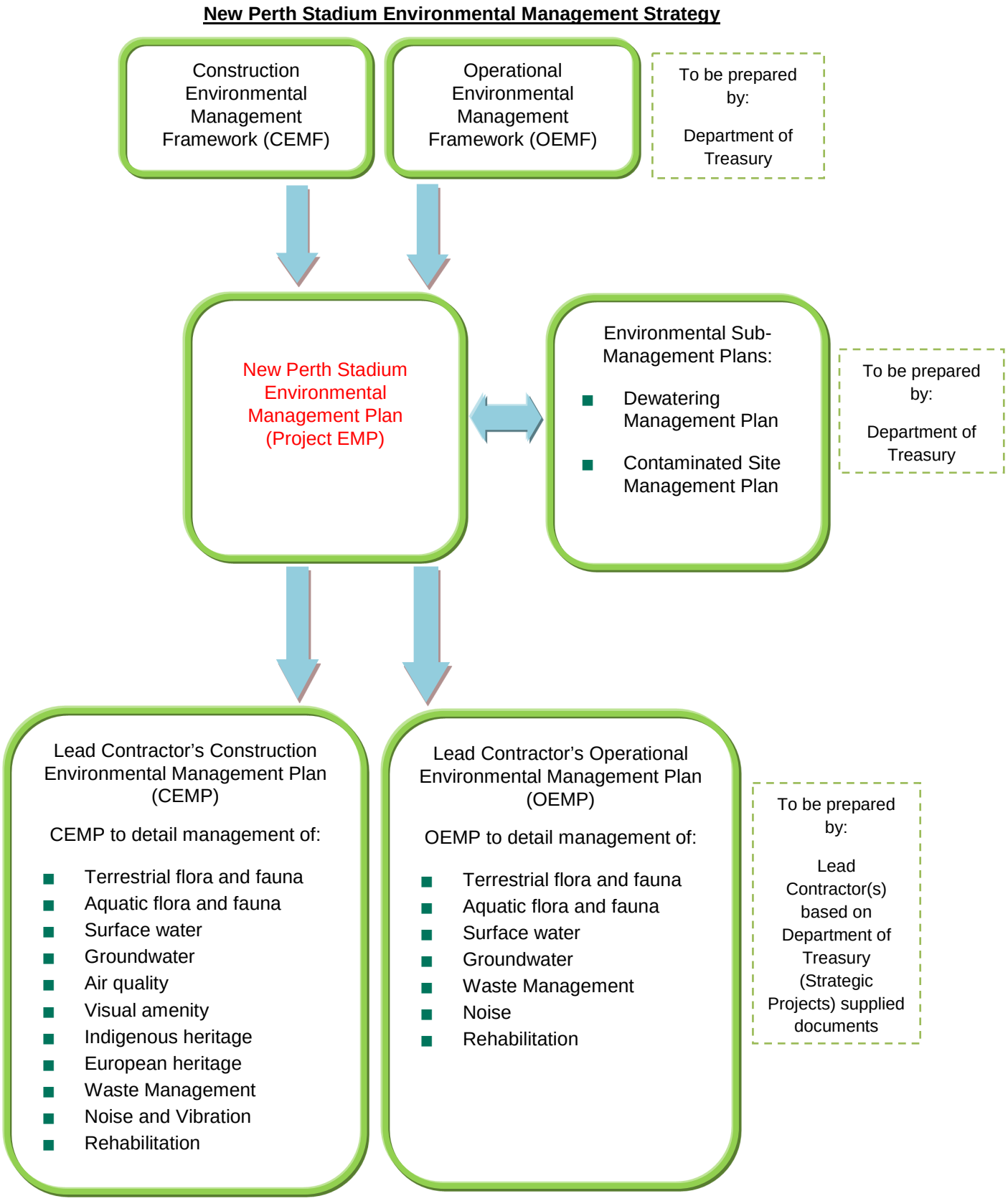


Figure 5: Environmental Management Strategy Structure

5.0 ROLES AND RESPONSIBLITIES

5.1 Overview

Fulfilling the responsibilities of the Environmental Management Strategy involves the participation of SP and the future Stadium Governance Body, the Lead Contractor(s) and their subcontractors. The key responsibilities for each party are outlined below.

5.2 Department of Treasury Strategic Projects

5.2.1 General

The key general responsibilities for SP (and the future Stadium Governance Body, where applicable to the Operating Phase) include:

- Develop, maintain and continuously improve the Environmental Management Strategy documents to the satisfaction of the regulatory agencies.
- Coordinate the delivery of the Project to meet the environmental objectives.
- Ensure that prior to commencement of work; the successful Lead Contractor(s) has developed a detailed CEMP/OEMP in accordance with the Project EMP and Environmental Sub-Management Plans.
- Liaise with regulatory agencies where required. Liaison with regulatory agencies will include, but not be limited to:
  - Regular meetings of the Site Conditions Working Group, consisting of representatives from SRT, DER and DOW.
  - Provision of relevant EMPs for review and comment by SRT, DER and DOW.
  - Monthly status update reporting to members of the Site Conditions Working Group as per Section 15.0.
  - Reporting of unexpected conditions where regulator advice on the appropriate mitigation measures may be sought.
  - Reporting of incidents to SRT and DER as per Section 15.0 where there is potential for environmental harm and corrective action is required.
- Coordinate the completion and Contaminated Site Auditor review of the contamination investigation reports to the satisfaction of DER.
- Regularly review and audit the Lead Contractor(s) performance against the Project EMP, Environmental Sub-Management Plans and their CEMP and take corrective action as necessary.
- Ensure the environmental processes involved in the development of the transport infrastructure complement that of the Stadium and Sports Precinct.

5.2.2 Strategic Project's Environmental Manager

The key responsibilities for SP's Environmental Manager include:

- Provide environmental advice and support to SP during the PCS Works and Stadium Works Construction Phases of the Project.
- Coordinate and manage contractors engaged to undertake environmental and contamination investigations on behalf of SP where required.
- Being the first point of contact for the Lead Contractor(s) to report environmental incidents and provide assistance to SP in resolving incidents occurring on site.

- Have the power to stop work on site where necessary due to foreseen environmental risks.
- Review and assess the Lead Contractor(s)' environmental monitoring procedures, results and monthly compliance reports.
- Conduct environmental audits to assess the Lead Contractor(s)' compliance with the Project EMP, Environmental Sub-Management Plans and their CEMP.
- Seek input from SP's Environmental Advisors being specialist technical consultancies, where required.

5.3 Lead Contractor(s) (Construction Phase)

5.3.1 General

The key general responsibilities for the Lead Contractor(s) include:

- Establish, implement, maintain and continuously improve a CEMP and any other necessary environmental documentation in accordance with the Project EMP and Environmental Sub-Management Plans.
- Conduct internal environmental audits to assess conformance with the Project EMP, Environmental Sub-management Plans and CEMP.
- Obtain relevant work specific environmental approvals, licences and permits prior to commencing certain works.
- Ensure that prior to commencement of work; subcontractors have complied with the relevant requirements of the Project EMP, Environmental Sub-Management Plans and CEMP.
- Regularly review subcontractors' performance against the requirements of the CEMP and take corrective action as necessary.
- Establish and maintain open and effective communications with stakeholders and SP as required.
- Ensure suitably qualified environmental specialists provide input into the development of the CEMP and any other environmental documentation.
- Undertake monitoring for the various environmental aspects as outlined in the Project EMP, Environmental Sub-Management Plans and the Lead Contractor's CEMP.

5.3.2 Lead Contractor's Construction Manager

The key responsibilities for the Lead Contractor's Construction Manager include:

- Supervising the on-site construction workforce.
- Ensuring that the requirements of this Project EMP and associated sub-plans are met, including the management measures.
- Ensuring that the appropriate level of training has been provided to all site staff to minimise environmental impacts from Project works and contamination.
- Informing SP's Environmental Manager of any environmental incidents.
- Ensuring the Lead Contractor's workforce responds to environmental incidents and implements the corrective actions detailed in the investigation report.
- Stopping work where it is deemed necessary to do so in order to prevent/manage an environmental incident or injury.

5.3.3 Lead Contractor's Environmental Representative

The key responsibilities for the Lead Contractor's Environmental Representative include:

- Identifying and reporting environmental incidents to the Lead Contractor's Construction Manager.
- Completing environmental monitoring, auditing, environmental reporting and compliance reports.
- Implementing environmental initiatives.
- Working with the Lead Contactor's Construction Manager to implement all EMPs, Environmental Sub-Management Plans and CEMP.
- Communicating environmental issues with the SP Environmental Manager where required.
- Have the power to stop work on site where necessary due to foreseen environmental risks.

5.4 Lead Contractor(s) (Operating Phase)

The key responsibilities for the Operating Phase Lead Contractor(s) body include:

- Establish, implement, maintain and continuously improve an OEMP and any other necessary environmental documentation in accordance with the Project EMP and relevant Environmental Sub-Management Plans.
- Conduct internal environmental audits to assess conformance with the Project EMP, Environmental Sub-Management Plans and OEMP.
- Obtain relevant work specific environmental approvals, licences and permits prior to commencing certain works.
- Ensure that prior to commencement of work; subcontractors have complied with the relevant requirements of the Project EMP, Environmental Sub-Management Plans and OEMP.
- Regularly review subcontractors' performance against the requirements of the OEMP and take corrective action as necessary.

5.5 Contaminated Sites Auditor

A DER accredited Contaminated Sites Auditor has been appointed for the Project. The Contaminated Sites Auditor's role is to review and provide feedback on the contamination investigation and management of the site in accordance with the *Contaminated Sites Act 2003*. All contamination non-conformance issues are to be recorded in the non-conformance register as described in Section 15.0. SP is to report non-conformances or environmental incidents to the Contaminated Sites Auditor as outlined in Section 15.0. The Contaminated Sites Auditor will have the power to stop work on site if the environment or sensitive receptors are at risk and can review parameters required to rectify the environmental non-conformance. Information (e.g. site records, registers and monitoring results etc.) must be made available to the Contaminated Sites Auditor at his request. Monthly soil and water quality data monitoring results will be provided to the Contaminated Sites Auditor for review.

The Contaminated Sites Auditor will be involved in the Project up to site classification or re-classification (under the *Contaminated Sites Act 2003*). Once the site has been demonstrated to be suitable for the proposed land use with no unacceptable risks to human health or the environment resulting from this land use, the Contaminated Sites Auditor will make a recommendation to DER to classify/re-classify the site. On classification/re-classification of the site, regulation of the Project will be adopted by the relevant regulatory agencies.

6.0 ENVIRONMENTAL MANAGEMENT OBJECTIVES

The environmental management objectives for the Project are to:

- Minimise and manage the environmental and social impacts arising from Project works.
- Manage impacts to the Swan River and other ecosystems surrounding the Project area.
- Maintain and enhance the health, amenity and landscape values of the Swan River in accordance with State Planning Policy 2.10 Swan-Canning River System (SPP 2.10), where practicable.
- Manage contamination including monitoring of groundwater, surface water, soil, air and ground gas during the Construction Phase of the Project and into the Operating Phase in accordance with the *Contaminated Sites Act 2003* and the DER *Contaminated Sites Management Series.*
- Undertake and manage rehabilitation of the Project as per the Rehabilitation Management Plan.
- Minimise and manage impacts to indigenous or otherwise protected fauna that may visit the site, including protection of the remaining fauna habitats.
- Promote a stable vegetation community with local species through rehabilitation.
- Implement environmental management practices to manage environmental and social impacts resulting from the Project.
- Manage emissions (including air and noise) so they do not adversely affect environment values or the health, welfare and amenity of people and land uses.
- Protect Indigenous and European heritage sites from impacts during the Construction Phase of the Project.
- Minimisation of waste through the adoption of best practice waste reduction and disposal procedures consistent with the EPA waste hierarchy.

7.0 CONSTRUCTION PHASE ENVIRONMENTAL IMPACTS, MANAGEMENT AND MONITORING

7.1 Overview

An EMF has been developed for each phase of the Project and the content used to develop this Project EMP. The Lead Contractor(s) engaged for the Construction Phase of the Project are required to prepare a CEMP applicable to their specific works and operations based on the content of the CEMF, this Project EMP and the Environmental Sub-Management Plans.

The Lead Contractor(s) are required to conduct phase specific risk assessments for each environmental and social factor and receptor to identify phase specific predicted environmental and social impacts.
The outcomes of this will be used as the basis for the development of the content of the Lead Contractor's CEMP. The Lead Contractor(s) will be required to prepare and maintain "an aspects and impacts" register as part of their CEMP. The CEMP will also include plans showing locations of important features of the environmental management systems, including the location of:

- Waste storage areas
- Locations of spill kits
- Vehicle laydown areas
- Site access points

- Public access areas
- Vehicle/wheel wash-down areas
- Re-infiltration areas.

The environmental commitments have been drafted based on regulatory requirements, baseline studies completed, and discussions held during the working groups and with the regulatory stakeholders. Potential contingency actions listed are minimum requirements and are not exhaustive. As the project progresses, additional environmental issues may be identified or unplanned contingencies occur which require alternate environmental management measures.

Monitoring procedures will be approved by SP prior to being implemented and SP will engage the regulatory agencies to review the monitoring procedures to ensure their requirements are met.

7.2 Terrestrial Flora and Fauna Management Plan

7.2.1 Management Objectives

The EPA objectives for flora and vegetation are to maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts, and for an improvement in knowledge (EPA, 2010a).

The Project's ecological management objectives are to maintain site terrestrial ecological values during the Construction Phase primarily by:

- Minimise and manage impacts on flora and vegetation not cleared for site works.
- Minimise and manage impacts to indigenous or otherwise protected fauna that are located on site, including the protection of remaining fauna habitats.
- Minimise the area of ground disturbance.
- Promote the growth of local species and a stable vegetation community through rehabilitation and maintenance of preserved areas.

7.2.2 Limits and Targets

All terrestrial fauna and flora shall be managed and protected in accordance with the following legislation:

- *Wildlife Conservation Act 1950* (WA)
- *Environmental Protection Act 1986* (WA), and
- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Broad guidance for managing risk to site flora communities is also provided by the following EPA guidance statements and State Planning Policy:

- EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA, 2000).
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002a).
- EPA Guidance Statement No. 6: Guidance for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems and for terrestrial fauna (EPA, 2006).
- EPA Guidance Statement No 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a).

- EPA and DEC Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. (eds. B.M. Hyder, J.Dell, M.A. Cowan) Perth, WA. (EPA, 2010b).
- *State Planning Policy 2.10 Swan Canning River System* (WAPC, 2006).

7.2.3 Potential Environmental Impacts

Potential negative effects of the Project to terrestrial flora and fauna during the Construction Phase may be through the following impacts:

- Direct loss of native vegetation abundance and biodiversity due to the clearing of vegetation within the Project area.
- Direct and indirect loss of fauna abundance and biodiversity through habitat and food source losses resulting from vegetation clearance.
- Loss of faunal habitat movement corridors leading to difficulty for animals to access feeding and breeding areas.
- Indirect impacts to flora due to the alteration in hydrology and water quality of shallow groundwater project dewatering activities.
- Direct impacts to vegetation and fauna habitat due to contamination risks associated with use of chemicals, and fuel spills from machinery.
- Noise disturbances to terrestrial fauna from project tools and machinery and vibration impacts as a result of machinery operation and other preconstruction and construction related operational noise (see noise and vibration management in Section 7.7).
- Impacts associated with excessive light if night works are proposed.
- Smothering of vegetation foliage from dust mobilised through excavation and other soil disturbances.
- Introduction of plant and animal pests.
- Introduction of soil pathogens such as *Phytophthora* spp.
- Edge effects resulting from decreased vegetation plot size reducing plot community resilience to stressors such as wind and heat.

7.2.4 Management Measures

The Lead Contractor's Environmental Representative is to be the principal point of advice in relation to the flora and fauna protection performance of the Project. They will have responsibility for helping achieve Project environmental objectives by considering and advising SP on matters requiring immediate attention and to direct that relevant actions be ceased immediately should adverse, or potentially adverse, environmental effects occur.

The Lead Contractor's Environmental Representative is to be on site during vegetation clearance. Visual monitoring and recording of any indigenous or otherwise protected avian fauna species sighting known to the area is to be undertaken, including the threatened Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso)* and the threatened Carnaby's Black Cockatoo (*Calyptorhynchus latirostris).*

Management measures to be taken by the Lead Contractor(s) to reduce or negate impacts to terrestrial flora and fauna during the Construction Phase are as follows:

- Maintain a buffer zone preserving riparian vegetation along the Swan River and around the River-fed Lake to minimise erosion, maintain bank stability and maintain habitat for terrestrial fauna by installing a fence to prevent disturbance and access into this area.

- Prevent or mitigate dust emissions impacts to flora and fauna by implementing the air quality management measures listed in Section 7.6.
- Prevent or mitigate noise and vibration impacts to flora and fauna by implementing the noise and vibration management measures listed in Section 7.6.5.1.
- Prevent or mitigate light disturbance to flora and fauna by implementing the visual amenity management measures listed in Section 7.8.
- Stage flora and vegetation clearing to the minimum necessary, where practicable.
- Retention and protection of the River-fed Lake (Figure 3) connected to the Swan River to maintain habitat for fish and local waterfowl as well as habitat for any migratory birds that utilise the Project area.
- Manage contamination to land, groundwater and surface water by implementing the waste management measures listed in Section 7.11 (which include a spill clean-up and remediation procedure), and in the CSMP (Golder, 2013a).
- Construct a fence around the Project area to keep activities and vehicle movements within a designated area and discourage terrestrial fauna from entering. Ensure this fence can remain in place for the duration of the Project until the Operating Phase.
- Maintain a photographic register of vegetation within close proximity to the project area to establish a record of baseline vegetation conditions.
- Implement an awareness program as part of the inductions to educate all personnel on the indigenous or otherwise protected fauna species and their habitats identified on and around the Project area and the related management measures. This induction should also cover potential risks from Construction Phase activities to these fauna and the related management measures required to mitigate these. Include recently identified fauna species in daily pre-work toolbox meetings.
- Implement any specific conditions applied to the Project by regulatory authorities.

7.2.5 Monitoring Procedures

Fauna monitoring will be conducted as part of daily environmental checks and inspections (see Appendix A for the Daily Environmental Inspection Checklist).

Monitoring procedures will include a daily site walk around (within the Project area) at the start of each morning to check for injured fauna or for fauna that may have become entrapped in fences and trenches/pits. If any fauna are found to be trapped, a suitably qualified fauna handler will be contacted to rescue the animal and provide treatment if required. All recorded observations of injured or trapped terrestrial fauna will be provided to SP for long term monitoring requirements.

The condition of any retained vegetation around the site will also be made at the same time. A weekly appraisal will be made of woody vegetation health around the immediate Project area. Decline of health as reflected by loss of leaves and any direct injury or damage will be noted and reported.

Any observations of fauna or flora damage or injury will be recorded and submitted weekly to the SP's Environmental Manager by the Lead Contractor's Environmental Representative. Any adverse environmental impacts to fauna or flora will be noted, reported and documented and then managed according to the management measures outlined in the Lead Contractor's CEMP and approved by SP.

Management actions to prevent the re-occurrence of these events should be then determined.

Indications of spills, leaks and unexpected/unauthorised discharges should also be noted at this time and then addressed.

At all times staff will be guided to complete regular visual monitoring and recording of any sightings of indigenous or otherwise protected or threatened fauna species known to the Project area such as avian species including the threatened Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) and the threatened Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*). A description of the appearance and call of these species should be covered in the environmental inductions.

7.2.6 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Potential contingency actions to be taken by the Lead Contractor(s) for the management of potential terrestrial flora and fauna impact triggers include, but are not limited to those outlined in Table 2.

Table 2: Contingency Actions for the Terrestrial Flora and Fauna Management Plan

Trigger	Potential Actions
A weed outbreak occurs on site	■ Review weed hygiene management procedures, which will include hand removal, spraying, etc. (to be developed by the Lead Contractor in the CEMP). ■ Develop and implement an appropriate weed management procedure.
Condition of any vegetation in close proximity to the Project area declines in comparison to baseline conditions.	■ Increase vegetation-monitoring frequency to detect if vegetation condition is within natural fluctuation or is further declining. ■ Review groundwater level and quality monitoring data and compare with vegetation condition parameters. ■ If groundwater conditions indicate that there is potential for impact to vegetation, investigate supplying vegetation with water until the groundwater level/quality returns to background levels. ■ If it does not appear that a change in groundwater conditions is the cause of the decline, then investigate alternative causes for the decline e.g. dust impacts, biological infestation. ■ Undertake rehabilitation activities in affected area (e.g. revegetation with local provenance species, if practicable).
Vegetation in close proximity to the Project area shows a build-up of dust on leaf surfaces.	■ Relocate the watering truck used for dust suppression to the relevant site and spray vegetation to remove dust particles.
An incidence of death or injury to conservation significant fauna occurs within the Project area due to Project Construction Phase works.	■ SP to advise DER. ■ Collect or capture dead/injured fauna and treat or preserve specimen based on DER advice. ■ Investigate mitigation measures in consultation with the DER.
Individuals or populations of species of conservation significance are at risk from Construction works	■ SP to advise DER. ■ Investigate relocation of populations and species in consultation with the DER.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.3 Aquatic Flora and Fauna Management Plan

7.3.1 Management Objectives

The EPA objective for fauna is to maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge (EPA, 2010a).

The EPA objective for wetlands (including rivers) is to maintain the integrity, ecological functions and environmental values of wetlands (EPA, 2010a).

The EPA objective for surface water and groundwater is to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are maintained (EPA, 2010a).

The Project's ecological management objectives to maintain site aquatic ecological values during the Construction Phase are:

- Minimise and manage the impacts to aquatic fauna and flora located around the Project area.
- Minimise and manage the impacts to aquatic fauna in the remaining constructed Lakes and in the Swan River.
- Minimise and manage the impacts on aquatic vegetation not requiring clearing for site works.

7.3.2 Limits and Targets

All aquatic fauna shall be managed and protected in accordance with the following legislation:

- *Wildlife Conservation Act 1950 (WA)*
- *Environmental Protection Act 1986* (WA)
- *Swan and Canning Rivers Management Act 2006.*
- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Given the amphibious nature of much of the site and the highest environmental values associated with these are aquatic habitats, the primary guidance for managing environmental risk to site ecological communities are the following documents:

- EPA Position Statement No. 4: Environmental Protection of Wetlands (EPA 2004b).
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002).
- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000a).

Due to the heavily disturbed nature of the site (Golder, 2012c), most Project area aquatic values are associated with waterfowl, some species of fish and oblong turtles.

7.3.3 Potential Environmental Impacts

Potential environmental impacts of the Project during the Construction Phase to aquatic fauna and flora are as follows:

- Direct loss of native vegetation abundance and biodiversity due to the clearing of aquatic vegetation within the Project area, including riparian vegetation with the removal/infill of lake habitats.

- Indirect loss of aquatic vegetation abundance and biodiversity through vehicle movements and excavation activity damaging vegetation.
- Bank sediment and riparian vegetation loss from the Swan River banks resulting from erosion in this area.
- Erosion of materials on site during rainfall events leading to deposition of sediments into lakes and the River.
- Local aquatic fauna habitat loss leading to short-term unsustainable population persistence for species dependant on these habitats e.g. waterfowl.
- Loss of faunal habitat movement corridors along the River leading to difficulty for animals to migrate and access feeding and breeding areas.
- Indirect impacts to aquatic fauna populations in the Project area due to removal of habitat/food sources and removal of aquatic ecosystems with the removal/infill of lake habitats.
- Indirect impacts to aquatic vegetation due to the alteration in hydrology and water quality of shallow groundwater project dewatering activities.
- Direct impacts to aquatic habitats due to contamination risks associated with use of chemicals, and fuel spills from machinery.
- Noise disturbances to aquatic fauna from Project tools and machinery and vibration impacts as a result of machinery operation and other preconstruction and construction related operational noise (see air quality Section 7.6 and noise and vibration Section 7.6.5.1).
- Smothering of aquatic foliage from dust mobilised through excavation and other soil disturbances.
- Introduction of aquatic flora and fauna pests.
- Introduction of soil pathogens such as *Phytophthora* spp.
- Indirect impacts to water bodies through mobilisation of landfill contaminants into groundwater and then to surface water receiving bodies, impacting water quality and therefore fauna habitat.
- Increased nutrient loading from water discharges contributing to eutrophication and toxic algal blooms in constructed lakes and the Swan River.

Note: Vibrations from onshore ground improvement and piling works associated with the PCS Works and Stadium Works are considered to have a negligible impact on marine mammals due to attenuation within soils and setback distances from the Swan River.

7.3.4 Management Measures

The Lead Contractor's Environmental Representative must be on site during draining or infilling of constructed lakes to:

- Undertake targeted capture and relocation as required
- Provide management advice in the event that threatened species are discovered, and
- Provide ongoing advice in relation to aquatic fauna management issues.

Management measures to be taken by the Lead Contractor(s) to reduce or negate impacts to Project area aquatic flora and fauna during the Construction Phase include:

- Limiting infill and dewatering activities to the minimum areas necessary.

- Implementation of a catch and relocation program for any conservation or ecologically significant aquatic vertebrate fauna (if any) inhabiting the Project area constructed lakes. The program will focus on trapping fish and turtles that might inhabit the Irrigation Lake proposed for infill as outlined in the Bamford Survey (2012) and the Aquatic Fauna Survey (Golder, 2012d).
- Undertake groundwater and surface water management measures and monitoring procedures as outlined in Sections 7.4 and 7.5 and as per the CSMP (Golder, 2013a) to manage impacts to groundwater and surface water which provide habitat to dependent aquatic flora and fauna.
- Avoidance of clearing or infilling lake habitats during the months known to host breeding avian fauna (October to April (Halse & Jaensch, 1989)).
- No transference of feral fish populations from the Irrigation Lake to the Swan River or the River-fed Lake during infilling activities.
- Maintain a buffer zone preserving riparian vegetation between the Swan River and the River-fed Lake to minimise erosion, maintain bank stability and maintain habitat for aquatic fauna by installing a fence to prevent disturbance and access into this area.
- Retention and protection of the River-fed Lake (Figure 3) connected to the Swan River to maintain habitat for fish and local waterfowl that utilise the Project area, including prohibition of fishing in the River-fed Lake.
- Construction of a fence around the Project area to keep activities and vehicle movements within a designated area and discourage waterfowl from entering. Ensure this fence can remain in place for the duration of the Project until the Operating Phase.
- Manage contamination to land, groundwater and surface water and spills and contamination risks, potentially impacting vegetation, by implementing the waste management measures listed in Sections 7.4 and 7.5 which include spill clean-up and remediation procedures.
- Prevent or mitigate dust emissions impacts to aquatic flora and fauna, specifically to the River-fed Lake and the Swan River by implementing the air quality management measures listed in Section 7.6.
- Prevent or mitigate noise and vibration impacts to aquatic fauna by implementing the noise and vibration management measures listed in Section 7.6.5.1.
- Maintain a photographic register of vegetation within close proximity to the project area to establish a record of baseline vegetation conditions.
- Implement an awareness program as part of the inductions to educate all personnel on the potential presence of indigenous or otherwise protected fauna, including species of waterfowl and other significant aquatic fauna and their habitats identified on and around the Project area. This induction should also cover potential risks from Construction Phase activities to these fauna and the related management measures required to mitigate these. Include recently identified fauna species in daily pre-work toolbox meetings.
- Implementation of any specific conditions applied to the Project by regulatory agencies.

7.3.5 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor(s).

Aquatic fauna monitoring for waterfowl and any other significant fauna such as frogs and turtles will be conducted as part of daily environmental checks and inspections (see Appendix A for the Daily Construction Environmental Inspection Checklist).

Aquatic monitoring procedures will include a daily site walk around the River-fed Lake and the Swan River foreshore (within the Project area) at the start of each morning for injured or trapped fauna. If any fauna are found to be trapped, a suitably qualified fauna handler should be contacted to rescue the animal and provide treatment if required.

Indications of spills, leaks and unexpected/unauthorised discharges should also be made at this time e.g. through observations of discharge or slicks on the water bodies. General water quality should be observed and excessive algal blooms and the presence of any odours also recorded. High rates or significant individual erosion events will also be noted.

Any observations of fauna or riparian vegetation damage or injury shall be recorded and submitted weekly to SP's Environmental Manager by the Lead Contractor' Environmental Representative. All recorded observations of injured or trapped terrestrial fauna will be provided to SP for long term monitoring requirements.

Decline of vegetation health as reflected by deteriorating condition such as loss of leaves and any direct injury or damage will be noted and reported. Any adverse environmental impacts to fauna or flora will be noted, reported and documented, and then managed according to the management measures outlined in the Lead Contractor's CEMP and approved by SP. Management actions to prevent the re-occurrence of fauna/flora injury and unexpected erosion events should be then discussed and developed.

Further monitoring will be provided by staff being required to complete regular visual monitoring and recording of any indigenous or otherwise protected or threatened fauna species sighting known to the Project area such as avian species including the migratory Common Sandpiper (*Tringa hypoleucos*) and Caspian Tern (*Hydroprogne caspia)*. A description of the physical appearance and call of these species should be covered in the environmental inductions.

7.3.6 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) for the management of potential aquatic flora and fauna impact triggers include, but are not limited to those outlined in Table 3.

Table 3: Contingency Actions the Aquatic Flora and Fauna Management Plan

Trigger	Potential Actions
Sediment plume or discharge is visually evident within the River-fed Lake or the Swan River.	■ SP to advise DER and SRT. ■ Investigate cause of sediment increase if sediment plume occurs within the retained lakes. ■ Check sediment traps, bunds and diversion drainage, and rectify cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area, if impact is as a result of Project works.
Condition of any aquatic vegetation remaining within Project area or in close proximity of the Project area declines in comparison to baseline conditions.	■ Increase aquatic vegetation-monitoring frequency to weekly to detect if vegetation condition is within natural fluctuation or is further declining ■ Compare aquatic vegetation condition parameters with surface water level and quality monitoring data. ■ If surface water conditions indicate that there is potential for impact to aquatic vegetation investigate adding/treating surface water until the surface water level/quality returns to background levels. ■ If it does not appear that a change in surface water conditions is the cause of the decline, then investigate alternative causes for the decline e.g. dust impacts, disease outbreak. ■ Undertake rehabilitation activities in affected area (e.g. re-vegetation with local provenance species, if practicable).
Aquatic vegetation remaining within the Project area or in close proximity of the Project area shows a build-up of dust on leaf surfaces.	■ Relocate the watering truck used for dust suppression to the relevant site and spray vegetation to remove dust particles.
An incidence of Fishkill* occurs within the Swan River or the River-fed Lake.	■ SP to advise DER and SRT. ■ Identify any sources of contamination if Fishkill occurs in retained lakes. ■ Investigate mitigation measures in consultation with the DER and SRT.
Individuals or populations of species of conservation significance within the River-fed Lake are at risk from Construction works.	■ SP to advise DER. ■ Investigate relocation of populations and species in consultation with the DER and/or Contaminated Site Auditor (if impacts due to contamination).
Erosion of the riparian environment of the River-fed Lake or the Swan River is visually worse than background levels.	■ SP to advise DER and SRT. ■ Investigate the cause of erosion. ■ If the change is due to Project works and is an activity that can be modified, remove the cause as appropriate.

* - "In the event of a fish kill, SP and the SRT are to be notified immediately. SRT emergency incident response contact details are 9278 0900 or 0419 192 845 (after hours).

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.4 Surface Water Management Plan

7.4.1 Management Objectives

The EPA (2010a) objectives for water and water quality (including surface and groundwater) are to:

- Maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- Emissions are to not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

The Projects environmental objectives to maintain surface and groundwater quality during the Construction Phase are to:

- Protect the ecosystem surrounding the Project area.
- Emissions are to not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Minimise and manage potential impacts to the quality of surface water and groundwater resources caused by the Construction Phase.
- Maximise the efficient use of water for the Project.
- Ensure the continued use of water resources.

7.4.2 Limits and Targets

The guidance trigger levels employed for surface water are the:

- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000a).
- *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* (Department of Health, 2011).
- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Long-term Irrigation Water Protection* (ANZECC/ARMCANZ, 2000b).
- Swan River Trust Guidelines.

Appendix B outlines the values of the guidance trigger levels as per the guidance material listed above.

ANZECC guidelines for estuary ecosystem types are the water quality trigger levels that have been applied to the Swan River due to its saline nature. The constructed lakes have been categorised as wetland ecosystem types, with the ANZECC guidelines for this category applied as the surface water quality trigger levels. Where estuarine or wetland guidelines are not available, the lowest/most conservative of the ANZECC freshwater and marine guideline values have been applied. Where ANZECC freshwater or marine guidelines have not been available, the following guidelines have been applied, in order of priority:

- Domestic non-potable water use guidelines (DOH, 2011).
- Long-term irrigation water protection guidelines (ANZECC/ARMCANZ, 2000b).

Table 4 provides the guideline trigger values for chemical stressors that can be applied to the Swan River. Trigger levels such as those in Table 4, provide baseline environmental data that can be used in monitoring to assess water quality and identify potential contaminants within a surface water body. The intent of trigger values is to protect aquatic ecosystems from degradation by maintaining current water quality.

Table 4: Trigger Values for Reporting Chemical Stressors in the Swan River and in the River-fed Lake^

Water Quality Indicator	Trigger Value
Chl a*	0.003
Total Phosphorus (TP) Ω	0.01
Free Reactive Phosphorus (FRP)*	0.005
Total Nitrogen Ω	1
Nitrogen oxides (NO_x)*	0.045
Ammonia (NH_4)*	0.04
Dissolved oxygen (DO) (% saturation)*	90-110
pH (pH units)*	7.5-8.5
Turbidity (NTU)Ω	≤10% increase above a defined upstream reference site, or no visible reduction in colour or light penetration of the receiving environment.
Salinity (as TDS)Ω	≤10% increase above a defined upstream reference site.
Temperature	≤10% increase above a defined upstream reference site.
Other contaminantsΩ	As per ANZECC Guidelines for freshwater or marine water ecosystems. Minimum 95% protection level to be used.

^ All values are in mg/L unless otherwise stated.
* Default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed ecosystems – Estuaries (ANZECC/ARMCANZ, 2000a)
Ω Swan River acceptable water quality (SRT, 2000).

Trigger values for reporting chemical stressors in the Irrigation Lake have not been included as one of the first tasks in the planned PCS Works is to fill in this lake.

Trigger levels such as those in Table 4, provide baseline environmental data that can be used in monitoring to assess water quality and identify potential contaminants within a surface water body. Where independent environmental baseline monitoring data suggests deviation from the guideline trigger levels and the presence of contaminants prior to works, the use of the guideline trigger levels is limited. A full list of toxicants and trigger levels for surface water at both a 95% and 80% level of protection as outlined in the ANZECC Guidelines (ANZECC/ARMCANZ, 2000a) is provided as Appendix B. Monitoring results will also be compared against site specific baseline monitoring data to identify any trends in water quality degradation.

As per the ANZECC/ARMCANZ (2000a) classification methodology, the protection level for the Swan River has been set at 95%. Although the River is a significant icon in Perth and Western Australia it has been significantly impacted upon by salinisation and agriculture in its upper catchments and urbanisation in its lower catchments selectively reducing the diversity of aquatic species requiring protection.

7.4.3 Potential Environmental Impacts

The potential impacts of the Project during the Construction Phase to surface water are:

- Disturbance to aquatic ecosystems due to the removal/infill of lake habitats.
- Alteration in hydrology and hydrogeology of underlying aquifer(s), estuaries, lakes and the Swan River environments as a result of disturbance to groundwater surface water connectivity.

- Impacts to water quality due to landfill contaminants and leachate seeping into the groundwater and surface water bodies.
- Indirect surface water contamination risks associated with the Construction Phase of the Project operating adjacent to a lake and river environment due to chemical and fuel spills, unmanaged stormwater flows and run-off.
- Dust build up on and in surface water due to dust emissions as a result of the removal of flora and exposure of underlying soil.

7.4.4 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise impacts to surface water during the Construction Phase are:

- Maintain a buffer zone preserving riparian vegetation along the Swan River and around the River-fed the River-fed Lake to minimise erosion, maintain bank stability and maintain habitat for terrestrial and aquatic fauna by installing a fence to prevent disturbance and access into this area.
- Control of contamination to land, groundwater and surface water due to spills and contamination risks, potentially impacting on the Swan River and remaining artificial lake sites by implementing the waste management measures as outlined in Section 7.4.4 and in the CSMP (Golder, 2013a).
- Retention and protection of the River-fed Lake (Figure 3) connected to the Swan River to maintain habitat for fish and local waterfowl that utilise the Project area.
- Development and implementation of a surface water monitoring program to monitor for any adverse impacts on the Swan River as per Section 7.4 and the CSMP (Golder, 2013a).
- Manage stormwater and other discharges to prevent flow into the River-fed Lake, to reduce potential impacts to the Swan River.
- Appropriately manage the wheel wash facility to minimise the impact on environment.
- Design and implementation of an appropriate stormwater capture and disposal program by the PCS Works Contractor, based on specific site works, including measures such as:
  - Deviation of stormwater around infrastructure to specified, bunded collection points.
  - Direction of stormwater to stormwater collection drains/sewer.
  - Prevention of stormwater pooling.
  - Prevention of stormwater flow near surface water bodies.
  - Location and design of bulk fuel and chemical storage facilities.
  - Water conservation.
  - Measures to prevent erosion.
  - Measures to control sediment transport.

- Preparation and implementation of a separate Stormwater Management Plan by the Stadium Works Lead Contractor, prior to commencement of site works, taking into consideration the following policies and guidelines:
  - State Planning Policy 2.9 *Water Resources* (WAPC, 2006)
  - State Planning Policy 2.10 *Swan-Canning River System* (WAPC, 2006)
  - Better Urban Water Management (WAPC, 2008)
  - Stormwater Management Manual for Western Australia (DOW, 2004-07)
- The Stormwater Management Plan developed by the Lead Contractor will be provided to SRT and DOW for comment and review.
- Should the water quality of stormwater be suitable, consideration should be given to the reuse of stormwater where appropriate, such as for dust suppression.
- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of protecting the Swan River, the River-fed Lake and the related management measures. This induction shall also cover potential risks from Construction Phase activities to these habitats and the related management measures required to mitigate these. Include recently identified surface water management issues in daily pre-work toolbox meetings.
- Implementation of any specific conditions applied to the Project by regulatory agencies.
- Construction Phase activities will be conducted in accordance with the Dewatering Management Plan (DMP) (Golder, 2012e) and CSMP (Golder, 2013a) to manage hydrology and hydrogeology impacts and related indirect impacts to surface water bodies.
- Prevent or mitigate dust emissions impacts indirectly impacting surface water quality by implementing the air quality management measures listed in Section 7.6.

7.4.5 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor(s).

Surface water monitoring will determine water quality and any potential impacts to the Swan River or other surface water bodies (such as the River-fed Lake) due to Construction Phase works. Surface water monitoring will be conducted with reference to the trigger levels in Section 7.4.2 where practicable and at least include the parameters listed in Table 5.

Monitoring locations will be established at the connection of the River-fed Lake and the Swan River, and in the Swan River (including in proximity to the discharge point from the River-fed Lake). Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in the Golder (2012f).

Table 5: Surface Water Quality Monitoring Parameters - Minimum Requirements

Parameter	Sampling Frequency	
	Retained Lakes	Swan River
Field monitoring		
Salinity	Twice weekly	Twice weekly
pH	Twice weekly	Twice weekly
Electrical conductivity/total dissolved solids (TDS)	Twice weekly	Twice weekly
Dissolved oxygen (mg/L and % saturation)	Twice weekly	Twice weekly
Temperature	Twice weekly	Twice weekly
Chlorophyll a	Twice weekly	Twice weekly
Oxidation-Reduction Potential	Twice weekly	Twice weekly
Laboratory analyses		
Total petroleum hydrocarbons (TPH)	Weekly	Weekly
Nutrients (carbon, nitrogen and phosphorus as dissolved totals and fractions (FRP, NOx, NH_3)	Weekly	Weekly
Dissolved elements (As, Al, B, Ca, Cl, Cr, Cd, Co, Cu, Fe, Hg, Mg, Mn, Mo, Ni, Pb, S, Se, Sn, Zn)	Weekly	Weekly
Alkalinity and SO_4	Weekly	Weekly
Total metals (Fe and Al)	Weekly	Weekly
Total suspended solids (TSS)	Weekly	Weekly

Should assessment of the results from the above laboratory analytes suggest an increase in concentrations of contaminants, then consideration should be given to including the analysis of the following contaminants:

Parameter	Sampling Frequency	
	Retained Lakes	Swan River
Organochlorine and organophosphate pesticides	Fortnightly	Fortnightly
Polycyclic aromatic hydrocarbons (including naphthalene)	Fortnightly	Fortnightly

Results of surface water quality field monitoring may trigger additional water sampling and laboratory analysis, should a perceived risk due to a change in observed trends be assessed. Laboratory analyses will be undertaken by a NATA accredited laboratory.

Surface water monitoring requirements will be reviewed based on the baseline results summarised in the DSI (Golder, 2013b) and each round of monitoring data. Laboratory analysis results may impact the surface water monitoring plan with respect to variations in frequency, sampling locations, number of locations and analytes monitored.

Any adverse environmental impacts to surface water quality identified as a result of monitoring will be managed according to the management measures outlined in this Project EMP and the CSMP (Golder, 2013a).

All data collected will be provided to SP for long term monitoring requirements.

7.4.6 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Potential Contingency actions to be taken by the Lead Contractor(s) for the management of potential surface water impact triggers include, but are not limited to those outlined in Table 6.

Table 6: Contingency Actions for the Surface Water Management Plan

Trigger	Potential Actions
Runoff from stockpiles of contaminated soil or Acid Sulfate Soil flows into undisturbed areas or surface water bodies (e.g. the Swan River, the River-fed Lake).	■ SP to advise DER. ■ Confirm that risk assessment is still valid. ■ Mitigate spill area and alter stockpile bund design accordingly to prevent from reoccurring.
Contaminated surface water is discharged to the surrounding environment.	■ SP to advise DER. ■ Confirm that risk assessment is still valid. ■ Prevent further flow of contaminated water to the surrounding environment. ■ Remove/stop the source of contamination.
Surface water quality is in exceedance of trigger values.	■ Identify source of water quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate.
Sediment plume or discharge is visually evident downstream of a disturbed area.	■ SP to advise DER and SRT ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area.
Surface water in the River-fed Lake or in the Swan River is visually impacted by dust or contains large volumes of sediment due to dust emissions.	■ Increase application of water to dusty areas by either increasing the frequency of watering truck applications or increasing the number of water trucks. ■ Stop work until weather and wind conditions improve.
Storm water system is blocked and/or overflowing.	■ Identify location and source of blockage. ■ Remove blockage. ■ Clean-up spilt or pooling storm water as required.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.5 Groundwater Management Plan

7.5.1 Groundwater Quality

An environmental investigation has been undertaken for the site, which included groundwater sampling, and the results of these investigations should be consulted for a more thorough understanding of groundwater quality at the site (Golder, 2013b).

Groundwater salinity (Total Dissolved Solids) at the site varies across the three main geological units and with distance from the Swan River, with varying degrees of saline groundwater intrusion:

- Fill: Average = 3 400 mg/L with ranges from 600 mg/L to 15 200 mg/L
- SRA: Average = 9 200 mg/L with ranges from 1 500 mg/L to 17 000 mg/L
- SCD: Average = 2 000 mg/L with from 400 mg/L to 4 700 mg/L.

The above values indicate that the SCD has the lowest salinity and that groundwater in the fill is relatively fresh as well. Groundwater within the SRA had widely variable salinity.

Laboratory test results for groundwater sampling across the site installed in the three different lithological units indicate that:

- pH is generally neutral to slightly basic across all units.
- Total Dissolved Solids (TDS) values in the range 400 mg/L in BH03SCD to 17 000 mg/L in BH01.
- Metals including aluminium, boron, cadmium, copper, iron, manganese, nickel, selenium, and zinc were reported marginally above guideline levels in some samples.
- Nutrients including ammonia, nitrates, phosphorus and total nitrogen were detected at concentrations above assessment guidelines in groundwater. Ammonia concentrations exceeded the ANZECC (2000a) guideline for estuarine, marine and freshwater environments in the majority of samples. Total nitrogen and total phosphorus concentrations exceeded the SRT guideline in the majority of samples.
- Concentrations of total nitrogen and ammonia are highest in the SRA, with total nitrogen concentrations below the stadium playing field of 4 mg/L in the Fill, 26 mg/L in the SRA and 3 mg/L in the SCD.
- Hydrocarbon (TRH) and naphthalene were detected in some groundwater wells. The site history does not suggest the use of hydrocarbon fuels at the site and the DSI report (Golder 2013b) suggests a non-petroleum source (i.e. natural organic matter, organic rich waste) for the observed TRH concentrations in groundwater.

Results indicated groundwater samples were below detection limits for volatile organic compounds, PCBs, organochlorine and organophosphorus pesticides, selected herbicides, monocyclic aromatic hydrocarbons, phenols, and halogenated phenols. Polycyclic aromatic hydrocarbons were not reported above detection limits with the exception of naphthalene as discussed above.

7.5.2 Changes to Current Groundwater Situation

Based on proposed site works, two main changes to site conditions are planned that will affect the current groundwater situation at the site:

- Irrigation of the northern 9 golf course holes will cease, which would result in a long term decrease in groundwater levels and thereby groundwater flow into the Swan River.
- PCS Works, which will cause a temporary increase in groundwater level at the surcharge area, resulting in a temporary increase in groundwater flow towards the Swan River. The connectivity between the Fill and the SCD is also expected to be locally enhanced through the installation of wick drains.

The groundwater at the site is currently influenced by the irrigation at the northern 9 holes, which keeps the groundwater levels and flow in this area artificially high and at an almost constant level. When the irrigation ceases, the groundwater level and flow will decrease and start to fluctuate due to seasonal rainfall.

Engineered Fill is considered likely to be placed on the site and this Fill will impose a load on the sediments below it, leading to a rise in pore water pressure and expelling (“squeezing”) of groundwater out of compressible materials. This may result in a temporary rise in groundwater levels at the site and increased

groundwater flow from the site during the proposed construction period. The SRA will likely contain the most unconsolidated materials and expel the greatest amount of groundwater when loaded. Wick drains installed from the Fill through the SRA and into the SCD will decrease the required time for settlement and expulsion of groundwater.

Based on the preliminary conceptual design for the development, surcharging and wick drain installation is planned over an area of approximately 40 000 m^2. It is estimated that 80 000 kL of groundwater could be expelled as a result of settlement over that area, of which about 75 000 kL will be squeezed out during the first year. This would result in a temporary increase in groundwater flow from the SRA into the Fill and SCD units.

7.5.3 Hydraulic Connection of Superficial Aquifer Units

The Fill, SRA and SCD are already generally considered to be hydraulically connected and part of the same regional unconfined aquifer system. The Fill and SCD units are in direct contact at the eastern extent of the site but are separated by up to 25 m thickness of SRA at the western ends of the site. This geological sequence may allow for development of semi-confined conditions in the SCD unit, which is supported by the observed slight variation in hydraulic gradient from the eastern (downward gradient) to the western (upward gradient) portions of the site.

The groundwater modelling results indicate that the installation of the wick drains at the proposed stadium playing field would enhance the connectivity between the Fill and SCD across the surcharge area and thereby reduce the head differences between the Fill and the SCD. However, over the long term there will still be a downward flow in the easterly wick drains, but an upward flow in the westerly wick drains, suggesting no significant long term change to flow directions.

7.5.4 Groundwater Seepage to Swan River

Golder has undertaken groundwater modelling (Golder 2013c) to asses potential impacts that the planned changes could have on groundwater flows and quality entering the Swan River, and to assess if groundwater management would potentially be required. The groundwater model results indicate:

- Groundwater Flow[1]:
  - Current groundwater flow with irrigation into the Swan River ranges from 0.8 L/s to 1 L/s.
  - Cessation of golf course irrigation will result in a decrease of about 35% to 45% in groundwater flow into the Swan River from the site with long term groundwater flow ranging from approximately 0.4 L/s during the dry season to 0.8 L/s during the wet season.
  - Particles applied to the western boundary of the surcharge area in the groundwater model took more than two months to travel to the Swan River.
- Surcharging:
  - Of the total groundwater expelled from the SRA during the first year of surcharging (75 000 kL) approximately 25% (19 000 kL) will flow into the Fill unit and about 75% (56 000 kL) into the SCD unit.
  - The modelled peak groundwater flow rate into Swan River is 1.5 L/s with an average flow of 0.6 L/s. The average groundwater inflow over the surcharge year is slightly less than the current groundwater inflow, which is due to the cessation of the irrigation prior to start of surcharging.
- Nutrient Loads:
  - Given the higher total nitrogen in the SRA than in the Fill and SCD, the proposed surcharging would cause an increase in the total nitrogen concentration in the Fill and SCD.

[1] Flow rates presented represent total collective westerly flow toward the Swan River through the entire saturated thickness of the Fill layer over a 240 m length of shoreline.

- Using the flow results from the 3D groundwater flow model, a water and mass balance model was developed to estimate the nutrient loading into the Swan River for different scenarios. The results indicate:
  - Current load (with irrigation) is approximately 136 kg of total nitrogen per year, or 544 kg in four years.
  - If irrigation was turned off, the nutrient load would decrease to approximately 83 kg of total nitrogen per year, or 332 kg in four years.
  - During the surcharging year the nutrient load would increase to approximately 319 kg of total nitrogen, which is 183 kg more than under current conditions. The total load over four years would be approximately 751 kg (i.e. 319 kg (Year 1) + 179 kg (Year 2) + 130 kg (Year 3) + 123 kg (Year 4) (Table 7)) (Golder, 2013c).

Table 7: Nutrient Concentrations and Load into the Swan River during Surcharging (Golder, 2013c)

Scenario	Average Groundwater Flow		Nutrient Concentration	Nutrient Load
	L/s	kL/yr	mg/L	kg/yr
Current Situation (with irrigation)	1.0	32 000	4.3	136
Current Situation (without irrigation)	0.5	15 700	5.3	83
During Surcharging	0.9	27 500	11.6	319
1 year after start of Surcharging	0.62	19 500	9.2	179
2 years after start of Surcharging	0.60	19 000	6.8	130
3 years after start of Surcharging	0.60	19 000	6.5	123

After two years, the model indicates that the yearly nutrient load to the Swan River is estimated to be less than the current load (i.e. yearly load in Year 3 is 130 kg and in Year 4 is 123 kg compared to the current 136 kg (Table 7)), indicating that while the Project has the potential to increase flows and nutrient loads into the Swan River, this impact is only evident for the first two years of surcharge, after which the flows and nutrient load are expected to decrease to levels below the current situation.

Based on the preliminary conceptual design of surcharging and wick drain installation, the groundwater modelling has identified that groundwater management would be required to reduce additional nutrient loading to the Swan River. If nutrient rich or contaminated groundwater is identified as mobilising towards the Swan River (or the River-fed Lake) during preparation and assessment of the detailed construction methodology, groundwater management and mitigation measures will be required to be developed and implemented by the Lead Contractor to maintain current water quality and if possible, improve water quality mobilising to the Swan River.

The modelling results indicate that if the current annual nutrient load into the Swan River of 136 kg is not to be exceeded during surcharging, then approximately 225 kg of nutrients would require to be removed from the groundwater, being the difference between the current load over two years of 272 kg and the estimated load of 498 kg during the first two years of surcharging.

In order to remove the estimated 225 kg of nutrients, at concentrations of 12 mg/L, this would require the abstraction of approximately 20 000 kL of groundwater. Although such a concentration would be suitable for discharge to the sewer, discharge on-site would necessitate a target nutrient load concentration of approximately 4 mg/L (current background values). In order to achieve this concentration through treatment, an estimated 30 000 kL of groundwater would require to be abstracted and treated prior to discharge on-site.

The flow velocity of groundwater towards the Swan River is estimated to be such that measures for the capture and management of the additional nutrient load associated with surcharge can be implemented prior to any discharge of groundwater entering the Swan River. The groundwater modelling results indicate that

groundwater abstraction between the surcharge area and the Swan River followed by treatment or off-site disposal is a feasible and effective management measure for reducing the otherwise additional nutrient load to the Swan River during the PCS Works.

Of the modelled scenarios, Golder considers that dewatering spears or wells are better options to abstract groundwater than an interception trench. A modelled sheet pile wall was found not to be effective in creating a flow barrier to the groundwater coming from the surcharge area and that groundwater abstraction would be required for this option as well. Given that the results show that groundwater abstraction alone can manage nutrient loads to the Swan River, Golder considers that a sheet pile wall is not required.

Alternative methods, such as capturing the expelled groundwater as close to the source (wick drains) as possible, could also be considered during the design phase of the PCS works. The closer to the source of the expelled SRA water, the less mixture with the groundwater in the Fill and the less groundwater could be required to be managed. However, this approach may not be practicable due to the impact of the surcharge loads.

As described in the CSMP (Golder, 2013a), a network of groundwater wells will be monitored to both track any increase in groundwater flow to the River-fed Lake and the Swan River, and to assess whether there is any deterioration in the quality of groundwater flowing towards the River-fed Lake and the Swan River.

For further details on the results of the modelling undertaken, and management of nutrient loading, refer to the Groundwater Modelling Report (Golder 2013c) and the DSI report (Golder 2013b).

Where groundwater abstraction is required to mitigate nutrient loads, then proposed management measures are to be detailed in the Lead Contractor's CEMP and phase-specific Dewatering and Groundwater Management Plan for endorsement by SP's Environmental Manager and the Contaminated Sites Auditor. The Lead Contractor's CEMP and phase-specific Dewatering and Groundwater Management Plan, which will detail proposed management measures to mitigate nutrient loads to the Swan River, will be provided to SRT for review and comment.

7.5.5 Management Objectives

The EPA (2010a) objectives for water and water quality (including surface and groundwater) are to:

- Maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance are protected.
- Ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

Western Australian Planning Commission objectives for the Swan-Canning River System as outlined in SPP 2.10 will also be considered, particularly in relation to:

- Minimisation of sediment transport and mobilisation of nutrients or contaminants from the site to the river.
- Prevention of further water quality degradation, and if possible, improvement of the situation.

The Project's environmental objectives with regard to the management of impacts to groundwater during the construction phase are to:

- Maintain and protect the quality, levels and useability of the groundwater within the underlying groundwater system.
- Ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Minimise and manage potential impacts to the quality of surface water and groundwater resources caused by the Construction Phase.

- Maximise the efficient use of water for the Project.
- Maintain and enhance the health, amenity and landscape values of the Swan River in accordance with SPP 2.10, where practicable.

7.5.6 Limits and Targets

The guidance trigger levels employed for groundwater are the:

- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000a)
- *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* (Department of Health, 2011)
- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Long-term Irrigation Water Protection* (ANZECC/ARMCANZ, 2000b).

Appendix C outlines the values of the guidance trigger levels as per the guidance material listed above.

Trigger levels such as those in Appendix C, provide baseline environmental data that can be used in monitoring to assess water quality and identify potential contaminants within a groundwater body. Where independent environmental baseline monitoring data suggests deviation from the guideline trigger levels and the presence of contaminants prior to works, the use of the guideline trigger levels is limited. Monitoring results will also be compared against site specific baseline monitoring data to identify any trends in water quality degradation.

The aquifers that have the potential to be impacted by the Construction Phase of the Project are likely to interact with flora, fauna and humans through the groundwater surface water connectivity and through irrigation. As such, a 95% level of protection has been adopted.

If dewatering is required, and abstracted groundwater is proposed to be discharged into the Swan River (directly or via the stormwater system), the Swan River Trust guidelines for disposal of dewatering discharge into the Swan River are outlined in Table 8.

Table 8: Swan River Trust Guideline Trigger Values for Dewatering Disposal into the Swan River

Item	Trigger Value	Source
Total Nitrogen (TN)	>1.0 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total Phosphorus (TP)	>0.1 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total iron (Fe+ and Fe_3+)	>1.0 mg/L	Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC, 2011a)
Dissolved aluminium	>150 ug/L	Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC, 2011a)
Total aluminium	>1.0 mg/L	Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC, 2011a)
TTA (Acidity)	>40 mg/L	Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC, 2011a)

Item	Trigger Value	Source
Odours and colours	No objectionable odours or visible colour changes in the receiving water	Swan River Trust Policy SRT/DE6 Dewatering (SRT, 2001)
Floatable matter	No visible floating oil, grease, scum, litter or other objectionable material	Swan River Trust Policy SRT/DE6 Dewatering (SRT, 2001)
Settleable matter	No deposits which adversely affect the recreation and ecosystem values of the receiving waters	Swan River Trust Policy SRT/DE6 Dewatering (SRT, 2001)
Turbidity	Not to alter the background levels in the receiving environment by more than 10%, or cause a visible reduction in light penetration of receiving environment	Swan River Trust Policy SRT/DE6 Dewatering (SRT, 2001)
Temperature	Not to vary more than 2 degrees Celsius from the background level (in the receiving environment)	Swan River Trust Policy SRT/DE6 Dewatering (SRT, 2001)
Salinity	Not to alter the background level in the receiving environment by more than 10%	Swan River Trust Policy SRT/DE6 Dewatering (SRT, 2001)
Dissolved Oxygen	<80-90% stable saturation	Healthy Rivers Action Plan (SRT, 2008) long-term targets
pH	Should not fall outside the range of 6-8.5	ANZECC Guidelines for freshwater (2000a)
All other toxicants	As per ANZECC Guidelines for marine* water ecosystems. Minimum 95% protection level to be used.	ANZECC Guidelines for marine water (2000b)

* marine guidelines are to be implemented due to the saline nature of the Swan River

7.5.7 Potential Environmental Impacts

The potential impacts of the Project during the Construction Phase to groundwater are:

- Ground improvement methodologies, particularly surcharging, could cause movement of groundwater through the compaction process, following the dominantly westerly flow direction of the groundwater toward the Swan River, potentially contaminating groundwater and the Swan River.
- Stone columns and wick drains have the potential to cause cross contamination between aquifers. This will depend on the depth of columns and the depth to groundwater at the location of columns.
- Alteration in hydrology and hydrogeology of underlying aquifer(s), estuaries, lakes and the River environments as a result of clearing flora and vegetation and removal of artificial lakes impacting groundwater/surface water connectivity.
- Should dewatering be required during the Construction Phase, potential impacts will be dependent on the water quality of extracted groundwater and the groundwater disposal option, potentially discharging contaminated water to a surface water body or other location.
- Impacts to groundwater quality due to landfill contaminants and leachate seeping into the groundwater and surface water bodies.
- Indirect risks associated with contamination of surface water bodies due to ground disturbance, spills and unmanaged storm water flow impacting connected groundwater bodies.
- Acidification and mobilisation of pollutants.

7.5.8 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise impacts to groundwater during the Construction Phase are:

- Control of contamination to groundwater and land and surface water due to spills and contamination risks, potentially impacting groundwater, by implementing the management measures as outlined in Section 7.5.8 and the CSMP (Golder, 2013a).
- Development and implementation of a groundwater monitoring program to monitor for any adverse impacts on the Swan River as per Section 7.5, the DMP (Golder, 2012e) and the CSMP (Golder, 2013a).
- Should dewatering be required, the management of dewatering treatment and disposal is to be undertaken as outlined in the DMP (Golder, 2012e).
- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of protecting the groundwater system and the related management measures. This induction shall also cover potential risks from Construction Phase activities to the groundwater system and the related management measures required to mitigate these. Include recently identified groundwater management issues in daily pre-work toolbox meetings.
- Implementation of any specific conditions applied to the Project by regulatory agencies.
- Monitor groundwater in a series of wells located to the eastern side of the River-fed Lake for contamination to manage potential flow of contaminated groundwater into the River-fed Lake and the Swan River as per the CSMP (Golder, 2013a).
- If nutrient rich or contaminated groundwater is identified as mobilising towards the Swan River (or the River-fed Lake), groundwater management and mitigation measures will be implemented to maintain current water quality and if possible improve water quality mobilising to the Swan River. Should nutrient loads within groundwater require management, details of the Lead Contractor(s) preferred management option, including proposed design details, are to be included in the Lead Contractor(s)' CEMP and phase specific Dewatering and Groundwater Management Plan(s). Consideration should be given to the following options:
  - A line of dewatering spears could be installed into the Fill, between the surcharge area and the Swan River
  - A line of abstraction wells could be installed into the Fill, between the surcharge area and the Swan River
- Construction Phase activities will be conducted in accordance with the Project's DMP (Golder, 2012e) and CSMP (Golder, 2013a) to manage hydrology and hydrogeology impacts and related indirect impacts to surface water bodies.

7.5.9 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor(s).

Groundwater monitoring will be conducted by a suitably qualified specialist to monitor any changes to the groundwater quality and pressures (heads, levels) and determine any potential impacts to the Swan River and aquifer system. Groundwater will be monitored according to the following regulations, where practicable:

- Department of Water, *Water Quality Protection Notice Monitoring Bores* (2006).

- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000a)
- AS/NZS 5667.1:1998. Water Quality - Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.
- DER Contaminated Sites Management Series Guidelines.

Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in the Golder (2012f).

Monitoring of the groundwater (using monitoring wells) and dewatering discharge is required during dewatering and surcharging activities. The monitoring will commence prior to dewatering and surcharging activities and continue after the cessation of both. Details of the proposed monitoring will be dependent on the nature and extent of dewatering or surcharging and will need to be outlined in the Phase specific Dewatering and Groundwater Management Plan(s) and/or CEMP(s). The following sections outline likely monitoring requirements based on the guidelines from DOW (2006) and DER (DEC, 2011a).

7.5.9.1 Groundwater Monitoring

Groundwater monitoring is to be undertaken as outlined in the CSMP (Golder, 2013a) and DMP (Golder, 2012e).

7.5.9.2 Dewatering Discharge

If dewatering is required, then dewatering discharge monitoring shall be undertaken as detailed within the DMP (Golder, 2012e).

It is proposed that photos of the dewatering effluent are taken on a regular basis, to document the visual quality of the water.

7.5.9.3 Monitoring in Accordance with ASS Guidelines

ASS monitoring shall be undertaken as detailed within the CSMP (Golder, 2013a).

7.5.9.4 Other Monitoring

Additional contaminants of concern may be required to be monitored based on the location of the dewatering program, with regard to contaminants of concern reported for the proposed location in the DSI (Golder 2013b). Additional monitoring would also depend on the chosen disposal option. If the dewatering discharge is proposed to be disposed to the stormwater, then additional monitoring will be required.

7.5.9.5 Settling Effects

The phase specific Dewatering and Groundwater Management Plan(s) will address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. This is not considered to be an issue if the construction dewatering requirements are of limited depth and duration. Proximity to nearby infrastructure including the Graham Farmer Freeway and the railway line will need to be assessed on a case by case basis.

The requirement for a monitoring and management strategy should therefore be assessed based on actual dewatering requirements. If settlement is considered a risk, survey points will need to be installed on adjacent structures with a minimum of two points per structure. These points should be surveyed prior to dewatering activities commencing and then at fortnightly intervals during the dewatering period. Survey data should be recorded and reviewed and the reasons for any changes or movements identified.

Groundwater monitoring will be reviewed against DSI (Golder, 2013b) results and following each round of monitoring data. Results may impact the groundwater monitoring plan with respect to variations in frequency, location of bores, number of bores and analytes monitored.

Any adverse environmental impacts to groundwater quality identified as a result of monitoring will be managed according to the management measures outlined in the Lead Contractor's CEMP.

All data collected will be provided to SP for long term monitoring requirements.

7.5.10 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) for the management of potential groundwater impact triggers include, but are not limited to those outlined in Table 9.

Table 9: Contingency Actions for the Groundwater Management Plan

Trigger	Potential Actions
Measured decline/increase in groundwater levels is at variance to the modelled change.	■ A groundwater specialist is to review groundwater monitoring results, to assess whether the variance is project related or a result of external influences. ■ Increase monitoring frequency to daily groundwater level measurements. ■ Additional strategically placed monitoring wells could be installed and monitored daily, depending on the outcome of the review of the results. ■ Assess validity of groundwater model.
Groundwater quality is in exceedance of trigger values.	■ A groundwater specialist is to review groundwater monitoring results. ■ Increase monitoring frequency (i.e. weekly laboratory analysis or inclusion of additional analytes to be tested). ■ Additional strategically placed monitoring wells may be required to be installed and monitored in accordance with the revised monitoring schedule to gain a better understanding of the cause. ■ Identify source of water quality change. ■ Implement actions outlined in the DMP (Golder, 2012e). ■ If the change is due to activity that can be modified, remove the cause as appropriate. This may include further optimising the rate of groundwater extraction.
Identified deteriorating groundwater quality	■ A groundwater specialist is to review groundwater monitoring results. ■ Increase monitoring frequency (i.e. weekly laboratory analysis or inclusion of additional analytes to be tested). ■ Additional strategically placed monitoring wells may be required to be installed and monitored in accordance with the revised monitoring schedule to gain a better understanding of the cause. ■ Identify source of water quality change. ■ Implement actions outlined in the DMP (Golder, 2012e). ■ If the change is due to activity that can be modified, remove the cause as appropriate. This may include further optimising the rate of groundwater extraction.

Trigger	Potential Actions
Groundwater quality monitored in the groundwater wells east of the River-fed Lake and the Swan River, with potential for discharge to these water bodies, is identified as being in exceedance of trigger values.	■ Assess validity of risk assessment. ■ If ecological risk is considered unacceptable, consider mitigation options as per the DMP (Golder, 2012e).
Extracted groundwater volume increases from modelled predictions.	■ SP and the Lead Contractor to discuss increased groundwater extraction volumes with DOW and other relevant regulatory agencies as required.
Survey of adjacent structures shows settlement or abnormalities.	■ The dewatering operation should cease immediately, if safe to do so. ■ A geotechnical specialist should be employed to review the data and propose appropriate measures. ■ SP and the Lead Contractor to discuss increased groundwater extraction volumes with DOW and other relevant regulatory agencies as required.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.6 Air Quality Management Plan

7.6.1 Management Objectives

The EPA (2010a) objectives relevant to atmospheric emissions are to:

- Ensure that atmospheric emissions (dust) do not impact on environmental values or the health, welfare and amenity of the population and land uses.
- Use all reasonable and practicable measures to minimise airborne dust and greenhouse gas emissions.

The Project's environmental objectives with regard to the risk and management of impacts to air quality during the Construction Phase are to:

- Protect the local air quality.
- Actively reduce greenhouse gas emissions.
- Manage the ambient air in the vicinity of the works, noting the protection of site workers will be addressed as part of separate occupational health and safety management (OHS) plans.
- Use all reasonable and practicable measures to minimise airborne dust and greenhouse gas emissions.

Air quality management measures are relevant to the management of ambient air in the vicinity of the works. The protection of site workers will be addressed as part of separate occupational health and safety management (OHS) plans, to be prepared by the Lead Contractor(s).

7.6.2 Limits and Targets

7.6.2.1 Dust

It is noted that the potential for dust generation is likely to decrease as the development proceeds. For example, there is a reduced potential for dust generation during construction of the Stadium, provided that other site features including bare areas and material stockpiles are appropriately managed.

The DER guidance (DEC, 2011) also refer to National Environmental Protection Measures (NEPMs) for ambient air quality and air toxics. In addition, the Kwinana Environmental Protection Policy (EPP) specifies guidelines for total suspended particulate that have also been adopted by DER. These are presented in Table 10, Table 11 and Table 12.

Table 10: Ambient Air Quality NEPM Standards for Lead and Particles

Pollutant	Averaging Period	Maximum Concentration	Goal to be Achieved by 2008 - Maximum Allowable Exceedances
Lead	1 year	0.50 µg/m^3	None
Particles as PM_{10}	1 day	50.0 µg/m^3	5 days a year
Particles as $PM_{2.5}$	1 day	25.0 µg/m^3	Under development
	1 year	8.0 µg/m^3	Under development

Table 11: Air Toxics NEPM

Pollutant	Averaging Period	Monitoring Investigation Level
Benzene	Annual average	0.003 ppm
Benzo(a)pyrene as a marker for polycyclic aromatic hydrocarbons	Annual average	0.3 ng/m^3
Formaldehyde	24 hours	0.04 ppm
Toluene	24 hours Annual average	1 ppm 0.1 ppm
Xylenes (as total of ortho, meta and para isomers)	24 hours Annual average	0.25 ppm 0.2 ppm

Table 12: Kwinana Environmental Protection Plan (EPP), Total Suspended Particulates (TSP) Ambient Air Quality Standards and Limits for Area C (rural/residential area)

Pollutant	Averaging Period	Standard
TSP	24 hours	90 µg/m^3

7.6.2.2 Asbestos

Asbestos is known to be present within the Project area. Asbestos presents a risk to human health rather than a risk to the environment. Due to the historic fill activities and the presence of asbestos product manufacturing facilities adjacent to the site, the DSI (Golder 2013c) did not identify a distinct definable area as being impacted by asbestos or Asbestos Containing Material (ACM). Therefore the presence of asbestos at other locations cannot be precluded.

Remedial actions will be put in place by the Lead Contractor(s) to remove or contain asbestos and ACM from the site if identified during construction works. Department of Health (2009) *Guidelines for the Assessment, Remediation and Management of Asbestos - Contaminated Sites in Western Australia* criteria will be adopted for assessment of air quality in relation to asbestos. Criteria are presented in Table 13.

Table 13: Air Quality Limit for Asbestos (DOH, 2009)

Pollutant	Limit
Asbestos	0.01 fibres/mL

The remedial approach will be presented in the Lead Contractor(s) CEMP for endorsement by SP's Environmental Manager and the Contaminated Sites Auditor.

7.6.2.3 Ground Gas

Ground gases were detected at the site during gas monitoring undertaken by Golder as part of the DSI (Golder, 2013b). It is currently unclear as to whether the ground gases are derived from the landfill waste or a contribution from the landfill waste as well as the underlying organic rich SRA. Golder considers that it is likely that the ground gases originate from both sources. Regardless of source, it is considered that management of ground gases will be required during the PCS works and into the future during construction and operation of the Stadium.

Construction workers in the immediate vicinity of works are those most likely to be impacted by the presence of ground gas. The ambient air environment in surrounding areas may be impacted by the odour impacts of ground gas. Potential hazards from ground gas are due to high levels of H_2S, CO_2 and methane. Lower explosive limit (LEL) and toxic gas monitors may be required for workers in the immediate area.

Guidelines for ground gas are 500 ppm (permanent gas level limit). Further details are provided in Section 10.3 of the CSMP (Golder, 2013a).

7.6.2.4 Odour

There is the potential for odour to be emitted from the site during construction due to the release of ground gas and the excavation of odorous material. The DER guidance (DEC, 2002) *Odour Methodology Guideline* will be used as guidance. The guidelines specify odour assessments based on odour intensity. If odour is a concern, then an odour management plan will need to be developed which should include field odour intensity surveys. The usual method is to perform daily site odour surveys.

7.6.3 Potential Environmental Impacts

The potential impacts of the Project during the Construction Phase to air quality are:

- An increase in greenhouse gas emissions to the environment due to the combustion of fuel and decomposition of soil and organic matter post-clearing.
- An increase in particulate emissions to the environment due to the combustion of fuel and resulting exhaust emissions.
- An increase in airborne dust to the environment due to:
  - Clearing of flora and vegetation exposing dust which can potentially become airborne with the correct wind direction.
  - Project preconstruction and excavation operations.
  - The transportation and loading/unloading process of fill and other sand.
  - On-site vehicle movements on unsealed roads.

- Air and greenhouse gas emissions greater than the baseline levels due to the operation of machinery and associated vehicle emissions may present health concerns if not managed correctly. Carbon monoxide, nitrogen oxides and particulates are emitted from fuel combustion (vehicles, power equipment and power plants). There is also the potential for other contaminants in windblown particulates, based on contaminants of concern reported in the DSI (Golder, 2013b).
- Dust (particulate) emissions may be generated as a result of earthwork activities, particularly during dry, windy conditions. Excessive dust generation may be detrimental to human health, reduce visual amenity as well as smother vegetation and impact fauna.
- Uncontrolled ground gas impacts due to the disturbance of landfill material *in situ* resulting in:
  - Subsurface migration, the underground movement of ground gas from landfills to other areas within the landfill property or outside the landfill property.
  - Emissions of ground gas to air which contains carbon dioxide, methane, volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and odorous compounds that can adversely affect public health and the environment.
  - Odour emissions.
- Odour generated from lake clearance operations and other preconstruction activities can cause related health issues (such as respiratory issues) and be unpleasant and irritate residential occupants, the public and stakeholders.

7.6.4 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise impacts to air quality during the Construction Phase are:

- Management of dust emissions as outlined in the CSMP (Golder, 2013a)
- Management of potential impact from ground gases as per the DSI (Golder2013c) and the CSMP (2013a).
- Development and implementation of an air quality monitoring programme (including requirements for both public and occupational monitoring) based on the content of this Project EMP. This program should be implemented by a suitably qualified professional.
- Procurement of well maintained, industry standard and fuel-efficient vehicles and plant where practicable to reduce the use of machinery causing emissions of greenhouse gases.
- Undertake appropriate and regular vehicle and plant maintenance to avoid excessive GHG and air emissions.
- Daily monitoring of weather conditions to ensure unfavourable activities (e.g. excessive dust and/or odours) are managed with due recognition of the prevailing conditions, ensuring that odours are kept away from residents and other users of the surrounding area.
- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of air quality management measures.
- Implementation of any specific conditions applied to the Project by the relevant regulatory agencies.

7.6.5 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor(s).

7.6.5.1 Air Quality

Air quality monitoring will be conducted by a suitably qualified specialist to determine any impacts to air quality due to the Construction Phase. Air quality will be monitored adhering to the following documents:

- DER's *Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities* (DEC, 2011b).
- Australian New Zealand Standard 3580: *Methods for Sampling and Analysis of Ambient Air (including 3580.9.7 Determination of Suspended Particulate Matter Dichotomous Sampler (PM 10, course PM and PM 2.5) - Gravimetric Method).*
- *National Environment Protection (Ambient Air Quality) Measure for PM 10*.

Air quality monitoring will be undertaken regularly by a qualified specialist via the installation of permanent air quality monitors at the boundary of the premises or at nearby sensitive receptors. Air quality monitoring assessing air quality compliance will be undertaken according to the limits and targets outlined in Section 7.6.2.

7.6.5.2 Asbestos

The requirement for asbestos management and monitoring will depend on the PCS Works process selected. If asbestos management is required, an asbestos management and monitoring procedure will be developed and implemented by a qualified specialist and incorporated into the Lead Contractor's CEMP as per the management measures and monitoring procedures in this Project EMP. The CSMP, in particular Appendix A of the CSMP, details the management of excavations and stockpiles that may contain asbestos.

7.6.5.3 Ground Gas

Ground gas monitoring will be conducted by a suitably qualified specialist to determine the presence of ground gas and manage greenhouse gas, odour and safety issues related to the gas. Ground gas will be monitored adhering to the following documents:

- *Siting, Design, Operation and Rehabilitation of Landfills* (DEC, 2005a).
- *Assessing Risks Posed by Hazardous Ground Gases to Buildings* (CIRIA, 2007).
- *Best Practice Environmental Management Siting, Design, Operation and Rehabilitation of Landfills* (EPA Victoria, 2010).

Ground gas monitoring shall be undertaken regularly by a qualified specialist via the installation of permanent ground gas monitors. Ground gas monitoring to assess the presence of ground gas will be undertaken according to the specifications and procedures detailed in this document, the CSMP (Golder, 2013a) and as per the Lead Contractor's CEMP. Sampling methodology, including quality control and quality assurance procedures, will be undertaken as in Golder (2012f). Ground gas monitoring procedures will be approved by SP prior to being implemented and SP may engage relevant regulatory agencies or the Contaminated Site Auditor to review the monitoring procedures to ensure their requirements are met.

Any potential for adverse environmental impacts from ground gas levels identified through ground gas monitoring will be managed according to the management measures outlined in the Lead Contractor's CEMP.

7.6.5.4 Meteorology

As part of the Project preparation works, prior to any clearing the Lead Contractor(s) will install and maintain an appropriate weather station. The model, parameters and location will be determined by a suitably qualified specialist (i.e. air quality). The data will be downloaded at an appropriate frequency and stored in a suitable database. All data collected will be provided to SP for long term monitoring requirements.

Local meteorological conditions such as wind speed, wind direction and atmospheric pressure will be monitored and logged to assist the interpretation of air quality and ground gas monitoring results and assist in the implementation of air quality and ground gas management measures.

All air quality, asbestos, ground gas and meteorology monitoring data collected will be provided to SP for long term monitoring requirements.

7.6.6 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) for the management of potential air quality impact triggers include, but are not limited to those outlined in Table 14.

Table 14: Contingency Actions for the Air Quality Management Plan

Trigger	Potential Actions
Portable ground gas levels are in excess of the time weighted average (TWA): ■ 10 ppm hydrogen sulfide ■ 5000 ppm carbon dioxide ■ 25% Lower Explosive Limit (LEL) of methane	■ Stop work activity in the area of excess gas levels. ■ Check that source of emissions is from the open hole or excavation in place of a secondary source such as vehicle exhaust fumes. ■ Evaluate the concentrations against the Short Term Exposure Limits* (STEL) for hydrogen sulfide and carbon dioxide, and against the 25% LEL trigger level for methane. ■ Should concentrations exceed STELs or the methane trigger, evacuate the work area and allow gases to dissipate. ■ Reassess gas concentrations after a minimum duration of 10 minutes. ■ If gas concentrations persist above STELs or the methane trigger implement the appropriate emergency incident response procedures.
Permanent ground gas level is in excess of 500 ppm.	■ Stop work activity in the area of excess gas levels. ■ Confirm elevated concentrations of ground gas. ■ Implement appropriate emergency evacuation procedures. ■ Implement the appropriate emergency incident response procedures.
Visible dust is generated from potentially contaminated material.	■ Increase dust management measures. ■ Stop work activity in the area impacted by visible dust. ■ Wait until wind conditions improve.
Airborne concentrations of asbestos are reported above recommended concentrations.	■ Stop work. ■ Identify source of airborne asbestos. ■ Increase dust management measures. ■ Wait until wind conditions improve. ■ Remove source to an off-site location.

Trigger	Potential Actions
Air quality is in exceedance of trigger values.	■ Identify source of air quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate.
Dust emissions complaint is received.	■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase dust management measures. ■ Wait until wind conditions improve.
Odour complaint is received.	■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase odour management measures. ■ Wait until wind conditions improve.

*STEL is the acceptable average exposure over a short period of time and values for each chemical can be sourced from WorkSafe's Hazardous Substance Information System (HSIS) website.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.7 Noise and Vibration Management Plan

7.7.1 Management Objectives

The EPA (2010a) objectives to manage noise emissions are to ensure:

- That noise emissions do not impact on environmental values or the health, welfare and amenity of the population and land uses.
- That noise emissions, both individually and cumulatively, comply with the relevant statutory requirements.
- Design and procurement activities incorporate measures for minimising noise emissions during construction and operation.
- That all reasonable and practicable measures are undertaken during construction and operations to minimise noise emissions.

The Project's environmental objectives with regard to the management of noise and vibration during the Construction Phase are to:

- Minimise and manage noise generation from the Project area.
- That noise emissions do not impact on environmental values or the health, welfare and amenity of the population and land uses.
- That noise emissions, both individually and cumulatively, comply with the relevant statutory requirements.
- Design and procurement activities incorporate measures for minimising noise emissions during construction and operation.
- That all reasonable and practicable measures are undertaken during construction and operations to minimise noise emissions.

7.7.2 Limits and Targets

Environmental noise in Western Australia is governed by the:

- *Environmental Protection Act 1986*
- *Environmental Protection (Noise) Regulations 1997*
- EPA Guidance Statement No 8: Environmental Noise (Draft) (EPA, 2007).

7.7.2.1 Construction Noise Criteria

In WA, construction activities should be undertaken in accordance with control of noise practices set out in the *Environmental Protection (Noise) Regulations 1997,* specifically:

- The assigned noise levels set in Regulations 7 & 8 of the *Environmental Protection Act 1986* do not apply to noise emitted from a construction site as a result of construction work on between 7 am and 7 pm on any day which is not a Sunday or public holiday, under certain conditions.
- Work may be done between 7 pm and 7 am and on Sundays and public holidays, under a stricter set of conditions.

Daytime Construction

For construction work carried out between 7 am and 7 pm on any day which is not a Sunday or public holiday:

- The construction work must be carried out in accordance with control of noise practices set out in Section 6 of Australian Standard 2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites*".
- The equipment used for the construction work must be the quietest reasonably available.
- The chief executive officer may request that a noise management plan be submitted for the construction work at any time.

Construction Out of Hours

For construction work done outside the hours shown above:

- The work must be carried out in accordance with Section 6 of AS 2436-1981.
- The equipment used for the construction work must be the quietest reasonably available.
- The Lead Contractor(s) must advise all nearby occupants of the work to be done at least 24 hours before it commences.
- The Lead Contractor(s) must show it was reasonable necessary for the work to be done out of hours.
- The Lead Contractor(s) must submit to the chief executive officer (CEO) a noise management plan at least 7 days before the work starts, and the plan must be approved by the CEO.

If the Lead Contractor(s) fails to comply with these conditions, or with the approved noise management plan, the noise from the construction site would be treated the same as noise from any other premises and would need to meet the assigned levels.

7.7.3 Potential Environmental Impacts

The potential noise and vibration impacts of the Project during the Construction Phase are:

- Vehicle and machinery operation, including excavators, drilling equipment, pile drivers and other equipment may cause an increase in localised vibration concerns to neighbouring properties (residential, commercial and recreational), terrestrial and aquatic fauna and heritage buildings/structures.
- Vehicle and machinery operation, including excavators, drilling equipment, pile drivers and other equipment may cause an increase in localised noise concerns to neighbouring properties (residential, commercial and recreational), terrestrial and aquatic fauna and heritage buildings/structures.

7.7.4 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise noise and vibration impacts during the Construction Phase are:

- All construction work will be carried out in accordance with control of environmental noise practices set out in Section 6 of AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites.*
- All construction work will be carried out within construction hours as set out in Section 7.7.2.1 of this report; otherwise, a separate Noise Management Plan will be produced to manage potential impacts.
- All 'warm-up' of equipment by employees and contractors arriving early to site will not be carried out outside of approved construction hours.
- White noise reversing beeper tones will be used in vehicles operating outside of normal hours of work, where practicable.
- All equipment, machines and vehicles on site during construction will be the quietest reasonable available consistent with operational requirements, and will be routinely maintained to ensure effectiveness of noise suppression systems and equipment.
- Implement noise monitoring procedures to quantify noise levels during the Project Construction Phase as a basis for adaptation of construction practices as/if appropriate.
- Through site induction programmes, all construction personnel and contractors will be informed of the importance of managing noise levels and their responsibilities during the Construction Phase of the Project.
- Any noise related complaints received during the Construction Phase will be registered and trigger review of the relevant operational/management procedures by SP's Environmental Manager and the Lead Contractor's Environmental Representative as a basis for development and implementation of appropriate modified practices.

7.7.5 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor(s).

Noise monitoring (and vibration monitoring, if required) will be conducted by a suitably qualified specialist to determine any adverse impacts due to noise or vibration emissions. Noise emissions will be managed according to relevant conditions in the EP Act and the *Environmental Protection (Noise) Regulations 1997.*

Noise monitoring will be undertaken regularly by a suitably qualified specialist via the installation of permanent noise monitors at the boundary of the premises or at nearby sensitive receptors. Monitoring will be undertaken according to the specifications and procedures of the noise monitor.

Vibration monitoring, if required, will be undertaken regularly by a suitably qualified specialist via the installation of permanent vibration monitors on identified buildings or structures in close proximity to the site or of heritage significance. Monitoring will be undertaken according to the specifications and procedures of the vibration monitors.

Noise and vibration monitoring results will be compared to regulated limits. Any adverse environmental impacts identified as a result of noise and vibration monitoring will be managed according to the management measures outlined in this Project EMP and the Lead Contractor's CEMP.

All data collected will be provided to SP for long term monitoring requirements.

7.7.6 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) for the management of potential noise impact triggers include, but are not limited to those outlined in Table 15.

Table 15: Contingency Actions for the Noise Management Plan

Trigger	Potential Actions
Noise or vibration levels are in exceedance of trigger values.	■ Identify source of noise or vibration levels increase. ■ If the change is due to activity that can be modified, remove the cause as appropriate.
Noise or vibrations complaint is received.	■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase noise management measures. ■ Wait until wind conditions improve.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.8 Public and Visual Amenity Management Plan

7.8.1 Management Objectives

The EPA (2010a) objective for visual amenity is to ensure that aesthetic values are considered and that measures are adopted to reduce visual impacts on the landscape to as low as reasonably practical.

The Project's environmental objective with regard to the management of visual amenity during the Construction Phase is to minimise and manage impacts to the visual amenity of the Swan River, Burswood Park recreational area and the Burswood Peninsula.

7.8.2 Potential Environmental Impacts

The potential visual amenity impacts of the Project during the Construction Phase are:

- Aesthetics and visual amenity issues associated with the construction Project area may be unfavourable to some residents in the area.
- Clearing of flora could cause concern to local residents and users of the public spaces and surrounding entertainment venues.

- Increased traffic volumes within the Project area as well as surrounding roads could cause concern to local residents and users of the public spaces and surrounding entertainment venues.
- Transportation of mud from the site onto public roads.
- Decreased public access to and along the river during the Project works.

7.8.3 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise visual amenity impacts during the Construction Phase are:

- Manage local resident's aesthetics and visual amenity concerns though good stakeholder engagement and consultation. Local residents and Burswood Peninsula users will be advised regularly via mail of general works to be undertaken throughout the Construction Phase of the Project and will be provided a draft schedule of timeframes. If the schedule of timeframes for the Project is to change, local residents will be advised.
- A community information and complaints phone service will be set up to manage queries and complaints resulting from the works. Should a complaint be received, the complaint will be recorded and managed as per the Public Complaints Management Procedure detailed in Section 12.0 of this document and as per the Project's Stakeholder Engagement Strategy.
- Staging as much of the clearing and construction works as possible to manage the duration of unsightly works, and to minimise the disruption of public access to and along the foreshore adjacent to the Project area where possible.
- Installation of appropriate fencing to block some of the Construction Phase activities from view by residents, River users and other patrons to the Burswood Peninsula. Fencing will also assist in controlling dust movement off-site. The maintenance of the integrity of the Project fence is the responsibility of the Lead Contractor(s).
- Increased traffic volumes will be managed through the development of a Traffic Management Plan. This will be addressed in a separate referral application under the Transport Solution.
- A wheel wash-down bay and/or rumble grate to be installed at site exits to clean tyres of mud prior to leaving the site.
- Assessment and management measures for light spill and noise from the Construction Phase should works be required outside the standard daylight working hours.
- Implementation of an awareness program as part of the inductions to educate all personnel on the social surroundings and the associated management measures.

7.8.4 Monitoring Procedures

Proposed monitoring procedures to be taken by the Lead Contractor(s) for visual amenity impacts during the Construction Phase are:

- Undertake a weekly review of complaints received throughout the duration of the Construction Phase of the Project to establish what aspects of the works are impacting on the visual amenity of Burswood Peninsula users and local residents during the Construction Phase. An appropriate management action will be determined if the issue is considered able to be resolved.
- Record all responses to complaints received during the Construction Phase. Where practicable and reasonable, implement changes to improve on the visual amenity of Burswood Peninsula users and local residents during the Construction Phase.
- Assess visual amenity impacts as part of the daily site inspection described in Section 13.2.

7.9 Indigenous Heritage Management Plan

7.9.1 Management Objectives

The EPA (2010a) objective for Indigenous heritage values is to ensure that:

- Changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.
- Emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Existing and planned recreational uses are not compromised.

The Project's environmental objectives with regard to the management of impacts to Indigenous heritage during the Construction Phase are to:

- Meet statutory obligations in relation to the management of Indigenous heritage.
- Implement where practicable the recommendations made by the Indigenous groups of the area in relation to Indigenous heritage management.
- Minimise and manage impacts to the Indigenous heritage environment through responsible heritage management.
- Ensure changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant Indigenous heritage legislation.
- Ensure emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

7.9.2 Limits and Targets

The primary pieces of State and Commonwealth legislation covering Aboriginal heritage in Western Australia are:

- *Aboriginal Heritage Act 1972*
- *Environmental Protection Act 1986* (indirectly)
- *Aboriginal and Torres Strait Islander Heritage Protection Act* (ATSIHP Act 1987) (C'th)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

Obligations under Indigenous heritage legislation include:

- Protection of Identified Aboriginal Sites - Under Section 17 of the *Aboriginal Heritage Act* 1972 it is an offence to excavate, destroy, damage, conceal or in any way alter any Aboriginal site.
- Protection of New Aboriginal Sites - The *Aboriginal Heritage Act* 1972 provides protection for all Aboriginal sites whether or not they are recorded on the Register of Aboriginal sites. The risk of damaging unknown sites can be minimised through prior consultations with the relevant groups and knowledgeable elders, which is being managed by SP.
- Aboriginal Skeletal/Ancestral Remains - There is potential for the discovery of new Aboriginal sites including burial grounds when earth moving activities take place. Skeletal/ancestral remains are of great significance to Aboriginal people, who feel strongly about the removal of remains from gravesites. If any such remains are found, the contractor must cease works and contact SP.

- Previously Unidentified Aboriginal Site - If a previously unidentified Aboriginal site is found (i.e. artefacts are uncovered), work is to be stopped and a Section 18 application is to be applied for an Indigenous heritage management measures are to be developed.
- Reporting of Disturbance to an Aboriginal Site - An Aboriginal site is disturbed when it is excavated, destroyed, damaged, concealed or in any way altered without prior authorisation of the Registrar of Aboriginal Sites and/or consent from the Minister for Aboriginal Affairs. The *Aboriginal Heritage Act* 1972 protects places and objects that may be of importance or significance to people of Aboriginal descent in Western Australia. These places and objects may be identified as a site and recorded on the Register of Aboriginal Sites. All sites are protected under the AHA whether or not they are recorded on the Register. Under Section 17 it is an offence to disturb a site.
- Disturbing an Aboriginal site is an offence against the AHA and may lead to legal action. Section 57 of the AHA outlines the various penalties that can be applied under the Act.

7.9.3 Potential Environmental Impacts

The potential impacts of the Project during the Construction Phase to Indigenous heritage values are:

- Indirect contamination to Indigenous heritage sites due to run-off, unintentional spills, erosion of contaminated soil, and dust.
- Indirect contamination to Indigenous heritage sites due to contamination of groundwater and surface water flows as a result of clearing, spills, preconstruction, run-off and contamination.
- Ground disturbance resulting in disturbance of known Indigenous sites of significance.
- Ground disturbance resulting in disturbance of unknown Indigenous sites of significance.
- Impact on Indigenous landscape values due to changes in landscape and topography.
- Impacts on Indigenous cultural Swan River values.
- Impacts to access to the River and its foreshores during and after construction of the Project.

Potential impacts to the physical locations including camp and burial sites will be variable. Site 15915 is located at the north-western corner of the Project area and may not be required to be cleared or disturbed. However, Site 15914 runs from north to west across the Project area and will be disturbed as part of the Project development.

7.9.4 Management Measures

Ethnographic and Archaeological surveys have been completed and SP has commenced consultation with the relevant Indigenous people. SP has received Section 18 approval and is preparing an Engagement Strategy and Aboriginal Heritage Management Plan that incorporates a Monitoring Management Plan. Management measures to be taken by the Lead Contractor(s) to minimise impacts to Indigenous heritage values during the Construction Phase are:

- Comply with the Engagement Strategy and Aboriginal Heritage Management Plan being prepared by SP, which will detail the required Indigenous stakeholder engagement and consultation, including having a representative of the Noongar people present during any disturbance, if requested.
- Management of the Swan River according to management measures addressed in Sections 7.4 and 7.5. Any impacts to the Swan River will be additionally managed through a detailed Indigenous/stakeholder consultation process.
- Visual identification of any heritage sites within the Project area including a buffer around these sites to prevent any unnecessary access.

- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of protecting local Indigenous heritage and the measure to take should any artefacts or skeletal material be found.
- Implementation of any specific conditions applied to the site by the Department of Aboriginal Affairs through the Section 18 Approval.

7.9.5 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) to manage potential Indigenous heritage values impact triggers include, but are not limited to those outlined in Table 16.

Table 16: Contingency Actions for the Indigenous Heritage Management Plan

Trigger	Potential Actions
Indirect contamination to Indigenous heritage sites.	■ Identify source of contamination and cease source if able. ■ SP to work with the DIA in consultation with a representative of the Noongar people to remediate the area.
Ground disturbance resulting in disturbance of unknown Indigenous sites of significance.	■ Cease disturbance activity and fence off area around site including a 20 m buffer. ■ If human remains are found, police are to be notified. ■ SP to work with the DIA (and/or police) in consultation with a representative of the Noongar people to assess and remediate the area.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.10 European Heritage Management Plan

7.10.1 Management Objectives

The EPA (2010a) objective for European heritage values is to ensure that:

- Changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.
- Emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Existing and planned recreational uses are not compromised.

The Project's environmental objectives with regard to the management of impacts to European heritage during the Construction Phase are to:

- Meet statutory obligations in relation to the management of European heritage.
- Minimise and manage impacts to the European heritage environment through responsible heritage management.
- Provide a plan through which the Government of Western Australia will achieve its vision of best practice heritage management.

- Changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.
- Emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

7.10.2 Limits and Targets

The primary pieces of State and Commonwealth legislation covering European heritage in Western Australia are:

- *Heritage of Western Australia Act 1990*
- *Heritage of Western Australia Amendment Regulations 2012*
- *Environmental Protection Act 1986* (indirectly)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

7.10.3 Potential Environmental Impacts

Two non-Indigenous heritage sites were identified within the Burswood Peninsula, close to the Project area. These sites could be potentially impacted by vibrations originating from Construction Phase works within the Project area.

7.10.4 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise impacts to European heritage during the Construction Phase are:

- Prior to the commencement of the Construction Phase, SP will identify if any of the two heritage sites (the Bunbury Railway Bridge over the Swan River and the Old Burswood Canal) or if any other surrounding buildings (heritage and otherwise) may require building surveys (including but not limited to dilapidation) to be carried out or require vibration monitors to be set up. The findings from these will be recorded.
- Visual identification of any European heritage sites in the Project area. Include a buffer around these sites to prevent any unnecessary access.
- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of protecting local European heritage and the measure to take should any artefacts be found.
- Implementation of any specific conditions applied to the site by the State Heritage Office.
- No unauthorised disturbance of European heritage sites that are within or near the Project area.
- To the extent practicable avoid any Construction Phase/disturbance works outside the Project area.
- Manage and monitor vibrations as per Section 7.7.

7.10.5 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) to manage potential European heritage values impact triggers include, but are not limited to those outlined in Table 17.

Table 17: Contingency Actions for the European Heritage Management Plan

Trigger	Potential Actions
Indirect disturbance to European heritage site.	■ Cease disturbance activity and fence off area around site including a 20 m buffer. ■ SP to work with the relevant regulatory authorities to assess and remediate the area.

If the implemented contingency actions do not resolve the issue, SP is to report the impacts as well as contingency measures applied to the relevant regulatory authorities within a timely manner.

7.11 Waste Management Plan

7.11.1 Management Objectives

The environmental objective adopted for the Project relating to solid and liquid waste is to ensure that wastes do not adversely affect the health, welfare and amenity of people and land uses, and that they are managed in accordance with the waste hierarchy outlined in DER guidance (DEC, 2005b).

The Project's environmental objectives with regard to waste management during the Construction Phase are to:

- Minimise and manage generation of waste from the Construction Phase of the Project by reducing waste streams and recycling material where possible.
- Dispose of waste in an environmentally acceptable manner and consistent with the requirements of the DER and other regulatory requirements.

Contaminated soils management is outlined in the Contaminated Sites Management Plan (Golder 2013a) and reference should be made to Section 10.1.6 for further details.

7.11.2 Limits and Targets

Waste management will be implemented according to the following regulations and legislation:

- *Environmental Protection (Controlled Waste) Regulations 2004.*
- *Environment Protection Act 1986*.
- Review of Waste Classification and Waste Definitions 1996 (as amended).
- *Litter Act 1979* (currently under review by DER and will be incorporated into the EP Act).
- Western Australian Guidelines for Direct Land Application of Biosolids and Biosolids Products, February 2002.
- *Dangerous Goods Safety Act 2004* and regulations.

7.11.3 Potential Environmental Impacts

Waste anticipated to be generated during the Construction Phase can be classified as:

- Waste soils
- Contaminated soils
- Wastewater
- Stormwater

- Sewage waste
- Industrial waste such as scrap metal
- Controlled wastes such as hydrocarbon waste
- Domestic waste from crib rooms.

The potential impacts of the Project during the Construction Phase associated with poor waste management are:

- Waste or leachate from waste storage areas has the potential to contaminate groundwater and surface water in the unlikely event of a spill that isn't immediately remediated.
- Putrescible wastes can become a food source for non-indigenous fauna and/or native animals.
- Waste storage areas can constitute an increased fire risk.
- Litter can impact the visual amenity.
- Odours from waste storage areas may be offensive.
- Soil, surface water and groundwater contamination may occur as a result of inappropriate storage and disposal.
- Excessive waste generation/inefficient use of resources.

7.11.4 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise waste during the Construction Phase are:

- All fuel and other hazardous material will be stored and transported in accordance with the *Dangerous Goods Safety Act 2004* and regulations. All fuel and other hazardous material stored on site will be stored in appropriately sealed containers on a designated and appropriately sized bunded pallet within an appropriate storage area.
- A licensed waste management contractor will regularly remove contaminated and classified wastes off-site for licensed disposal or recycling. Volumes are recorded in a waste disposal register.
- Spill kits will be located in prominent areas throughout the site and the Lead Contractor(s) are responsible for training all site personnel on their use.
- The Lead Contractor(s) shall prepare a spill clean-up and management procedure.
- General domestic waste will be collected and stored in appropriately sealed bins.
- A waste recycling program will be implemented to reduce waste and maximise recycling. The waste recycling program will include:
  - Separate labelled bins for general waste and for recycled waste.
  - A separate bin for aluminium can recycling.
- Sewage will be treated via an appropriate sewage system or stored within designated tanks associated with portable toilet facilities and removed at regular intervals by an appropriately licenced contractor.
- Management of stormwater will be undertaken as outlined in Section 7.4.

- Adhere to the waste management hierarchy of elimination, reduction, reuse, recycling, treatment and disposal where possible. Disposal should only be considered as a last resort.
- Manage all waste generated in a manner which minimises any potential impacts to the environment.
- Ensure waste management complies with regulatory requirements and/or licence conditions.
- Personnel will be required to participate in an environmental induction program and relevant training prior to working on site. Staff inductions and training will be developed to include:
  - A component that identifies the risks and impacts associated with wastes.
  - Correct handling and storage procedures for waste.
  - Principles of waste minimisation.
  - Recycling awareness training to inform all site personnel of what can be recycled and methods of recycling available.
  - Correct transport and disposal procedures for waste.
  - Emergency Spill Response Procedure.
  - Waste reporting requirements.
  - Maintenance of anaerobic sewage treatment system.
- Spill clean-up procedures will be implemented, including the preferred remediation process for all contaminated material on site, including diesel, wastewater and stormwater.
- Testing and treatment of any cut and fill material will be undertaken in accordance with DER guidance (DEC, 2005b).
- Soils proposed for re-use on site will follow the guidelines for soil management as presented in Section 10.1.6 of the CSMP (Golder, 2013a).
- Disposal of contaminated soil and other material is managed under the conditions in the CSMP (Golder, 2013a).

7.11.5 Monitoring Procedures

The Lead Contractor(s) will be required to monitor for contamination as per requirements of the CSMP (Golder, 2013a). This may include:

- Vapour monitoring
- Soil testing
- Waste classification e.g. if soil (cut or contaminated material) is required to be taken off-site
- Groundwater and Swan River monitoring
- Abstracted water monitoring as part of earthworks e.g. surcharge expelled water.

The frequencies for monitoring of parameters are provided in the CSMP (Golder, 2013a).

Litter and general waste disposal practices will be monitored daily during the Daily Construction Environmental Inspection (see Appendix A for the Daily Construction Environmental Inspection Checklist).

7.11.6 Contingencies

The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor and the relevant regulatory authorities where required by Section 15.0. Contingency actions to be taken by the Lead Contractor(s) to manage potential waste impact triggers include, but are not limited to those outlined in Table 18.

Table 18: Contingency Actions for the Waste Management Plan

Trigger	Potential Actions
Complaints from relevant regulatory bodies are received regarding the disposal of waste in an environmentally unacceptable manner.	■ Investigate and consult with the relevant government body to identify the deficiencies in the management of waste and the appropriate means of rectifying the issue.
Soils generated from cut activities re-used on site do not meet the soil management guidelines, as outlined in the CSMP.	■ Cease operations in the area where the soil has been used as fill. ■ Investigate and consult with the Contaminated Site Auditor and the DER, where practicable to identify the appropriate means of rectifying the issue.
Leak or spill of hydrocarbon waste or hydrocarbon contaminated material occurs within the Project area.	■ SP to advise DER. ■ Implement Emergency Incident Response Procedure (refer Section 14.0).
Leak or spill of sewage waste occurs within the Project area.	■ Implement Emergency Incident Response Procedure (refer Section 14.0).
The volume of non-recyclable wastes disposed (following the first year of the Construction Phase) has exceeded that of the previous year.	■ Investigate the cause of not achieving a reduction in volume disposed of non-recyclable wastes. If the change was not met due to activity that can be modified, remove the cause where appropriate and identify additional measures by which this target can be met in the coming year.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, SP is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

7.12 Soil Management Plan

For management objectives, limits and targets, potential environmental impacts, management measures and monitoring procedures relating to the management of soil, refer to Section 10.1 of the CSMP (Golder, 2013a) attached as Appendix E.

7.13 Dewatering Management

For management objectives, limits and targets, potential environmental impacts, management measures and monitoring procedures, see the DMP (Golder, 2012e) attached as Appendix D.

7.14 Contaminated Site Management

For management objectives, limits and targets, potential environmental impacts, management measures and monitoring procedures, see the CSMP (Golder, 2013a) attached as Appendix E.

8.0 OPERATING PHASE ENVIRONMENTAL IMPACTS, MANAGEMENT AND MONITORING

8.1 Overview

An EMF has been developed for each phase of the Project and the content used to develop this Project EMP. The Lead Contractor engaged for the Operating Phase of the Project is required to prepare an OEMP applicable to their specific operations based on the content of the OEMF, this Project EMP and the Environmental Sub-Management Plans (where applicable).

The Lead Contractor is required to conduct phase specific risk assessments for each environmental and social factor and receptor to identify phase specific predicted environmental and social impacts. The outcomes of this will be used as the basis for the development of the content of the Stadium Governance body's OEMP. The Lead Contractor will be required to prepare and maintain an aspects and impacts register as part of their OEMP.

The environmental commitments have been drafted based on regulatory requirements, baseline studies completed, discussions held during the working groups and with the regulatory stakeholders. Potential contingency actions listed are minimum requirements and are not exhaustive. Additional environmental issues may be identified or alternative contingency actions may become available as the project progresses.

Monitoring procedures will be approved by SP or the Stadium Governance body prior to being implemented and may engage the regulatory agencies to review the monitoring procedures to ensure their requirements are met.

8.2 Terrestrial Flora and Fauna

8.2.1 Management Objectives

The Project's environmental objectives with regard to the management of impacts to terrestrial flora and fauna during the Operating Phase are to:

- Minimise and manage impacts on flora not cleared for site works.
- Promote the growth of local species and a stable vegetation community through rehabilitation and maintenance of preserved areas.
- Minimise and manage the impacts on terrestrial vegetation not cleared during site works.
- Minimise and manage impacts to indigenous or otherwise protected fauna that are located on site, including the protection of remaining fauna habitats.

8.2.2 Potential Environmental Impacts

Potential impacts to terrestrial flora and fauna during the Operating Phase are particularly dependent on the conservation and preservation of remaining undisturbed avian fauna habitat (the River-fed Lake (Figure 3), the adjacent Swan River environment and any remaining tree habitats).

The potential impacts of the Project during the Operating Phase to terrestrial flora and fauna are:

- Groundwater dependant (phreatophytic) vegetation as terrestrial fauna habitat may be impacted by alteration in shallow groundwater hydroperiod and level as a result of sustained changes to groundwater and surface water levels and connectivity.
- Increased greenhouse gas emissions contributed by the operation of new buildings and associated vehicle emissions.
- Increased risk of chronic fuel and chemical toxicity associated with the entertainment venue operating adjacent to wildlife habitat including pollution due to incidents such as poor waste management and spills.

- Introduction of terrestrial flora and fauna pests.
- Introduction of soil pathogens such as *Phytophthora* spp.
- Indirect terrestrial flora and fauna habitat conservation risks associated with a large entertainment venue operating adjacent an estuary and river habitat including increased human impacts, high traffic volumes, increased risk of pollution due to incidents such as poor waste management and storm-water discharge and alteration in hydrology and hydrogeology of underlying aquifer(s), estuaries, lakes and the River environments as a result of pollution and contamination.
- Aural and other impacts to terrestrial fauna due to noise and vibration impacts as a result of increased vehicle operation and operational noise such as that produced by a crowd of 70 000 people.
- Respiratory impacts to terrestrial fauna due to increased particulate emissions as a result of increased traffic volumes within the Project area.
- Indirect effects from light pollution affecting circadian rhythms and migratory activity patterns.

8.2.3 Management Measures

Management measures to be taken by the Lead Contractor to minimise impacts to terrestrial flora and fauna during the Operating Phase are:

- Maintenance and upkeep of rehabilitated flora and vegetation surrounding the Project.
- Prevention and mitigation of contamination to land, groundwater and surface water resulting from spills through the implementation of the waste management measures as outlined in Section 8.8 and the CSMP (Golder, 2013a).
- Implementation of any specific conditions applied to the Project by regulatory authorities.

8.2.4 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor during the Operating Phase.

Monitoring of rehabilitated vegetation areas and landforms will be undertaken by a suitably qualified Environmental Representative to determine if further rehabilitation works are required. Monitoring should also be made of any disturbed areas to ascertain if remedial works are required to prevent deterioration of these occurring after project works have ceased. Monitoring will continue during the first three years of the Operating Phase and following this three year period, a review will determine if monitoring is to occur and to at what frequency.

8.2.5 Contingencies

The Lead Contractor has responsibility for the implementation of contingency actions, is to notify the Stadium Governance Body within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. Contingency actions to be taken by the Lead Contractor to manage potential terrestrial flora and fauna impact triggers include, but are not limited to those outlined in Table 19.

Table 19: Contingency Actions for Management of Terrestrial Flora and Fauna

Trigger	Potential Actions
A weed outbreak occurs on site	■ Review weed hygiene management procedures, which will include hand removal, spraying, etc. (developed by the Lead Contractor in the Rehabilitation Management Plan). ■ Develop and implement appropriate weed management procedure.
Condition of any vegetation remaining within the Project area or in close proximity to the Project area declines in comparison to baseline conditions.	■ Increase vegetation-monitoring frequency to detect if vegetation condition is within natural fluctuation or is further declining. ■ Review groundwater level and quality monitoring data and compare with vegetation condition parameters. ■ If groundwater conditions indicate that there is potential for impact to vegetation, investigate supplying vegetation with water until the groundwater level/quality returns to background levels. ■ If it does not appear that a change in groundwater conditions is the cause of the decline, then investigate alternative causes for the decline e.g. dust impacts, biological infestation. ■ Undertake rehabilitation activities in affected area (e.g. revegetation with local provenance species).
An incidence of death or injury to conservation significant fauna occurs within the Project area due to Project operations.	■ Stadium Governance body to advise DER. ■ Collect or capture dead/injured fauna and treat or preserve specimen based on DER advice. ■ The Stadium Governance body to advise relevant regulatory agencies if required. ■ Investigate mitigation measures in consultation with the DER.
Individuals or populations of species of conservation significance are at risk from operations.	■ Stadium Governance body to advise DER. ■ Investigate relocation of populations and species in consultation with the DER.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, the Stadium Governance body is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

8.3 Aquatic Flora and Fauna

8.3.1 Management Objectives

The Project's environmental objectives with regard to the management of impacts to aquatic flora and fauna during the Operating Phase are to:

- Minimise and manage the impacts to aquatic flora and fauna located around the Project area.
- Minimise and manage the impacts to aquatic flora and fauna in the River-fed Lake and in the Swan River.
- Promote the growth of local species and a stable vegetation community through rehabilitation and maintenance of preserved areas.
- Minimise and manage the impact to native aquatic fauna habitat.

8.3.2 Potential Environmental Impacts

The potential impacts of the Project during the Operating Phase to aquatic flora and fauna are:

- Indirect aquatic flora and fauna habitat conservation risks associated with a large entertainment venue operating adjacent an estuary and river habitat including increased human impacts and high traffic volumes.
- Indirect aquatic flora and fauna habitat contamination risks associated with a large entertainment venue operating adjacent an estuary and river habitat including increased risk of pollution due to incidents such as poor waste management and storm-water discharge.
- Indirect aquatic flora and fauna habitat contamination risks due to the alteration in hydrology and hydrogeology of underlying aquifer(s), estuaries, lakes and the River environments as a result of pollution and contamination.
- Aural and other impacts to aquatic fauna due to noise and vibration impacts as a result of increased vehicle operation and operational noise such as that produced by a crowd of 70 000 people.
- Respiratory impacts to aquatic fauna due to increased particulate emissions as a result of increased traffic volumes within the Project area.
- Indirect effects from light pollution affecting circadian rhythms and migratory activity patterns.
- Introduction of aquatic flora and fauna pests.

8.3.3 Management Measures

Management measures to be taken by the Lead Contractor to minimise impacts to terrestrial and aquatic flora and fauna during operations are to:

- Develop roosting sites around the River-fed Lake during the rehabilitation planning phase to provide higher quality habitat to offset habitat loss and also predator protection.
- Prohibit fishing in the River-fed Lake to maintain a breeding habitat for fish.
- Reinstate woody vegetation on and around the Project area that provides roosting sites and food resources for Black Cockatoo as vegetation of choice.
- Avoid use of fertilisers and pesticides near waterways and near surfaces that could carry these to waterways.
- Rehabilitate impacted Swan River foreshore through context-sensitive armouring and re-vegetation, where required.
- Manage contamination to land, groundwater and surface water and spills and contamination risks, potentially impacting remaining habitat areas (Both terrestrial and aquatic), by implementing the waste management measures listed in Section 8.8 and the Contaminated Site Management Plan (Golder, 2013a) which include a spill clean-up and remediation procedure.
- Prepare a Nutrient Irrigation Management Plan to manage the use of fertilisers and pesticides near waterways and near surfaces that could carry these to waterways.
- Implementation of any specific conditions applied to the Project by regulatory authorities.

8.3.4 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Lead Contractor during the Operating Phase.

To determine if any long term impacts have occurred to the immediate Swan River foreshore and the River-fed Lake, follow-up vegetation and bank condition monitoring along the Swan River adjacent to the Project area and around the River-fed Lake will be undertaken in spring for three years during the Operating Phase.

Rehabilitated vegetation areas and landforms will be monitored to determine if further rehabilitation works are required. Monitoring of any disturbed areas will be undertaken to ascertain if remedial works are required to prevent deterioration of these occurring after Project works have ceased. Monitoring will continue during the first three years of the Operating Phase and following this three year period, a review will determine if monitoring is to occur and to at what frequency.

8.3.5 Contingencies

The Lead Contractor has responsibility for the implementation of contingency actions, is to notify the Stadium Governance body within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. Contingency actions to be taken by the Lead Contractor for the management of aquatic flora and fauna triggers include, but are not limited to those outlined in Table 20.

Table 20: Contingency Actions for Management of Aquatic Flora and Fauna

Trigger	Potential Actions
Sediment plume or discharge is visually evident within the River-fed Lake or the Swan River.	■ Stadium Governance body to advise DER and SRT. ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area.
Condition of any aquatic vegetation remaining within Project area or in close proximity of the Project area declines in comparison to baseline conditions.	■ Increase aquatic vegetation-monitoring frequency to detect if vegetation condition is within natural fluctuation or is further declining ■ Compare aquatic vegetation condition parameters with surface water level and quality monitoring data. ■ If surface water conditions indicate that there is potential for impact to aquatic vegetation investigate adding/treating surface water until the surface water level/quality returns to background levels. ■ If it does not appear that a change in surface water conditions is the cause of the decline, then investigate alternative causes for the decline e.g. dust impacts, disease outbreak ■ Undertake rehabilitation activities in affected area (e.g. re-vegetation with local provenance species).
An incidence of Fishkill occurs within the Swan River or the River-fed Lake.	■ Stadium Governance body to advise DER and SRT. ■ Identify the source of contamination. ■ Investigate mitigation measures in consultation with the DER and SRT.
Erosion of the riparian environment of the River-fed Lake or the Swan River is visually worse than background levels.	■ Stadium Governance body to advise DER and SRT. ■ Investigate the cause of erosion. ■ If the change is due to Project works and is an activity that can be modified, remove the cause as appropriate.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, the Stadium Governance body is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

8.4 Surface Water

8.4.1 Management Objectives

The Project's environmental objectives with regard to the management of impacts to surface water during the Operating Phase are to:

- Protect the ecosystem surrounding the Project area.
- Emissions are to not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Minimise and manage potential impacts to the quality of surface water and groundwater resources caused by the Operating Phase.
- Maximise the efficient use of water for the Project.
- Ensure the continued use of water resources.

8.4.2 Potential Environmental Impacts

The potential impacts of the Project during the Operating Phase to surface water are:

- Alteration in hydrology and hydrogeology of underlying aquifer(s), estuaries, lakes and the River environments as a result of pollution and contamination.
- Conservation risks associated with the entertainment venue operating adjacent an estuary and river habitat such as increased human impacts due to high pedestrian and vehicle traffic volumes.
- Contamination risks associated with the entertainment venue operating adjacent an estuary and river habitat including pollution due to incidents such as poor waste management and storm-water discharge.

8.4.3 Management Measures

Management measures to be taken by the Lead Contractor to minimise impacts to surface water during operations are:

- Implementation of the Stormwater Management Plan prepared by the Construction Phase Lead Contractor based on specific site works and guidelines such as the *Better Urban Water Management* (WAPC, 2008), including measures such as:
  - Deviation of stormwater around infrastructure to specified, bunded collection points.
  - Direction of stormwater to stormwater collection drains/sewer.
  - Prevention of stormwater pooling.
  - Prevention of stormwater flow near surface water bodies.
  - Location and design of bulk fuel and chemical storage facilities.
  - Water conservation.
  - Measures to prevent erosion.
  - Measures to control sediment transport.

- Continue to monitor ground and surface water for three years into the Operating Phase of the Project to determine any adverse impacts to water quality and implement contingency measures where required.
- Manage pedestrian and vehicle traffic by constructing a network of pedestrian access ways and roads to preserve of the riparian flora in the 10 m wide Swan River buffer zone between the Swan River and the Project area. Managing the flow of pedestrian and vehicle traffic will minimise erosion, maintain bank stability and maintain some habitat for terrestrial and aquatic fauna.
- Manage waste at the Stadium by providing sufficient waste disposal bins, recycling bins and other waste collection points within and surrounding the Stadium.
- Maintain the extensive stormwater and urban water collection and management system within the Stadium and associated infrastructure design to prevent contamination to land, groundwater and surface water due to spills and unmanaged surface water flows.
- Should the water quality of stormwater be suitable, consideration should be given to the reuse of stormwater where appropriate, such as for irrigation.
- Implementation of any specific conditions applied to the Project by regulatory agencies.

8.4.4 Monitoring Procedures

Surface water monitoring will be undertaken during the first three years of the Operating Phase of the Project to ensure that the ongoing quality of surface water in the surrounding ecosystem is not detrimentally affected. Monitoring to be undertaken by the Lead Contractor will include at a minimum:

- Monthly water quality sampling of the parameters and units outlined in Table 5 in the Swan River. Numerous samples should be taken for each point of potential contamination to provide both reference and impacted site results. It is recommended that there are a minimum of five sampling locations within the Swan River, including two locations upstream and two locations downstream of the Project area.
- Monthly water quality sampling of the parameters and units outlined in Table 5 for the River-fed Lake within the Project area to identify any adverse alterations in baseline water quality. Positive identification of adverse alterations in baseline water quality will require the implementation of management and contingency measures listed in the Lead Contractor's OEMP and the CSMP (Golder, 2013a).
- Monthly inspections of the stormwater capture system to ensure that debris are cleared to prevent the possibility of blockages. An inspection should be undertaken prior to inclement weather should it be forecast with enough warning to do so.
- Weekly inspections of the River-fed Lake within the Project area to identify and remove any waste from the lakes.
- Monitoring will continue during the first three years of the Operating Phase and following this three year period, a review (undertaken by the Stadium Governance body, in liaison with relevant regulatory authorities if required) will determine if monitoring is to occur and to at what frequency.
- Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in the Golder (2012f).

8.4.5 Contingencies

The Lead Contractor has responsibility for the implementation of contingency actions, is to notify the Stadium Governance Body within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. Contingency actions to be taken by the Lead Contractor for the management of potential surface water impact triggers include, but are not limited to those outlined in Table 21.

Table 21: Contingency Actions for Management of Surface Water

Trigger	Potential Actions
Contaminated surface water is discharged to the surrounding environment.	■ Stadium Governance body to advise DER. ■ Confirm that risk assessment is still valid. ■ Implement the Environment Incident Response Procedure. ■ Prevent further flow of contaminated water to the surrounding environment. ■ Remove the source of contamination. ■ Undertake remediation/rehabilitation within the affected area, if practicable.
Surface water quality is in exceedance of trigger values.	■ Identify source of water quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate.
Sediment plume or discharge is visually evident downstream of a disturbed area or within the River-fed Lake/the Swan River.	■ Stadium Governance body to advise SRT and DER. ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area, if practicable, as per DER/SRT advice.
Storm water system is blocked and/or overflowing.	■ Identify location and source of blockage. ■ Remove blockage. ■ Clean-up spilt or pooling storm water as required.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, the Stadium Governance body is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

8.5 Groundwater

8.5.1 Management Objectives

The Project's environmental objectives with regard to the management of impacts to groundwater during the Operating Phase are to:

- Maintain and protect the quality, levels and useability of the groundwater within the underlying groundwater system.
- Ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Minimise and manage potential impacts to the quality of surface water and groundwater resources caused by the Operating Phase.
- Maximise the efficient use of water for the Project.

8.5.2 Potential Environmental Impacts

The potential impacts of the Project during the Operating Phase to groundwater are:

- Alteration in hydrology and hydrogeology of underlying aquifer(s), estuaries, adjacent lakes and the Swan River environments as a result of clearing flora and disturbance of lakes.

- Landfill contaminants and leachate seeping into the groundwater over time due to disturbances during the Construction Phase.
- Contamination risks associated with an entertainment venue operating above an aquifer habitat including pollution due to incidents such as poor waste management and storm-water discharge.

8.5.3 Proposed Management Measures

Management measures to be taken by the Lead Contractor to minimise impacts to groundwater during operations are:

- Control of contamination to groundwater and land and surface water due to spills and contamination risks, potentially impacting groundwater, by implementing the waste management measures as outlined in Section 8.8 and the CSMP (Golder, 2013a).
- Maintain the extensive stormwater collection and management system within the Stadium and associated infrastructure design to prevent contamination to land, groundwater and surface water due to spills and unmanaged surface water flows.
- Avoid use of fertilisers and pesticides near waterways and near surfaces that could carry these to waterways.
- Prepare a Nutrient Irrigation Management Plan to manage the use of fertilisers and pesticides near waterways and near surfaces that could carry these to waterways.
- Implementation of any specific conditions applied to the Project by regulatory agencies.

8.5.4 Monitoring Procedures

Specific monitoring procedures to be undertaken by the Lead Contractor for the management of groundwater during operations are:

- Quarterly monitoring of groundwater bores for first three years of the Operating Phase to allow continued monitoring of water quality trends (at a minimum the parameters outlined in Section 8.5.4) and groundwater pressures to identify any adverse effects of the Operating Phase to groundwater quality trends.
- Monthly inspections of stormwater capture infrastructure to ensure blockages and overflows do not occur. Inspections should be carried out more regularly should inclement weather be forecast.
- Monitoring will continue during the first three years of the Operating Phase and following this three year period, a review (undertaken by the Stadium Governance body, in liaison with relevant regulatory authorities if required) will determine if monitoring is to occur and to at what frequency.
- Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in the SAP (Golder, 2012f).

8.5.5 Contingencies

The Lead Contractor has responsibility for the implementation of contingency actions, is to notify the Stadium Governance Body within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. Contingency actions to be taken by the Lead Contractor for the management of potential groundwater impact triggers include, but are not limited to those outlined in Table 22.

Table 22: Contingency Actions for Management of Groundwater

Trigger	Potential Actions
Measured decline in groundwater levels is at variance to the modelled change.	■ A groundwater specialist is to review groundwater monitoring results. ■ Increase monitoring frequency to daily groundwater level measurements. ■ Additional strategically placed monitoring wells could be installed and monitored daily, depending on the outcome of the review of the results. ■ Investigate options to further optimise groundwater extraction. ■ Recalibrate groundwater model.
Contaminated groundwater is discharged to the surrounding environment	■ Stadium Governance body to advise DER. ■ Confirm that risk assessment is still valid. ■ Prevent runoff of contaminated water to the surrounding environment. ■ Remove the source of contamination. ■ Repair the groundwater storage infrastructure or address the pathway to the surrounding environment.
Groundwater quality is in exceedance of trigger values.	■ A groundwater specialist is to review groundwater monitoring results. ■ Increase monitoring frequency (i.e. weekly laboratory analysis or inclusion of additional analytes to be tested). ■ Additional strategically placed monitoring wells may be required to be installed and monitored in accordance with the revised monitoring schedule to gain a better understanding of the cause. ■ Identify source of water quality change. ■ Actions outlined in DMP (Golder, 2012e) to be strictly followed. ■ If the change is due to activity that can be modified, remove the cause as appropriate. This may include further optimising the rate of groundwater extraction.
Survey of adjacent structures shows settlement or abnormalities.	■ Any dewatering operations should cease immediately, if safe to do so. ■ A geotechnical specialist should be employed to review the data and propose appropriate measures.

Trigger	Potential Actions
Identified deteriorating groundwater quality	■ Stadium Governance body is to advise the Contaminated Sites Auditor should they have a continued involvement in the Project. ■ A groundwater specialist is to review groundwater monitoring results. ■ Increase monitoring frequency ■ Additional strategically placed monitoring wells may be required to be installed and monitored in accordance with the revised monitoring schedule to gain a better understanding of the cause. ■ Identify source of water quality change. ■ Implement actions outlined in the DMP (Golder, 2012e). ■ If the change is due to activity that can be modified, remove the cause as appropriate.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, the Stadium Governance body is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

8.6 Noise

8.6.1 Management Objectives

The Project's environmental objectives with regard to the management of noise impacts during the Operating Phase are to:

- Minimise and manage noise generation from the Project area
- Minimise any impacts to sensitive receptors surrounding the Project (including: local residents, recreational users, commercial users and flora and fauna).

8.6.2 Operational Noise Criteria

Regulation 7 defines the prescribed standard for noise emissions as follows:

1) Noise emitted from any premises or public place when received at other premises
   a) Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind, and
   b) Must be free of
      i) Tonality
      ii) Impulsiveness, and
      iii) Modulation.

As defined in Regulation 7, noise emissions are taken to significantly contribute to a level of noise if the noise emission exceeds a value which is 5 dB below the assigned level.

Assigned noise levels vary according to the receiving premises and the time of day. Regulation 8 details the assigned noise levels for each of the three noise descriptors used;

- L_{Amax} - noise level not to be exceeded at any time
- L_{A1} - noise level not to be exceeded for more than 1% of the time
- L_{A10} - noise level not to be exceeded for more than 10% of the time.

Table 23 presents the assigned outdoor noise levels for different periods of the day. The influencing factor (IF) is calculated based on the amount of land that is designated for commercial and industrial use and the presence of major roads within 450 m of the noise sensitive receiver.

Table 23: Assigned Outdoor Noise Level

Premises Receiving Noise	Time of Day	Assigned Level		
		L_{A10}	L_{A1}	L_{Amax}
Residential	0700-1900 hours Monday to Saturday	45 + IF	55 + IF	65 + IF
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays	40 + IF	50 + IF	65 + IF
	1900-2200 hours all days	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays	35 + IF	45 + IF	55 + IF
Commercial	All hours	60	75	80
Industrial and utility premises	All hours	65	80	90

Levels described in Table 23 are conditional on no characteristics such as tonality, modulation or impulsiveness. If such characteristics exist then any measured level is adjusted according to Table 24.

Table 24: Adjustments to Measured Levels

Where Tonality is Present	Where Modulation is Present	Where Impulsiveness is Present
+5 dB(A)	+5 dB(A)	+10 dB(A)

The regulations allow for exemptions from the assigned noise levels for special activities that benefit the community such as outdoor concerts and community activities such as sporting events. Regulation 16 exempts noise emitted by spectators at an organised sporting activity; however, the regulation specifies a procedure to deal with noise problems that may occur from an exempt noise.

8.6.3 Potential Environmental Impacts

The potential noise impacts of the Project during the Operating Phase are:

- Large events proposed to be held at the Stadium such as sporting events and music concerts will cause an increase in localised noise and potentially vibration concerns from neighbouring properties (residential, commercial and recreational) and heritage buildings.
- With a proposed capacity of 60 000 people, large numbers of crowds entering and leaving the area via several different transportation methods pose to cause noise and disruption to local residents. There may even be the risk of antisocial behaviour with crowds lingering in the area prior to dispersal.

8.6.4 Management Measures

Management measures to be taken by the Stadium Operator to minimise noise impacts during operations are:

- Local residents' noise concerns will be managed though good stakeholder engagement and consultation. Local residents and Burswood Peninsula users will be aware of the intensions of the Perth Stadium including the types of events to be held at the Stadium, the degree of noise to be generated and the hours of operation well before the Operating Phase begins.
- Prepare a separate Noise Management Plan to be approved by the relevant local council and/or DER if events to be held outside of normal hours are proposed.
- Implementation of any specific conditions applied to the Project by the relevant regulatory agencies.
- Crowd control will be managed and large events may require police presence. There is also proposed to be several transportation options for crowds to disperse after an event including public transportation via the train line, pedestrian walkways to the Perth CBD and taxis operate within the Burswood Entertainment precinct.

8.6.5 Monitoring Procedures

This section outlines the monitoring procedures to be undertaken by the Stadium Operator.

Noise monitoring will be conducted by a suitably qualified specialist to determine any adverse impacts due to noise emissions. Noise emissions will be managed according to relevant conditions in the EP Act and the *Environmental Protection (Noise) Regulations 1997.*

Noise monitoring will be undertaken regularly by a suitably qualified specialist at the boundary of the premises or at nearby sensitive receptors. Monitoring will be undertaken in accordance with *Environmental Protection (Noise) Regulations 1997* and include the L_{Amax}, L_{A10} and L_{A1} noise levels.

Noise monitoring results will be compared to the assigned noise level as outlined in Regulation 7.
Any adverse environmental impacts identified as a result of noise monitoring will be managed according to the management measures listed in Section 8.6.4.

Monitoring will continue during the first three years of the Operating Phase and following this three year period, a review (undertaken by the Stadium Governance body, in liaison with relevant regulatory authorities if required) will determine if monitoring is to continue and at what frequency.

8.6.6 Contingencies

The Stadium Operator has responsibility for the implementation of contingency actions, is to notify the Stadium Governance Body within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. Contingency actions to be taken by the Stadium Operator for the management of potential noise impact triggers include, but are not limited to those outlined in Table 25.

Table 25: Contingency Actions for Management of Noise

Trigger	Potential Actions
Noise levels are reported in exceedance of trigger values	■ Identify source of noise or vibration levels increase. ■ If the change is due to activity that can be modified, remove the cause as appropriate.
Noise complaint is received.	■ Investigate reason for complaint. ■ Increase noise management measures, if practicable.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, the Stadium Governance body is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

8.7 Visual Amenity

8.7.1 Management Objectives

The Project's environmental objectives with regard to the management of visual amenity during the Operating Phase are to:

- Minimise and manage impacts to the visual amenity of the Swan River and the Burswood Peninsula.

8.7.2 Potential Environmental Impacts

The potential visual amenity impacts of the Project during the Operating Phase are:

- Aesthetics and visual amenity issues associated with a large sporting Stadium and related infrastructure may be unfavourable to some residents in the area, as it has replaced a public golf course.
- Increased traffic volumes within the Project area as well as surrounding roads could cause concern to local residents and users of the public spaces and surrounding entertainment venues.
- If events were to be held at the Stadium during the night, lighting would be required to light the Stadium, which may cause disruption to neighbouring properties.
- Excessive light exposure impacts to fauna if the Stadium is to operate at night.

8.7.3 Management Measures

Management measures to be taken by the Lead Contractor and/or Stadium Operator to minimise visual amenity impacts during the Operating Phase are:

- Local residents' aesthetics and visual amenity concerns will be managed though good stakeholder engagement and consultation. Local residents and Burswood Peninsula users will be aware of the intensions of the Stadium well before the Operating Phase begins.
- The areas surrounding the Stadium will be landscaped to increase aesthetics of the Project and to follow the aesthetics of the Burswood Peninsula area's gardens. Replacement of habitat favoured by species previously frequent in the area such as the Carnaby's Black Cockatoo will be integrated into the landscaping design.
- Increased traffic volumes will be managed through the development of a Traffic Management Plan.
- Lighting of the Stadium will operate according to local government restrictions and regulations.
- Noise at the Stadium will be managed according to local government restriction and regulations (see Section 7.7).

8.7.4 Monitoring Procedures

The proposed monitoring procedures to be undertaken by the Lead Contractor and/or Stadium Operator to assess visual amenity impacts during the Operating Phase are to:

- Undertake a monthly review of complaints received to establish what aspects of the Project are impacting on the visual amenity of Burswood Peninsula users and local residents. Record all responses to complaints received during the Operating Phase. Where practicable and reasonable, implement changes to improve on the visual amenity of Burswood Peninsula users and local residents.

- Monitoring will continue during the first three years of the Operating Phase and following this three year period, a review will determine if monitoring is to occur and to at what frequency.

8.8 Waste

8.8.1 Management Objectives

The Project's environmental objectives with regard to the management of waste during the Operating Phase are to:

- Minimise and manage generation of waste from the Operating Phase of the Project by reducing waste streams and recycling material where possible.
- Dispose of waste in an environmentally acceptable manner and consistent with the requirements of the DER and other regulatory requirements.

8.8.2 Limits and Guidelines

These management measures for waste have been developed in accordance with the provisions of the *Environmental Protection Act 1986, Contaminated Sites Act 2003* and *Environmental Protection (Controlled Waste) Regulations 2004.* DER is the administering authority for this legislation.

8.8.3 Potential Environmental Impacts

Waste resulting from the Project during the Operating Phase can be classified as:

- Sewage waste
- Domestic waste.

The potential impacts of the Project due to poor waste management during the Operating Phase are odour and contamination risks associated with these services.

8.8.4 Management Measures

General municipal waste disposal, recycling programs, sewage systems and associated facilities will be installed and operating during the Operating Phase of the Project. Appropriate waste contractors will be engaged to remove municipal and recycling waste. The Lead Contractor will be responsible for ensuring the Stadium is litter free and for engaging a suitable waste management contractor/cleaning contractor. The Lead Contractor may develop a specific waste management plan for the Stadium.

8.8.5 Contingencies

The Stadium Operator has responsibility for the implementation of contingency actions, is to notify the Stadium Governance body within the allocated timeframe (refer Section 15.0) and shall document the event as a non-conformance. Contingency actions to be taken by the Lead Contractor to manage potential waste impact triggers include, but are not limited to those outlined in Table 26.

Table 26: Contingency Actions for Management of Waste

Trigger	Potential Actions
Complaints from relevant regulatory bodies are received regarding the disposal of waste in an environmentally unacceptable manner.	■ Investigate and consult with the relevant government body to identify the deficiencies in the management of waste and the appropriate means of rectifying the issue.
Leak or spill of hydrocarbon waste or hydrocarbon contaminated material occurs within the Project area.	■ Stadium Governance body to advise DER. ■ Implement Emergency Incident Response Procedure (refer Section 14.0).

Trigger	Potential Actions
Leak or spill of sewage waste occurs within the Project area.	■ Stadium Governance body to advise DER. ■ Implement Emergency Incident Response Procedure (refer Section 14.0).
The volume of non-recyclable wastes disposed (following the first year of the Operating Phase) has exceeded that of the previous year.	■ Investigate the cause of not achieving a reduction in volume disposed of non-recyclable wastes. If the change was not met due to activity that can be modified, remove the cause where appropriate and identify additional measures by which this target can be met in the coming year.

If the implemented contingency actions do not resolve the issue and the relevant regulatory authorities have not previously been notified, the Stadium Governance body is to report the issue as well as contingency measures applied to the relevant regulatory authorities within a timely manner. Environmental incidents will be reported as per Section 15.0.

8.9 Dewatering Management

For management objectives, limits and targets, potential environmental impacts, management measures and monitoring procedures, see the DMP (Golder, 2012e) attached as Appendix D.

8.10 Contaminated Site Management

For management objectives, limits and targets, potential environmental impacts, management measures and monitoring procedures, see the CSMP (Golder, 2013a) attached as Appendix E.

9.0 REHABILITATION MANAGEMENT PLAN

9.1 Overview

Rehabilitation of the Project will be a joint effort between the PCS Works and Stadium Works Lead Contractor(s) of the Construction Phase and the Lead Contractor(s) of the Operating Phase, with each phase having a number of requirements to address. The minimum rehabilitation requirements are detailed below. It is expected that during the Construction Phase appropriate clearing of flora and vegetation and the demarcation and protection of designated preservation areas will be undertaken along with the rehabilitation of the Project leading into the Operating Phase. It is expected that the Operating Phase will be tasked with monitoring the rehabilitation undertaken by the Lead Contractor during the Construction Phase and undertaking maintenance where required.

Rehabilitation will be required within the landscaped areas, river-fed lake (the River-fed Lake), north-western area and sections of the Swan River foreshore. A Rehabilitation Management Plan will be prepared by the Stadium Works Lead Contractor. The role of the PCS Works Lead Contractor(s) in preparing the site for rehabilitation will be outlined in the contract documents.

The objectives of rehabilitation for the Project are to:

- Undertake and manage rehabilitation of the Project as per the Rehabilitation Management Plan to be prepared by the Stadium Works Lead Contractor.
- Minimise and manage impacts to indigenous or otherwise protected fauna that are located on site, including protection of the remaining fauna habitats.
- Promote a stable vegetation community with local species through rehabilitation.

The rehabilitated areas surrounding the infrastructure will be landscaped with the aim of maintaining the visual amenity of the area as well as creating a secure environment for patrons. Plant species used will be local to the region, where practicable (i.e. there will be areas that are lawn-scaped).

The north-west corner of the Project area is to be rehabilitated to reflect the natural environmental state providing habitats for local fauna accessing the area. The objective will be to provide a habitat for migratory and threatened birds that accessed the area prior to development of the Project. Plant species that are attractive to Black Cockatoo species will be planted in this area.

9.2 Construction Phase

The Lead Contractor for the construction of the Stadium will be required to develop and implement a standalone Rehabilitation Management Plan outlining a strategy to implement landscaping and rehabilitation. The Rehabilitation Management Plan is to be developed by the Lead Contractor in liaison with SRT and will be approved by SP prior to being implemented.

Prior to clearing for earthworks to be undertaken, a suitably qualified environmental professional shall undertake a walkover of the Project area to:

- Identify any trees or topsoil that would be suitable to be salvaged (i.e. transplanted, mulched or stockpiled) and used in rehabilitation, particularly rehabilitation of the north-western area. These should be removed to an area where they can be stored for the duration of the Project.
- Inspect the trees and Project area for nests and juvenile species of birds and other animals prior to and during clearing works. If identified, a fauna handling specialist should be contacted to appropriately remove the nests or capture the fauna. Nests and fauna should then be relocated/released to a suitable location.

Following clearance of the Project area, rehabilitation requirements will be related to the appropriate storage of any material selected for use in rehabilitation. The Lead Contractor(s) will have to undertake ongoing monitoring of the stored materials to ensure they are not located in stormwater flow ways, are not being disturbed by works and are free of weeds.

Protection of designated preservation areas (such as the River-fed Lake) will be undertaken as part of the rehabilitation procedures throughout the Construction Phase.

The Lead Contactor(s) along with SP's Environmental Manager will also identify any areas that could be part of progressive rehabilitation works and will undertake rehabilitation as required throughout the Construction Phase. By the end of the Construction Phase, rehabilitation will have been completed.

9.3 Operating Phase

The Lead Contractor for the Operating Phase will be required to implement the rehabilitation monitoring and maintenance components of the Rehabilitation Management Plan developed during the Construction Phase to monitor the status of the landscaping and rehabilitation as well as undertake measures should rehabilitation be unsuccessful.

10.0 MANAGEMENT OBJECTIVES AND KEY PERFORMANCE INDICATORS

The CEMP and OEMP are to outline the specific environmental management objectives, targets and key performance indicators for the respective environmental factor (see Sections 7.2 to 7.11 and Sections 8.2 to 8.8). Environmental management objectives are to be based on those developed by SP as listed in Section 0. The purpose of the targets and key performance indicators are to provide measureable indicators in order to assess whether the environmental management objectives are being achieved and are suitably protecting sensitive receptors and the environment.

11.0 MATERIAL TRACKING

A material tracking system (MTS) shall be prepared and implemented by the Lead Contractor(s) during the Construction Phase to document all materials brought onto the site and all stockpiling, placement of all materials (whether clean or unacceptable) on the site and the placement and movement of all materials (whether clean or unacceptable) going off-site, including quantities. Prior to the commencement of any development the Lead Contractor(s) are responsible for undertaking a site walk over and updating the initial MTS with a site figure outlining:

- The location of all stockpiled material and estimated volumes which are to be removed off-site.
- Any areas where superficial natural soils and estimated volumes which will need to be removed off-site.

The MTS must be documented by the Lead Contractor(s) and a copy of the MTS records must be retained on site and be provided on request by the Lead Contractor(s) to SP at any time. The MTS shall be in place for all incoming materials as well as any excavated soil or stockpiled material. Any soil or water arriving on or leaving the site as a minimum will need to have paperwork indicating the environmental condition of the material and its suitability for use on site.

Accurate records of any stockpile volumes and their duration on site shall be maintained by the Contractor(s) in the MTS to ensure stockpiles are not on site for greater than four days after receipt of analytical results. Photographs of stockpiles of potentially contaminated material will be taken by the Contractor(s) to show their condition throughout the construction period. Records will also be kept by the Contractor(s) of all soil management strategies or contingency actions that are implemented, including the date, locations and justification for any management implemented.

Any material leaving site will need to include the following as a minimum:

- Details of areas of excavation including location, actual volumes, dimensions, date removed
- Details of locations where material is stored and details of location and volume where the material has been placed
- Details of any treatment undertaken on site
- If material is disposed of to landfill or treatment facility, weighbridge dockets and receipts from the facility
- Reference to analytical results, including quality control results and waste classification category if available.

For specific material tracking requirements, see the CSMP (Golder, 2013a).

12.0 TRAINING

The Lead Contractor(s) during the Construction Phase will develop and induct all staff and contractors onto the Project. The induction will include an environmental component, and as a minimum include:

- All aspects of the Emergency Response Procedure
- All aspects of the Environmental Incidents Management Procedure
- Environmental roles and responsibilities
- Communication of environmental matters
- Environmental compliance
- Environmental audits and inspection

- Environmental management objectives and key performance indicators
- Environmental monitoring
- Information regarding Project specific environmental factors (e.g. location of heritage site, indigenous or otherwise protected fauna)
- Project communication
- OHS requirements such as the site evacuation procedure.

The Stadium Governance body shall ensure that each person employed to work at the Stadium during the Operating Phase undertakes appropriate training and inductions associated with the operation of the Stadium facility. The induction shall include, as a minimum:

- All aspects of the Emergency Response Procedure
- All aspects of the Environmental Incidents Management Procedure
- Environmental roles and responsibilities
- Communication of environmental matters
- Environmental compliance
- Environmental management objectives and key performance indicators
- Environmental monitoring
- Project communication
- OHS requirements such as the site evacuation procedure.

The DMP (Golder, 2012e) and CSMP (Golder, 2013a) specify specific training required applicable to identifying acid sulfate soils (ASS) and managing dewatering and contaminated sites issues.

Prior to the presentation of the induction, SP will review and approve the content to assess if it meets the requirements of the Project EMP, the Environmental Sub-Management Plans and the CEMP/OEMP, as well as regulatory requirements. The Lead Contractor(s) shall ensure each person that remains on site for five days or more will undertake an induction, ensuring that their participation is recorded, and records are maintained. The Lead Contractor(s) will also develop a short term induction to cover all visitors attending site for less than five days. This induction process is in addition to, and complements the health and safety induction process.

13.0 COMMUNICATION OF ENVIRONMENTAL MATTERS

13.1 Toolbox Meetings

A “Toolbox” meeting shall be held daily by the Lead Contractor during the Construction Phase of the Project. Discussion of the following items, as a minimum shall be included in the meetings:

- Concerns and/or questions raised by personnel.
- Previous environmental incidents that have occurred.
- New information, environmental management procedures or controls which are to be implemented.
- New areas of contamination which may have been encountered during construction works.

- Reiteration of specific environmental management procedures which have already been communicated to site personnel.

Regular meetings between the Lead Contractor's Construction Manager, Contractor's Environmental Representative and the SP's Environmental Manager shall be undertaken. These meetings shall cover the Project's progress and schedule of the construction works and discuss any environmental issues which require attention.

13.2 Construction Environmental Inspection Checklist

During the Construction Phase the site will be subject to daily site inspections at the commencement of each day by the Lead Contractor(s)' Environmental Representative. The purpose of the daily site inspection will be to:

- Assess the environmental site conditions
- Assess changes to the site from the previous working day, such as changes to designated personnel pedestrian pathways
- Assess compliance with all relevant licence conditions
- Review of relevant documentation which includes the Environmental Complaints and Incident Register

A Construction Environmental Inspection Checklist is to be developed by the Lead Contractor(s) to guide the daily inspection. The checklist items shall include but not be limited to those outlined in Appendix A and the checklist format is to be based on the format outlined in Appendix A.

The Construction Environmental Inspection Checklist is to be kept on record by the Lead Contractor and provided to SP's Environmental Manager on request.

14.0 EMERGENCY RESPONSE PROCEDURE

The Lead Contractor(s) will be responsible for preparing an Emergency Response Procedure (independent of the CEMP and the OEMP). The Emergency Response Procedure will outline emergency and incident response procedures, situations where works should be promptly ceased and will establish an emergency contact number which can be telephoned 24 hours a day, seven days per week. The Emergency Response Procedure shall detail the following items, as a minimum, where applicable:

- The on site location of Material Safety Data Sheets (MSDS)
- The on site location of spill kits
- Location of hazardous material storage areas and safe storage procedures
- The location of safety equipment such as fire extinguishers and first aid kits
- Emergency personnel and their roles
- Emergency response contact details
- Emergency incident reporting procedures
- Evacuation procedures
- Likely emergency scenarios and associated specific emergency plans
- Emergency scenarios which would result in stopping of works/operations.

15.0 MANAGEMENT OF ENVIRONMENTAL EVENTS

An environmental event can be one of the following: non-conformance, trigger exceedance, environmental incident or environmental complaint and is to be recorded in an environmental event register as soon as practicable after the event. An environmental event register will be maintained by the Lead Contractor(s), which shall include, at a minimum:

- A description of the environmental event (date and time of occurrence, persons involved, location of event and immediate actions taken).
- Date environmental event was reported and who it was reported to.
- Summary of monitoring results, where applicable.
- Likely cause assigned to the environmental event and relation to other environmental events, where applicable.
- Contingencies implemented or proposed to be implemented.
- Responsible person and close-out date for contingencies to be implemented.

The environmental event register will be provided to SP in the monthly environmental compliance report. Environmental events are to be reported to SP as outlined in the following sections.

Environmental events will be managed by the Lead Contractor(s) responsible for each phase and SP under the implementation of this document. Procedures for managing environmental events including the recording, reporting and implementation of contingencies or corrective action and responsible persons will be detailed in the CEMP to be prepared by the Lead Contractor(s). The Contaminated Site Auditor will be provided with the opportunity to provide feedback on the assessment of risk posed by contaminated site related environmental events, the development of control measures and corrective actions, and the assessment of the adequacy of the controls to prevent further recurrence.

15.1 Non-conformance

15.1.1 Definition

A non-conformance is a failure to comply with documented procedures or a breach of conditions imposed on the Project. Non-conformances include, but are not limited to, the following:

- A breach or non-conformance of statutory requirements or procedures (including management, monitoring and contingencies) which have been prescribed in the Project EMP, CEMP(s), OEMP, CSMP or DMP.
- A breach or non-conformance of relevant licence conditions.

15.1.2 Reporting

Non-conformances are to be reported to SP within contractually specified timeframes or on a weekly basis, whichever comes first.

All environmental non-conformances are to be recorded in the environmental event register.

15.2 Trigger Exceedance

15.2.1 Definition

Contingency action triggers have been detailed in the contingency sections of the individual management plans. When a trigger is exceeded, contingency measures are to be implemented.

15.2.2 Reporting

Trigger exceedances will be recorded in the environmental event register, plotted (where practicable) and reported to SP within the monthly Compliance Report unless one of the following applies:

- A trigger has occurred more than twice within a seven day period. This must be reported to SP verbally by close of business on the day of occurrence with written notification provided within 24 hours.
- A trigger exceedance shows a trend (trends analysis to be conducted weekly by the Lead Contractor), e.g. a trend demonstrating deteriorating surface water, groundwater or air quality. This exceedance must be reported to SP within 24 hours of assessment of the trend. SP is then responsible for reporting the trend to the Contaminated Site Auditor.
- A trigger exceedance also constitutes an environmental incident, as defined in Section 15.4. This must be reported to SP as per the reporting requirements outlined in Section 15.4.3.

15.3 Environmental Incidents

15.3.1 Definition

An environmental incident is an unplanned event that causes or has potential to cause harm to the environment. Examples include, but are not limited to, off-site emissions, a spill to the environment, unauthorised ground disturbance, recorded fauna death.

15.3.2 Classification

Incidents are to be classified as Level 1, Level 2 or Level 3, based on the reasonable potential outcome using guidance provided in Table 27.

Table 27: Classification of Incidents

Classification	Description	Examples
Level 1	Localised or contained event restricted to within the Project area with no measurable or limited impact to the environment.	■ Chemical or fuel spill within designated containment. ■ Injury near miss to fauna
Level 2	Localised event restricted to within the Project area that results in short-term and/or reversible impact to the environment . Specifically for dust, an event that results in off-site emission and an associated impact to the public.	■ Stormwater runoff from a stockpile of contaminated soil or ASS breaches containment, but does not flow off-site. ■ Chemical or fuel spill outside of contained area that is contained within the project area and is cleaned up immediately. ■ Single or multiple fauna injury or death within project area.
Level 3	Localised event that results in long-term and/or irreversible impact to the environment or an event resulting in off-site release that causes or has potential to cause environmental harm or degradation.	■ Stormwater runoff from stockpiles of contaminated soil or ASS flows off-site. ■ Chemical or fuel spill that results in off-site release or impacts surface water or groundwater. ■ Multiple fauna deaths on and off site related to project activities.

Level 3 incidents are to be managed in accordance with Emergency Response Procedures prepared by the Contractor(s).

15.3.3 Reporting

Reporting of incidents is to be undertaken as follows:

Level 1 incidents: the Lead Contractor(s) is to verbally report the incident to SP at the next scheduled onsite meeting and record the incident in the environmental event register. SP will then report the incident to the Contaminated Site Auditor, DER and SRT via the monthly compliance and monthly status update reports.

Level 2 incidents: the Lead Contractor(s) is to verbally report the incident to SP by close of business on the day of the incident occurring, and is to provide a written report to SP within 24 hours. The incident will be recorded in the environmental event register. SP will then report the incident to the Contaminated Site Auditor, DER and SRT via the monthly compliance report and monthly status update reports.

Level 3 incidents: the Lead Contractor(s) is to immediately verbally report the incident to SP, and provide a written report by close of business on the same day. SP is to then report the incident to the Contaminated Site Auditor, DER and SRT as soon as practicable. The Lead Contractor will also record the incident in the environmental event register.

Environmental Incident reports can be provided to Regulators on request.

15.3.4 Incident Management

The Lead Contractor shall develop detailed incident response procedures and emergency plans that are consistent with the following:

1) Subject to the nature and extent of the environmental incident, the Lead Contractor(s)' Construction Manager or Environmental Representative shall cease the work that is the immediate cause of the environmental incident, assess the situation and implement immediate controls to contain the event and minimise potential impacts where possible.

2) The Lead Contractor(s)' Construction Manager or Environmental Representative shall notify SP's Environmental Manager within the allocated timeframe (refer above). SP's Environmental Manager will inform the Contaminated Site Auditor and other regulatory agencies where required.

3) Written notification of the time, date and nature of the environmental incident, plus the implemented or proposed corrective action if required, shall be forwarded to SP's Environmental Manager within the required timeframe (refer above), who will inform the Contaminated Site Auditor and/or other regulatory agencies where required.

4) The Lead Contractor(s)' Construction Manager in conjunction with SP's Environmental Manager (and Contaminated Site Auditor, as needed) shall assess the environmental incident investigation report, assess the corrective action to be taken, and agree on the time frame within which the corrective action is to be implemented.

5) The Lead Contractor(s)' Construction Manager shall ensure that the corrective action is implemented within the time frame stipulated. For Level 3 incidents, controls shall be agreed with SP's Environmental Manager and the Contaminated Site Auditor prior to recommencing identified activities.

6) The Lead Contractor(s)' Construction Manager in conjunction with SP's Environmental Manager shall monitor the corrective actions to assess their effectiveness at addressing the cause of the incident.

Figure 6: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Construction Phase.

The following general procedure (illustrated in Figure 7) is to be followed in the event of an environmental incident during the Operating Phase:

1) Subject to the nature and extent of the environmental incident, the Lead Contractor shall cease the work that is the immediate cause of the environmental incident, assess the situation and implement immediate controls to contain the event and minimise potential impacts where possible.

2) The Lead Contractor ’s Operations Manager and Environmental Representative shall notify the Stadium Governance Body’s Environmental Manager within the allocated timeframe (refer above). The Stadium Governance Body’s Environmental Manager will inform the Contaminated Site Auditor and other regulatory agencies where required.

3) Written notification of the time, date and nature of the environmental incident, plus the implemented or proposed corrective action if required, shall be forwarded to the Stadium Governance body within the required timeframe (refer above), who will inform the Contaminated Site Auditor and/or other regulatory agencies where required.

4) The Stadium Governance body shall assess the environmental incident investigation report, assess the corrective action to be taken, and agree on the time frame within which the corrective action is to be implemented.

5) The Lead Contractor ’s Operations Manager and/or Environmental Representative shall ensure that the corrective action is implemented within the time frame stipulated. For Level 3 incidents, controls shall be agreed with Stadium Governance body prior to recommencing identified activities.

6) The Lead Contractor ’s Operations Manager and/or Environmental Representative shall monitor the corrective actions to assess their effectiveness at addressing the cause of the incident.

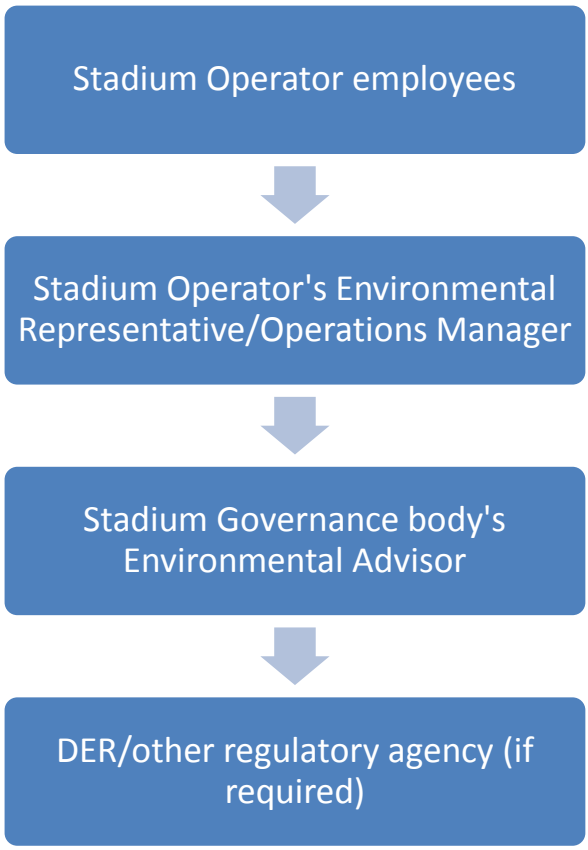


Figure 7: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Operating Phase.

Environmental incidents are to be recorded in an Environmental Incident Register to be kept by the Lead Contractor(s), which is to be made available to SP or the Stadium Governance body upon request. The register must also be made available to the DER officers and any other authorised parties to view upon request.

SP and the Stadium Governance body and/or the Lead Contractor(s) (if directed by SP or the Stadium Governance body as relevant) will notify the relevant regulatory agencies if required by law of any major incidents with actual or potential significant environmental or social impacts as soon as practicable after the occurrence of the incident. Incidents occurring during the Project will be managed according to management measures in the CEMP/OEMP and/or the Emergency Response Procedure.

15.4 Public Complaints

All complaints received from the public are to be recorded in a complaint register, which will record the following information:

- Contact details of the party raising concern.
- Details of issue/incident.
- Action taken or required.
- Response of the party raising concern to the action taken.
- Actions taken to prevent reoccurrence.

Should SP's Environmental Manager assess that the complaint is a result of a non-conformance or incident, the relevant registers and procedures outlined in Sections 15.3.4 are also to be followed. All complaints shall be referred to the Lead Contractor(s) or the Stadium Governance body and SP as soon as practical after receipt or other notification of the Environmental Complaint.

The Emergency Response Procedure, as outlined above, will establish an emergency contact number which can be telephoned 24 hours a day, seven days per week.

A stakeholder engagement strategy has been developed and is being implemented by the State to ensure the community is kept informed of Project developments. The results of the contamination investigations being completed for the Project and the proposed management of existing contamination will be made publicly available on the Project specific Perth Stadium website, consistent with the intent of the Contaminated Sites Management Series Community Consultation Guideline (DEC, 2006).

16.0 ENVIRONMENTAL REPORTING REQUIREMENTS

16.1.1 Project Compliance

Monthly compliance reports will be provided to SP by the Lead Contractor(s) during the Construction Phase covering as a minimum:

- Environmental activities
- Environmental monitoring results
- Project audit results
- Non-conformances
- Environmental incidents
- Public complaints
- Rehabilitation progress.

For a period of three years, compliance reports will be provided to the Stadium Governance body by the Lead Contractor during the Operating Phase covering as a minimum:

- Environmental activities
- Environmental monitoring results
- Rehabilitation progress
- Non-conformances
- Environmental incidents
- Public complaints.

Compliance reporting is to be undertaken at monthly intervals for the first six months. After a period of six months, the frequency of compliance reporting could be reviewed to assess whether the reporting period could be lengthened.

In addition to the monthly compliance reports, annual environmental compliance reports and/or an Environmental Compliance Completion Report will be completed by the Lead Contractor(s) and submitted to SP/the Stadium Governance body.

In addition, regulatory authorities may undertake independent compliance monitoring, which would be facilitated by SP and the Lead Contractor. It is expected that prior notification of the compliance monitoring would be provided by the regulatory authority to ensure that the appropriate Project personnel are available to assist where required.

16.1.2 Compliance Tracking

A corrective actions and compliance tracking program will be maintained by the Lead Contractor(s) to manage and track Project compliance with the conditions of environmental approval and commitments in the Project EMP, Environmental Sub-management Plans and CEMP/OEMP. The tracking document will be a standalone document and will be provided to SP/Stadium Governance body as part of the monthly compliance reports.

16.1.3 Phase Handover

The Contractor(s) will contractually be required to prepare a Handover Management Plan (separate to the CEMP) prior to ceasing work on site. At least two months prior to the completion of works, the appropriate Contractor(s) will liaise with SP and coordinate at least two meetings to discuss handover.

Records shall be kept by the Contractor(s) in relation to management measures, monitoring results and contingencies that have been implemented, including the date, specific details (e.g. when exceedance of trigger value occurred and for what period) and justification (e.g. monitoring data shows exceedance of criteria). Records and results shall be retained for up to five years by the Contractor(s) and be provided to SP on request, including for inspection or reporting on request by stakeholders.

After completion of site works, the Contractor(s) must prepare an Environmental Compliance Completion Report for SP which includes, but is not limited to, the following:

- Results of any monitoring data, monitoring data storage and system use.
- Other data storage and system use.
- Details of management measures undertaken at the site.
- Summary of the amount of contaminated soil removed off-site as per the MTS.
- Effectiveness of the management procedures and controls implemented at the site.
- Any potential risks to sensitive receptors, the environment or human health which may have occurred.
- Evidence of any non-conformances during site works.
- Stakeholder consultation undertaken.
- Environmental issues observed and management measures undertaken.
- Risk management.
- Rollover of environmental management and monitoring measures.

16.2 Records of Environmental Activities

Environmental records for the Construction Phase will be maintained to demonstrate compliance with the Project EMP; Environmental Sub-management Plans and the CEMP and will include:

- Monitoring results
- Inspection records
- Internal audit reports

- Compliance tracking reports
- Reports of pollution incidents, environmental non-conformances, complaints, action taken and follow-up actions
- Induction and training records.

This information will be provided in the monthly compliance reports to be provided to SP.

Environmental records for the Operating Phase will be maintained to demonstrate compliance with the Project EMP, the OEMP and the Environmental Sub-Management Plans (where applicable) and will include:

- Monitoring results
- Reports of any pollution incidents, environmental non-conformances, complaints, action taken and follow-up actions.

This information will be made available to the Stadium Governance body on request.

17.0 REVIEW

The Project EMP, the Environmental Sub-management Plans and the CEMP/OEMP will be reviewed annually or as necessary following implementation, to address procedural changes and confirm all documents are conforming to environmental objectives and approval requirements. The first review will be held three months after the commencement of work to ensure the Project EMP, the Environmental Sub-management Plans and the CEMP/OEMP are applicable to actual Project operations. Other reviews will be undertaken under the following circumstances:

- When there is a change in the scope of the Project that requires changes/additions to environmental management measures, or monitoring procedures.
- Where unpredicted adverse environmental impact necessitates a change in environmental management measures or monitoring procedures.
- Following the completion of environmental audits, as required.
- Where changes in environmental legislation have been made and are applicable and/or relevant to the Project.

The Project EMP is considered to be a 'live' document and will be revised prior to the Operating Phase, allowing the outcome of any incidents and/or monitoring results during the Construction Phase to be taken into consideration when preparing the Operational Environmental Management Plan. Future revisions of this Project EMP will be provided to relevant regulatory authorities for review and comment.

18.0 AUDITING

18.1 Internal Audits and Inspections

The Lead Contractor's Environmental Representative, is to conduct daily (see Section 13.2) and weekly inspections during the Construction Phase.

The weekly inspections will be undertaken in conjunction with the daily inspections, and will involve the Lead Contractor's Environmental Representative attending the Lead Contractor's Project toolbox pre-work meeting and then conducting a walk around of the site. The objective of the weekly environmental inspection is to:

- Assess the management of contamination, including ASS, as per the CSMP (Golder, 2013a).
- Assess conformance with other environmental management aspects of the Project EMP, DMP (Golder, 2012e) and the CEMP/OEMP, as practicable.

- Review the monitoring of key performance indicators outlined in the individual EMPs (assessed weekly)
- Review of the previous week's Construction Environmental Inspection Checklists

Any areas of concern or non-conformance outcomes from the weekly inspections will be documented in an email to SP.

A suitably qualified and experienced Environmental Auditor will be engaged by the Lead Contractor to conduct regular internal environmental audits during the Construction Phase of the Project. This is independent to the role of the Contaminated Site Auditor. The objective of the internal environmental audits is to assess the Lead Contractors' compliance with the Project EMP, Environmental Sub-Management Plans and CEMP/OEMP. The internal environmental audits should be documented based on an environmental audit checklist similar to the example provided in Appendix A. The results of the regular environmental audits will be recorded and any non-conformances, along with proposed corrective actions, will be reported to SP in the monthly environmental compliance report.

The Contractor(s) internal audit schedule will be provided to SP for approval. It is intended that internal audits will be conducted regularly (i.e. monthly) at commencement of the site works and then where the Lead Contractor has demonstrated conformance for an extended period (at SP's discretion), a reduction in the frequency of the environmental audits can be negotiated with SP.

SP may engage a suitably trained person to conduct environmental audits and inspections as and when required.

18.2 Independent External Audits

In accordance with *ISO 19011 Guidelines for Quality and/or Environmental Management Systems Auditing*, a regular auditing program will be implemented by SP. An audit program will be developed and undertaken by a qualified (e.g. RABQSA) Environmental Auditor (Lead or Principal Auditor level) independent of the internal Environmental Auditor to ensure the Lead Contractor(s)' compliance with the Project EMP, Environmental Sub-Management Plans and CEMP/OEMP. The first audit for each phase will be conducted within three months of work commencing on site. Depending on the results of this initial audit, external audits will then continue either biannually or annually.

19.0 REFERENCES

ANZECC/ARMCANZ. (2000a). National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

ANZECC/ARMCANZ. (2000b). National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Long-term Irrigation Water Protection* (ANZECC/ARMCANZ, 2000).

Bamford, M.J. and Bamford, A.R. (2012). *Assessment of the importance of the Burswood Peninsula and Claisebrook for Non-Avian Fauna*. Bamford Consulting Ecologists, Kingsley.

Department of Environment and Conservation (DEC). (2002). *Odour Methodology Guideline.* Department of Environment and Conservation, Perth W.A.

Department of Environment and Conservation (DEC). (2005a). *Siting, Design, Operation and Rehabilitation of Landfills, Draft, November 2005.* Department of Environment and Conservation, Perth W.A.

Department of Environment and Conservation (DEC). (2005b). *Landfill Waste Classification and Waste Definitions 1996 (Amended 2005).* Department of Environment and Conservation, Perth W.A.

Department of Environment and Conservation (DEC). (2006). *Contaminated Sites Management Series Community Consultation Guideline.* Department of Environment and Conservation, Perth W.A.

Department of Environment and Conservation (DEC). (2011a). *Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes.* Department of Environment and Conservation, Perth W.A.

Department of Environment and Conservation (DEC). (2011b). *Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities* (2011). Department of Environment and Conservation, Perth W.A.

Department of Health (DOH). (2009). *Guidelines for the Assessment, Remediation and Management of Asbestos - Contaminated Sites in Western Australia.* Department of Health, Perth, W.A.

Department of Health (DOH). (2011). *Guidelines for the Non-potable Uses of Recycled Water in Western Australia.* Department of Health, Perth, W.A.

Department of Water (DOW). (2006). *Water Quality Protection Notice Monitoring Bores*. Department of Water Perth, W.A.

Environmental Protection Authority (EPA). (2000). Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia. Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2002a). EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection. Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2004a). EPA Guidance Statement No 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2004b). EPA Position Statement No. 4: Environmental Protection of Wetlands. Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2006). EPA Guidance Statement No. 6: Guidance for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems and for Terrestrial Fauna. Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2007). EPA Guidance Statement No 8: Environmental Noise (Draft). Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2010a). Guide to EIA Environmental Principles, Factors and Objectives. Environmental Protection Authority, Perth, W.A.

Environmental Protection Authority (EPA). (2010b). EPA and DEC Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. (eds. B.M. Hyder, J.Dell, M.A. Cowan). Environmental Protection Authority, Perth, WA.

Golder Associates (2012a). *Preliminary Site Investigation Report, Proposed Perth Major Stadium*. Golder Report Number 117643077-005-R-Rev1, May 2012.

Golder Associates (2012b). *Conceptual Design of Ground Improvement Preconstruction Site Works Proposed New Perth Stadium and Sports Precinct Burswood.* Golder Report Number 127642088-001-R-Rev0, September 2012.

Golder Associates (2012c). *New Perth Stadium Flora and Fauna Survey Report.* Golder Report Number 117643077-012-R-Rev0, September 2012.

Golder Associates (2012d). *New Perth Stadium Aquatic Fauna Survey.* Golder Report Number 127643056-020-R-Rev0, December 2012.

Golder Associates (2012e). *New Perth Stadium Dewatering Management Plan*. Golder Report Number 117643077-040-R-Rev0. July 2013.

Golder Associates (2012f). *Sampling and Analysis Plan.* Golder Report Number 117643077-005-R-Rev3. July 2012.

Golder Associates (2012g). *Preliminary Hydrogeological Report New Perth Stadium and Sports Precinct Burswood*. Golder Report Number 127642046-008-R-Rev2.

Golder Associates (2013a). *New Perth Stadium Contaminated Site Management Plan*. Golder Report Number 117643077-041-R-Rev0. July 2013.

Golder Associates (2013b). *New Perth Stadium Detailed Site Investigation Interpretive Report.* Golder Report Number 127643056-010-R-Rev0. July 2013.

Golder Associates (2013c). *New Perth Stadium Groundwater Modelling Report*. Golder Report Number 127643056-029-R-Rev1. July 2013.

Swan River Trust (SRT). (2001). Swan River Trust Policy SRT/DE6 Dewatering. Swan River Trust Perth, W.A.

Swan River Trust (SRT). (2007). *Potential Impacts of Climate Change on the Swan and Canning Rivers.* Swan River Trust Perth, WA.

Swan River Trust (SRT). (2008). Healthy Rivers Action Plan. Swan River Trust Perth, WA.

TPHCWGS (Total Petroleum Hydrocarbon Criteria Working Group Series). (1998). *Analysis of Petroleum Hydrocarbons in Environmental Media*. TPH Working Group. USA.

Western Australian Planning Commission (WAPC). (2006). *State Planning Policy 2.10 Swan Canning River System*. Western Australian Planning Commission, Perth, WA.

Western Australian Planning Commission (WAPC). (2008). *Better Urban Water Management*. Western Australian Planning Commission, Perth, WA.

Report Signature Page

GOLDER ASSOCIATES PTY LTD

Sarah Brown
Environmental Scientist

Ed Clerk
Associate, Principal Environmental Scientist

SB;RKW/IYK;EWC/eh

Endorsed

Public Transport Authority Environmental Manager

Endorsed

Manager Planning, Department of Treasury Strategic Projects

Approved

Principal Project Director, Strategic Projects

A.B.N. 64 006 107 857

\\pth1-s-file01\jobs\env\2011\117643077 - pta desktop review burswood\correspondence out\036- r-project emp\project emp\rev1\117643077-036-r-rev1 project emp.docx

APPENDIX A

Construction Environmental Daily Inspection Checklist

Project Name: New Perth Stadium Project	**Date:**
Inspector/s:	

Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions Required/Comments**	**Actions input into register?**
		Yes	**No**		
Waste Management					
Is the site free of litter?					
Are there any spills near the sewerage system (black & grey water) and/or portaloos?					
Is controlled waste stored efficiently in an appropriate area and free from surface water run-off?					
Are waste hydrocarbons stored appropriately for removal in a sufficient bund?					
Spill & Hazardous Chemical Storage					
Chemical Storage Facilities: ■ Is bund free of water & chemicals?					
Diesel fuel facilities: ■ Are bollards or earthen bunds present to protect facility from collision? ■ Is a concrete apron or HDPE lined bund free of water & fuel? ■ Are fire extinguishers (dry chemical) and spill kits available?					
Are hydrocarbon and chemical containers stored in adequately bunded area(s) capable of containing 110% of the volume?					
Any excavations close to gas/sewer lines?					

Project Name: New Perth Stadium Project	**Date:**
Inspector/s:	

Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions Required/Comments**	**Actions input into register?**
		Yes	**No**		
Are stationary engines fitted with drip tray or located in a secondary containment facility?					
Is there evidence of hydrocarbon spills?					
Surface Water Management					
Are drainage ways free of litter?					
Is there any ponding or flooding?					
Are topsoil and other stockpiles stored away from water courses and drainage lines?					
Is there evidence of sedimentation erosion or scour?					
Site Contamination Management					
Have any new materials been found on-site?					
Do contractors have an updated hazardous goods register/MTS?					
Noise and Vibration Monitoring					
Have any complaints been received? If yes have the following actions been undertaken? ▪ Monitoring is undertaken and reported within seven days of the complaint. ▪ If exceedances are detected, the situation should be reviewed in order to identify means to reduce the impact to acceptable levels.					

Project Name: New Perth Stadium Project					**Date:**
Inspector/s:					
Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions Required/Comments**	**Actions input into register?**
		Yes	**No**		
Are residents in the immediate area advised of proposed work? Does this include the construction program, and progress; particularly noting when noisy or vibration generating activities are planned? Does the notification include a community liaison number or site contact for queries and complaints?					
If any out of hours work is proposed has documentation been completed justifying the requirements (i.e. risk assessment, safety)?					
Is all unnecessary equipment being shut off when not in use?					
Vegetation Clearing					
No evidence of clearing/disturbance outside approved areas?					
Rehabilitation nursery/topsoil in good condition?					
Weed Management					
Any weed species observed?					
Fauna (Daily)					
Any signs of construction vehicle(s) outside designated areas/fauna collisions/speed limits adhered to?					
Any access to unauthorised areas?					
Any signs of feral animals or activity in or around waste facilities?					
Are food waste facilities covered & removed regularly?					
No signs of feeding native fauna on-site?					
Any contamination of Lake 2 and/or the Swan River?					

Project Name: New Perth Stadium Project	**Date:**
Inspector/s:	

Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions Required/Comments**	**Actions input into register?**
		Yes	**No**		
Do trenches have bunds upstream exit points to allow trapped fauna to escape?					
Are all pipelines under construction capped each night to eliminate fauna being trapped?					
Are trenches inspected for signs of fauna in them each morning prior to starting work?					
Any signs of or native animals on-site/trapped fauna?					
Is native fauna promotional signage on notice boards & kept updated?					
Dust Odour & Air Quality Management (Daily)					
Off-site and on-site dust monitoring indicates that dust levels are within adopted performance criteria. Is data recorded daily?					
Is construction traffic as per the site speed limit signage 10 km/hr?					
Are vehicles idling when not required?					
Are unauthorised vehicles venturing off designated tracks?					
Are exposed ground surfaces watered down where possible?					
Is the water cart sufficient for the task?					
Are all roadways & cleared areas kept damp in dust-prone conditions?					
Have any public comments been made?					
Are 1.8 m ring lock fences & breeze cloth in good condition/no gaps or holes?					

Project Name: New Perth Stadium Project	**Date:**
Inspector/s:	

Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions Required/Comments**	**Actions input into register?**
		Yes	**No**		
Is earthworks & clearing being conducted in appropriate stages?					
Are there visible signs of dust lift-off in or around site boundaries/dust deposition on vegetation or buildings/is the site stable?					
Are odours in or around vegetation stockpiles or bins?					
Traffic Management					
Any public complaints with regard to traffic management?					
Any traffic safety incidents with regard to traffic management?					
Any damage to conservation areas with regard to traffic management?					
Are site vehicles adhering to site speed limits?					
Are all site vehicles keeping to site access ways?					
Aboriginal Heritage					
Any objects found during grubbing, clearing & earthworks phase?					
If suspected finds are located are contractors stopping work?					
If suspected finds were found was the DIA and SP contacted?					
Visual Amenity and Public Access					
Are there any unsightly works/ activities/ storage areas that could be managed better to improve visual amenity?					
Are there any site activities causing restricted public access to the area immediate adjacent the Project boundary?					
Any public complaints with regard to visual amenity/ public access?					

Project Name: New Perth Stadium Project				**Date:**	
Inspector/s:					
Work Area:	**N/A**	**Acceptable (*tick)***		**Actions Required/Comments**	**Actions input into register?**
		Yes	**No**		
Is mud or dirt visible on the roads entering/exiting the site?					

Inspection Comments:

Inspection Action Items:

APPENDIX B

Guideline Trigger Levels for Surface Water Monitoring

Table B1: Guideline Trigger Levels for Surface Water Monitoring – Swan River and the River-fed Lake (95% Protection Levels)

Chemical Group	Chemical Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Sample Quality Parameters	pH (Lab)	pH Units	0.1	**7.5-8.5**				
	Sodium (Filtered)	mg/L	0.5					
	Chloride	mg/L	1				**2500**	
	Sulfate (as SO_4)	mg/L	1				**5000**	
	Nitrogen (Total Oxidised)	mg/L	0.005	0.045				
	Nitrogen (Total)	mg/L	0.05	0.75				
	Phosphorus	mg/L	0.01	0.03				
	Hardness (as $CaCO_3$) (Filtered)	mg/L	5					
Heavy Metals	Aluminium	mg/L	0.05		**0.055**			
	Arsenic	mg/L	0.001				**0.07**	
	Arsenic (Filtered)	mg/L	0.001				**0.07**	
	Boron	mg/L	0.005		**0.37**			
	Boron (Filtered)	mg/L	0.005		**0.37**			
	Cadmium	mg/L	0.0001		**0.0002**			
	Cadmium (Filtered)	mg/L	0.0001		**0.0002**			
	Chromium	mg/L	0.001			**0.027**[(4)]		
	Chromium (Filtered)	mg/L	0.001			**0.027**[(4)]		
	Copper	mg/L	0.001			**0.0013**		
	Copper (Filtered)	mg/L	0.001			**0.0013**		
	Iron (Total)	mg/L	0.05		**0.3**			
	Lead	mg/L	0.001		**0.0034**			

Chemical Group	Chemical Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Lead (Filtered)	mg/L	0.001		**0.0034**			
	Manganese	mg/L	0.001		**1.9**			
	Manganese (Filtered)	mg/L	0.001		**1.9**			
	Mercury (filtered)	mg/L	0.00005		**0.00006**			
	Mercury	mg/L	0.0001		**0.00006**			
	Molybdenum	mg/L	0.001				**0.5**	
	Molybdenum (Filtered)	mg/L	0.001				**0.5**	
	Nickel	mg/L	0.001		**0.011**			
	Nickel (Filtered)	mg/L	0.001		**0.011**			
	Selenium	mg/L	0.002		**0.011**			
	Selenium (Filtered)	mg/L	0.002		**0.011**			
	Zinc	mg/L	0.001		**0.008**			
	Zinc (Filtered)	mg/L	0.001		**0.008**			
Organochlorine Pesticides	Aldrin & Dieldrin (Sum of total)	mg/L					**0.003**	
	DDT (3)	mg/L	0.000002		**0.00001**			
	Endrin	mg/L	0.000004			**0.000008**		
	g-BHC	mg/L	0.00005		**0.0002**			
	Heptachlor	mg/L	0.00001		**0.00009**			
	Heptachlor & heptachlor epoxide (Sum of total)	mg/L					**0.003**	

Chemical Group	Chemical Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Organophosphorous Pesticides	Chlorpyriphos	mg/L	0.000009			**0.000009**		
	Diazinon	mg/L	0.00001		**0.00001**			
	Fenitrothion	mg/L	0.0002		**0.0002**			
	Malathion	mg/L	0.00005		**0.00005**			
	Parathion	mg/L	0.000004		**0.000004**			

Table B2: Guideline Trigger Levels for Surface Water Monitoring – Irrigation Lake (80% Protection Levels)

Chemical Group	Chemical Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Wetlands	ANZECC & ARMCANZ (2000) Freshwaters (80%)	ANZECC & ARMCANZ (2000) Marine Waters (80%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Sample Quality Parameters	pH (Lab)	pH Units	0.1	**7.0-8.5**				
	Sodium (Filtered)	mg/L	0.5					
	Chloride	mg/L	1				**2500**	
	Sulfate (as SO_4)	mg/L	1				**5000**	
	Nitrogen (Total Oxidised)	mg/L	0.005	0.1				
	Nitrogen (Total)	mg/L	0.05	1.5				
	Phosphorus	mg/L	0.01	0.06				
	Hardness (as $CaCO_3$) (Filtered)	mg/L	5					

Chemical Group	Chemical Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Wetlands	ANZECC & ARMCANZ (2000) Freshwaters (80%)	ANZECC & ARMCANZ (2000) Marine Waters (80%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Heavy Metals	Aluminium	mg/L	0.05		**0.055**			
	Arsenic	mg/L	0.001				**0.07**	
	Arsenic (Filtered)	mg/L	0.001				**0.07**	
	Boron	mg/L	0.005		**1.3**			
	Boron (Filtered)	mg/L	0.005		**1.3**			
	Cadmium	mg/L	0.0001		**0.0008**			
	Cadmium (Filtered)	mg/L	0.0001		**0.0008**			
	Chromium	mg/L	0.001			**0.091**[(4)]		
	Chromium (Filtered)	mg/L	0.001			**0.091**[(4)]		
	Copper	mg/L	0.001		**0.0025**			
	Copper (Filtered)	mg/L	0.001		**0.0025**			
	Iron (Total)	mg/L	0.05		**0.3**			
	Lead	mg/L	0.001		**0.0094**			
	Lead (Filtered)	mg/L	0.001		**0.0094**			
	Manganese	mg/L	0.001		**3.6**			
	Manganese (Filtered)	mg/L	0.001		**3.6**			
	Mercury (filtered)	mg/L	0.00005			**0.0014**		
	Mercury	mg/L	0.0001			**0.00014**		
	Molybdenum	mg/L	0.001				**0.5**	
	Molybdenum (Filtered)	mg/L	0.001				**0.5**	
	Nickel	mg/L	0.001		**0.017**			
	Nickel (Filtered)	mg/L	0.001		**0.017**			

Chemical Group	Chemical Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Wetlands	ANZECC & ARMCANZ (2000) Freshwaters (80%)	ANZECC & ARMCANZ (2000) Marine Waters (80%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Selenium	mg/L	0.002		**0.034**			
	Selenium (Filtered)	mg/L	0.002		**0.034**			
	Zinc	mg/L	0.001		**0.031**			
	Zinc (Filtered)	mg/L	0.001		**0.031**			
Organochlorine Pesticides	Aldrin & Dieldrin (Sum of total)	mg/L					**0.003**	
	DDT (3)	mg/L	0.000002			**0.00004**		
	Endrin	mg/L	0.000004			**0.000002**		
	g-BHC	mg/L	0.00005				**0.2**	
	Heptachlor	mg/L	0.00001			**0.0007**		
	Heptachlor & heptachlor epoxide (Sum of total)	mg/L					**0.003**	
Organophosphorous Pesticides	Chlorpyriphos	mg/L	0.000009			**0.0003**		
	Diazinon	mg/L	0.00001		**0.002**			
	Fenitrothion	mg/L	0.0002		**0.0004**			
	Malathion	mg/L	0.00005		**0.0011**			
	Parathion	mg/L	0.000004		**0.00004**			

APPENDIX C

Guideline Trigger Levels for Groundwater Monitoring

July 2014
Report No. 117643077-036-R-Rev1

Table C1: Guideline Trigger Levels for Groundwater Monitoring

Chemical Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Sample Quality Parameters	pH (Lab)	pH units	0.01	7.5-8.5				
	Chloride	mg/L	1				2500	
	Sulfate (as SO4)	mg/L	1				5000	
	Nitrate (as NO3-)	mg/L	0.05		0.7			
	Nitrite (as NO2-)	mg/L	0.05				30	
	Nitrogen (Total Oxidised)	mg/L	0.005	0.045				
	Ammonia	mg/L	0.005	0.04				
	Nitrogen (Total)	mg/L	0.05	0.75				
	Cyanide (total)	mg/L	0.004			***0.004***		
	Reactive Phosphorus (as P)	mg/L	0.002	0.005				
	Phosphorus	mg/L	0.01	0.03				
Microbiological	E. coli	cfu/100 ml	1					10(1)
Heavy Metals	Arsenic (Filtered)	mg/L	0.001				0.07	
	Boron (Filtered)	mg/L	0.005		0.37			
	Cadmium (Filtered)	mg/L	0.0001		0.0002			
	Chromium (Filtered)	mg/L	0.001					0.1
	Copper (Filtered)	mg/L	0.001			***0.0013***		
	Lead (Filtered)	mg/L	0.001		0.0034			
	Manganese (Filtered)	mg/L	0.001		1.9			
	Mercury	mg/L	0.00005		0.00006			
	Molybdenum (Filtered)	mg/L	0.001				0.5	
	Nickel (Filtered)	mg/L	0.001			***0.07***		
	Selenium (Filtered)	mg/L	0.002		0.005			

Chemical Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Zinc (Filtered)	mg/L	0.001		0.008			
MAH	Benzene	mg/L	0.0005			***0.5***		
	Ethylbenzene	mg/L	0.0005				0.003	
	Styrene	mg/L	0.0005				0.004	
	Toluene	mg/L	0.0005				0.025	
	Xylenes (m & p)	mg/L	0.001		0.2 (2)			
	Xylene (o)	mg/L	0.0005		0.35			
Organochlorine Pesticides	Aldrin & Dieldrin (Sum of total)	mg/L					0.003	
	Chlordane (Sum of total)	mg/L	0.00001		0.00003			
	DDT	mg/L	0.000002		0.00001			
	Endrin	mg/L	0.000004			***0.000004***		
	g-BHC	mg/L	0.00001		0.0002			
	Heptachlor	mg/L	0.000005		0.00001			
	Heptachlor & heptachlor epoxide (Sum of total)	mg/L					0.003	
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005		0.00002			
	Chlorpyriphos	mg/L	0.000009			***0.000009***		
	Diazinon	mg/L	0.00001		0.00001			
	Fenitrothion	mg/L	0.0002		0.0002			
	Malathion	mg/L	0.00005		0.00005			
	Parathion	mg/L	0.000004		0.000004			

Chemical Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Herbicides	Carbofuran	mg/L	0.0005		0.00006			
	Atrazine	mg/L	0.0005		0.013			
	Simazine	mg/L	0.0005		0.0032			
PAH	Benzo(a)pyrene	mg/L	0.00001				0.0001	
	Naphthalene	mg/L	0.00002			***0.05***		
Halogenated Benzenes	1,2,3-Trichlorobenzene	mg/L	0.0005		0.003			
	1,2,4-Trichlorobenzene	mg/L	0.0005			***0.02***		
	1,2-Dichlorobenzene	mg/L	0.0005		0.16			
	1,3-Dichlorobenzene	mg/L	0.0005		0.26			
	1,4-Dichlorobenzene	mg/L	0.0003		0.06			
	Chlorobenzene	mg/L	0.0005				0.01	
Phenolics	Phenol	mg/L	0.0001		0.32			
Phenolics-Halogenated	2,3,4,6-Tetrachlorophenol	mg/L	0.00001		0.01			
	2,4,6-Trichlorophenol	mg/L	0.00001		0.003			
	2,4-Dichlorophenol	mg/L	0.00001		0.12			
	2-Chlorophenol	mg/L	0.0001		0.34			
	Pentachlorophenol	mg/L	0.00001		0.0036			
Solvents	Methyl-t-butyl ether	mg/L	0.0005				0.012	
Volatile Organic Compounds	1,1,2-Trichloroethane	mg/L	0.0005			***1.9***		
	1,2-Dichloroethane	mg/L	0.0005				0.03	
	1,1-Dichloroethene	mg/L	0.0005				0.3	
	Carbon tetrachloride	mg/L	0.0005				0.03	
	Dichloromethane	mg/L	0.005				0.04	
	Hexachlorobutadiene	mg/L	0.001				0.007	

Chemical Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DER Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Tetrachloroethene	mg/L	0.0005				0.5	
	Vinyl chloride	mg/L	0.0003				0.003	

APPENDIX D

Dewatering Management Plan

July 2014
Report No. 117643077-036-R-Rev1

July 2014

GOVERNMENT OF WESTERN AUSTRALIA

NEW PERTH STADIUM

Dewatering Management Plan

REPORT

Report Number. 17643077-040-R-Rev1

Distribution:

1 Electronic Copy - Public Transport Authority
1 Electronic Copy - Department of Treasury, Strategic Projects
1 Electronic Copy - Golder Associates Pty Ltd

Golder Associates

Table of Contents

TABLES

FIGURES

Embedded in Text

After Main Text

APPENDICES

1.0 INTRODUCTION

1.1 Overview

Golder Associates Pty Ltd (Golder) has been engaged to prepare a Dewatering Management Plan (DMP) for the new Perth Stadium (the Project) located in the Burswood Peninsula in Western Australia. This document has been prepared using information available at the time of preparation, including that of the acid sulfate soils (ASS) investigation, contamination investigation and groundwater modelling carried out for the State. This document should be updated as additional information becomes available.

The Project is to design, construct, operate and maintain a new Perth Stadium contained within a new "Sports Precinct" within the Burswood Peninsula, Western Australia.

For planning purposes the Project is to be delivered in three parts:

- **Part 1:** the construction of the Stadium and associated Sports Precinct. This will be undertaken in two phases:
  - Construction Phase, which includes:
    - Preconstruction Site Works (PCS Works) - The objective of the PCS Works is to prepare some parts of the site in advance of the main construction contract so that long term ground movements in those designated areas are within prescribed limits and to facilitate timely construction of the Stadium and associated works. This will necessitate ground treatment such as surcharge, dynamic compaction and/or stone columns so that upon completion of the PCS Works, construction of the Stadium can commence without undue delay caused by site preparation works.
    - Stadium Construction Works (Stadium Works) - Includes the construction of the Stadium, its plaza and associated infrastructure on the pre-treated site and will necessitate the use of deep piles to support the Stadium structure. Construction of surrounding infrastructure, such as pedestrian access ways, roads, bridges, services and site rehabilitation will also be completed during the Stadium Works.
  - Operating Phase: the commissioning of the internal fit-out of the Stadium facilities to be undertaken with the identified Operating Phase Lead Contractor. Ongoing environmental monitoring of the site and management of site facilities will continue during this phase.
- **Part 2:** the construction of the transport infrastructure including the rail works, the train station upgrade and Victoria Park Drive road bridge upgrades.
- **Part 3:** the construction of the new pedestrian bridge over the Swan River, including bus and pedestrian facilities at Gloucester Park.
- Delivery of the Project, including Parts 1, 2 and 3, has potential environmental and social impacts and has required referral to the Environmental Protection Authority (EPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (EP Act). Referral applications have been lodged for Parts 1, 2 and 3, with the EPA determining that the proposals did not require formal assessment.

Delivery of the two phases within Part 1 of the Project is required by 2018. This requires that the PCS Works commence by mid-2013 to allow Stadium Works to commence in 2014, facilitating completion by 2018.

1.2 Scope

The scope of this DMP is concerned with the Construction Phase and Operating Phase of Part 1 of the Project. It focuses on the development of the Stadium and Sports Precinct including the:

- Stadium and its plaza
- Bus hub
- Pedestrian access ways and the Stadium ring road
- Parklands.

This DMP excludes the following components which are discussed in separate documentation:

- Swan River pedestrian bridge
- Train station
- Rail realignment
- Road upgrades to Victoria Park Drive.

1.3 Dewatering Management Plan Objectives

Localised dewatering may be required during various Stadium construction activities. The dewatering will require management to ensure adverse environmental impacts are minimised and to protect the environment.

Dewatering works will require approval from Department of Water (DoW) to abstract groundwater, unless an exemption applies. Application for a licence to dewater is through submission of Form 3G under Section 5C of the *Rights in Water and Irrigation Act 1914* for a Licence to Take Water. For construction of dewatering wells, applications must be made through the submission of Form 1 "Application for a licence under section 26D of the *Rights in Water and Irrigation Act 1914*".

The discharge of abstracted groundwater would also require permission from regulatory authorities. The required permission depends on the chosen dewatering disposal option, but could include the Department of Environment and Conservation ((DEC) now Department of Environment Regulation (DER)), Swan River Trust (SRT), the Water Corporation, local council and asset owners (e.g. owner of stormwater system).

The dewatering requirements have not yet been fully identified at this stage. As the need for construction dewatering arises during the detailed design phase, the Lead Contractor responsible for a particular construction activity that would require dewatering will be responsible for preparing a specific Dewatering and Groundwater Management Plan(s) for submission to DoW to accompany their application for a Licence to Take Water (5C Licence).

The objective of this document is to provide a basis for the development of specific Dewatering and Groundwater Management Plan(s) at the site and outlines the minimum requirements to be included into the specific plans to allow for proper management of abstracted groundwater. This document provides preliminary information on the following:

- **Site condition** – Description of the site including geology, surface water, hydrogeology and groundwater quality, sufficient to inform the relevant regulatory agencies of the hydrogeological setting at the site.
- **Site dewatering** – Description of site work which requires dewatering, including dewatering methodology and estimated dewatering schedule, rate and volume.

- **Effect of dewatering** – Outline the potential affects the dewatering could have on proponents such as groundwater, surface water, ecology and habitat, settlement of structures and local bore users.
- **Dewatering treatment and disposal** – Outline dewatering disposal options and treatment requirements for each disposal option.
- **Monitoring requirements** – Outline the dewatering monitoring requirements, such as for groundwater, dewatering discharge and surrounding and receiving environment.
- **Contingency planning** – Outline contingencies put in place for the dewatering operation where performance criteria are not met or unforeseen events occur.
- **Roles and responsibilities** – Outline the role and responsibilities of different aspects of the dewatering operation such as dewatering, treatment, monitoring and reporting.

1.4 Project Location and History

The Project will be located on the northern nine holes of the Burswood Park Golf Course and State Tennis Centre located on the Burswood Peninsula in Perth Western Australia. The Project area is shown in Figure 1 and highlighted by the solid red border and will be referred to as the "Project area" throughout this document. The Project area is bounded by the Swan River to the west; the Graham Farmer Freeway to the north and east; and the remainder of the Burswood Park Golf Course to the south.

Included within the Project area is the Sports Precinct, which includes the Stadium structure, bus hub, pedestrian access ways and other associated infrastructure. The pedestrian bridge, train station and road upgrades are, for the most part, contained outside the Project area and are discussed in separate documentation.

An environmental Detailed Site Investigation (DSI) has been completed in accordance with the DER Contaminated Sites Management Series Guidelines (Golder, 2013b). The DSI reported elevated concentrations of contaminants in soil, groundwater, sediment and surface water, as well as concentrations of ground gases (methane and carbon dioxide). Soil and groundwater contaminants and ground gases will require management during construction works, and proposed management measures are outlined in the relevant sections of this management plan and the CSMP.

2.0 PROJECT SCOPE

2.1 Preconstruction Site Works

The PCS Works is necessary to prepare the site for construction and in particular, to treat the underlying ground conditions which currently give rise to differential settlement across the site. The main components of the PCS Works are site preparation, such as fencing and clearing and ground treatment such as compaction of uncontrolled fill, surcharging with the installation of wick drains and the installation of stone columns.

2.2 Stadium Construction Works

The Stadium Works will commence following completion of the PCS Works; however, it may occur in parallel, with the Stadium structure being the main element of the Construction Phase. The development loads associated with the Stadium structure itself are significant and will require to be supported through the use of piles which transfer these loads to stronger materials beneath the Swan River Alluvium (SRA) layer.

2.3 Operation

The Operating Phase of Part 1 of the Project involves the transition of the Stadium from construction to operation and being opened to the public. The Operating Phase will include the commissioning of the internal fit-out of the Stadium facilities and ongoing environmental management of the Sports Precinct by the Operating Phase Lead Contractor.

3.0 APPLICABLE LEGISLATION

Relevant environmental legislation applicable to the dewatering for the Project includes the following:

- ***Environmental Protection Act, 1986*** (EP Act) - Part IV of the EP Act governs the environmental impact assessment process, administered by the Western Australian Environmental Protection Agency (EPA). Approval under Part V of the EP Act is not applicable as the Project is not considered a prescribed premises; however, a works approval and licence may be required at a later date if a water treatment facility is required. The EP Act imposes various general environmental protection obligations.

- ***Rights in Water and Irrigation Act, 1914*** (RIWI Act) - Licenses are required for the removal of water from a watercourse or groundwater aquifer in a proclaimed area. The Burswood Peninsula is within the Perth Groundwater Proclaimed Area and therefore a request for a license to take groundwater must be made to the Department of Water (DoW) under the RIWI Act if groundwater abstraction is required. As ASS is present on-site and may be disturbed by dewatering activities, reference should be made to the Contaminated Site Management Plan (CSMP) (Golder 2012f) to assist with management of such materials.

- ***Contaminated Sites Act, 2003*** - The proposed site is a contaminated site classified as "Possibly *Contaminated - Investigation Required*". The basic summary of records search response from the DER database indicates that "*landfill material has been identified beneath the site including impacts to soil, groundwater and sediment*". A DER Accredited Contaminated Site Auditor has been appointed and all environmental matters (including the individual management plans) related to the project will be reviewed by the Auditor from a contaminated sites perspective prior to implementation.

- ***Occupational Safety and Health Act, 1984*** - Construction of the new Perth Stadium as well as any plants/facilities designed to remediate contaminated material on-site must be in accordance with the Occupational Safety and Health Regulations. This legislation is administered by WorkSafe Western Australia and compliance is required with the Act and Regulations to ensure operations meet standards of workplace safety and protection.

A full list of legislation applicable to the Project is outlined in the Project EMP (Golder 2012e).

3.1 Guidance Literature

The DMP was prepared using the following key guidance documents:

- ANZECC/ARMCANZ, 2000: *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy - Paper No. 4, Volume 1, October 2000.

- Australian/New Zealand Standard AS/NZS 5667.1:1998. *Water Quality - Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples*.

- Department of Environment (2004): *Acid Sulfate Soils Guidelines Series - Guidance for Groundwater Management in Urban Areas on Acid Sulfate Soils*. October 2004.

- Department of Environment (2006): *Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulfate Soil Areas*. June 2006.

- Department of Environment and Conservation (2010): *Assessment Levels for Soil, Sediment and Water. Contaminated Sites Management Series*. February 2010.

- Department of Environment and Conservation (2011): *Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes*. July 2011.

- Department of Water (2006): *Dewatering of Soils at Construction Sites*. WPQN 13. April 2006.

- Swan River Trust (2012): Draft Discussion Paper - *Disposal of Dewatering Effluent in the Swan Canning Catchment*. May 2012.
- Water Corporation 2012a: Requirements for one-off discharge of industrial waste, http://www.watercorporation.com.au/_files/PublicationsRegister/3/iwpub15.pdf
- Water Corporation 2012b: Industrial Waste – Information sheet 04 – Charges 2012/2013, http://www.watercorporation.com.au/_files/publicationsregister/3/IWPUB04.pdf
- Water Corporation 2012c: Application for one-off discharge of industrial waste, http://www.watercorporation.com.au/_files/PublicationsRegister/3/IWFRM2-1-1.pdf

4.0 ENVIRONMENTAL MANAGEMENT STRATEGY

This DMP has been prepared as part of an Environmental Management Strategy to ensure that the Department of Treasury Strategic Projects (SP) establishes and maintains best practice controls to manage potential environmental and social impacts during the Project. The structure of the Environmental Management Strategy is outlined in Figure 2. The position of this document within the structure is highlighted in red text.

The DMP has been prepared on behalf of SP in consultation with the relevant regulating agencies and may be submitted with the contract specific Dewatering and Groundwater Management Plan(s) to be prepared by the Lead Contractor(s) for any licence or permit applications required. Final approval of any amendments to the contract specific plans by SP will be required before any form of work begins on-site.

For detailed information on the Environmental Management Strategy refer to the Project EMP (Golder 2012e).

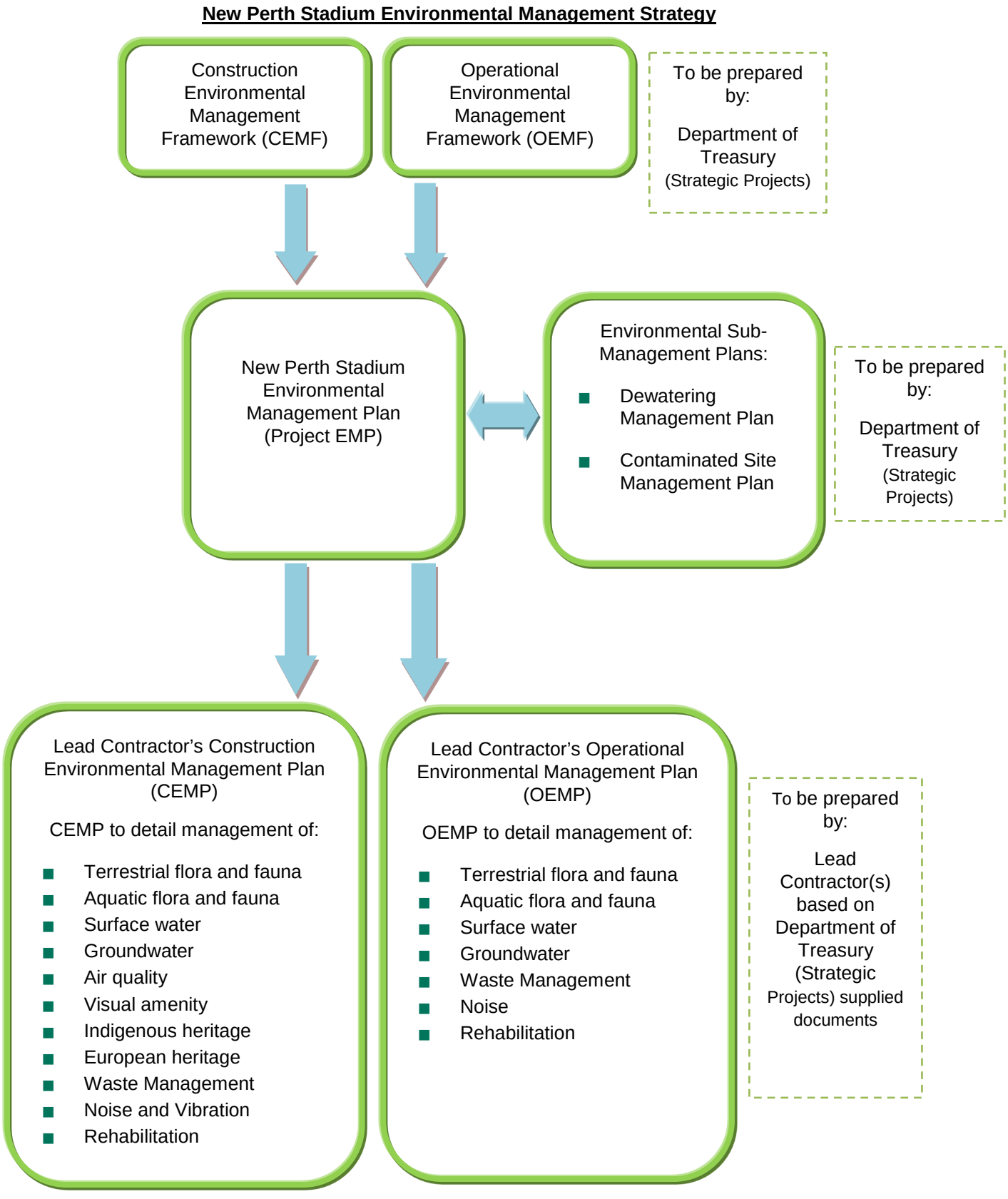


Figure 2: New Perth Stadium Environmental Management Strategy Structure

5.0 SITE CONDITION

5.1 Site Description

5.1.1 Surface Features

Burswood Peninsula is located within an ox-bow bend of the Swan River, approximately 3 km to the east of the Perth Central Business District (CBD) and is generally comprised of low-lying ground.

The majority of the Project area proposed for the Sports Precinct site is currently occupied by the northern nine holes of the Burswood Park Golf Course. Surface features across the Burswood Park Golf Course comprise:

- Undulating grass fairways, greens, sand bunkers, trees and paved paths.
- A clay-lined lake (the Irrigation Lake) in the central part of the site that is used for irrigation.
- An unlined lake (the River-fed Lake) in the western part of the site that is hydraulically connected to the Swan River.
- Golf course maintenance and irrigation facilities, including a deep artesian bore in the south-western part of the site and a pumping facility in the north-eastern part of the site.
- An open area to the east of Victoria Park Drive that has been used by the Burswood Park Board for storage of waste vegetation and inert matter.

5.1.2 Current Site Levels

The levels across the planned Sports Precinct site vary as follows:

- Ground surface generally between about RL 2 and RL 5 m AHD across the grass fairways and greens, with localised higher and lower points, sloping down to about RL 0 m AHD adjacent to the western lake, sloping up to about RL 5 m AHD around the southern and eastern margins of the golf course.
- Ground surface generally between about RL 0.5 and RL 1 m AHD across a practice fairway located between the western lake and the Swan River.
- Ground surface generally between about RL 2 and RL 6 m AHD across the open area to the east of Victoria Park Drive.
- Road surface on Victoria Park Drive generally between about RL 3 and RL 8 m AHD, grading up towards the bridge over the railway.
- Water level in the eastern clay-lined irrigation lake at about RL 3 m AHD.
- Water level in the western unlined lake at about RL 0 m AHD.

5.2 Geology and Subsurface Conditions

In chronological order from youngest to oldest, the four principal geological units have been assigned as follows:

- Unit 1 - Fill.
  - Unit 1a – Sand Fill material which contains no waste material and was placed as a capping material
  - Unit 1b – Waste Fill material which contains uncontrolled fill material including rubbish.
- Unit 2 - Swan River Alluvium (SRA).

- Unit 3 - Sandy Channel Deposits (SCD).
- Unit 4 - Kings Park Formation; Mullaloo Sandstone Member (KPF).

The composition of the above units is briefly described below. Further details are given in Golder (2012b).

At least two ancient river channels (palaeochannels) run beneath the site. The most recent of these channels is infilled with soft, highly compressible SRA. This recent palaeochannel is up to about 32 m in depth below the ground surface, with relatively steep side slopes in parts. An older palaeochannel is infilled with the stronger SCD.

5.2.1 Unit 1 – Fill

The fill unit comprises all materials placed by man since European settlement and comprises industrial, domestic and imported sandy fill. Due to an absence of detailed records on what type of material was placed in any given location and the lack of significant compaction, all fill can be considered as uncontrolled fill. Recent boreholes indicate the fill is generally granular with zones of concrete, brick, plastic, blue-metal, metal objects and with clayey zones. The fill material may contain asbestos in places, but asbestos has not been specifically observed in the investigations to date.

The Burswood Park Board has reported numerous examples of sudden collapse within the fill resulting in uneven levels on the grass fairways. Excavation and rehabilitation of these depressions and excavation for new works encountered a total of twelve car bodies over the life of the golf course to date.

5.2.2 Unit 2 – Swan River Alluvium (SRA)

The SRA is typically described as a normally to lightly consolidated, high plasticity and high liquid limit, dark grey to black, soft to firm, organic Clayey Silt to Silty Clay. The SRA may contain shells, shell fragments, sand and organic material in trace amounts or as dominant interbeds within a silt or clay matrix.

In addition to deposition within the river channel, SRA may also include overbank deposition (floodplain deposits) that occur during floods. These deposits occasionally may include a sand levee that occurs along the edge of the channel as suspended sand drops out quickly away from the main channel flow.

5.2.3 Unit 3 – Sandy Channel Deposits (SCD)

The SCD are generally dominated by medium dense to very dense, fine to coarse grained grey Sand and Sandy Silt or Clay. Layers of both Gravelly Sand and medium to high plasticity Silty Clay and Sandy Clay up to 9 m thick were also encountered, indicating varying deposition conditions within the palaeochannel. A 2.5 m thick lense of Clayey Silt with frequent shell fragments, similar to the SRA described above was encountered at one borehole location.

5.2.4 Unit 4 – Kings Park Formation; Mullaloo Sandstone Member (KPF)

The basement material beneath the sports precinct is the KPF. The Mullaloo Sandstone Member of the KPF is generally the material that KPF refers to in this report. The Mullaloo Sandstone Member generally comprises pale grey and yellow, very dense Sand with minor medium quartz gravel. Although the name might suggest that the Mullaloo Sandstone is a rock-like material, the boreholes drilled for the sports precinct indicate that the material generally consists of very dense, uncemented Sand to Gravelly Sand. It is possible that the material is cemented in places.

5.3 Surface Water

The closest surface water features are the Swan River surrounding the site and two man-made lakes within the site.

5.3.1 Swan River

Data relating to variations in the Swan River due to tidal fluctuations was collected from the Department of Transport between 1 January 2011 and 31 August 2011 at the Barrack Street Jetty and was used as representative values for the site. The tidal range at the Barrack Street Jetty varied from about RL -0.35 to about RL 1 m AHD.

5.3.2 Man-Made Lakes

Currently the Burswood Park Golf Course uses an irrigation system for the greens and surrounding grounds that likely imparts an artificial recharge and groundwater mounding over those areas. Likewise there are two main lakes and artificial water courses at the site. The western lake (the River-fed Lake) is directly connected with the Swan River by an inlet on its north-west end.

The eastern lake (the Irrigation Lake), located near the middle of the site is supplied by a deep groundwater bore screened in the Leederville Aquifer. This lake is clay-lined and therefore should be largely isolated from the local groundwater table. However, it is understood from communication with the Burswood Park Golf Course operator that the Irrigation Lake is currently leaking.

5.4 Hydrogeology

Figure 3 shows a conceptual hydrogeological plan and cross-section through the site and has been developed from the geological model. It is important to note that the geological model does not differentiate between the smaller scale gravel, sand, silt and clay layers that occur within individual units and may affect the local groundwater flow pattern. The hydraulic conductivity may vary significantly throughout the surficial aquifer as a result.

The three principal geological units that will be hydrogeologically influenced by the proposed construction are the Fill, SRA, and SCD. The Fill, SRA and SCD in the Burswood area are all collectively included in the Superficial Aquifer for the Perth area as outlined in Davidson (1995). Below the Superficial Aquifer are the King's Park and Leederville Aquifers. These aquifers would not be affected by construction dewatering for the planned Stadium construction.

Across the Burswood Peninsula variations in both the thickness and presence of the three superficial units exist. At the western side of the site, towards the river, the SCD and Fill are separated by up to 24 m thickness of SRA which acts as a semi-confining unit for the SCD. However, in parts of the north and east areas, the SRA is absent and the Fill is in direct contact with the SCD unit. These three units are generally considered to be hydraulically connected and part of a regional unconfined aquifer system.

The Superficial Aquifer is connected to the Swan River with the fill unit likely having the most direct connection with the Swan River.

5.4.1 Groundwater Levels

Groundwater level readings taken between June 2012 and February 2013 indicate groundwater levels in the superficial aquifer across the site generally range from approximately RL 0.1 m AHD at the west end of the peninsula to RL 2.0 m AHD near the middle of the peninsula. Groundwater levels were generally higher to the south and east of the site and decrease towards the Swan River to the north and west.

The groundwater levels at the site are influenced by tides (close to Swan River), rainfall and irrigation resulting in localised changes in flow direction due to diurnal and seasonal fluctuations. Natural seasonal fluctuation of groundwater levels is likely to be less than 1.0 m but this fluctuation is currently dampened by the on-site irrigation.

5.4.2 Groundwater Flow

Davidson (1995) indicates that groundwater flow in the vicinity of Burswood is in a north-westerly direction towards the Swan River. The groundwater levels outlined above generally corroborate this assessment. There is likely some augmentation of groundwater level and flow by irrigation of the golfing grounds and parkland as well as the presence of the impervious surfaces of the Graham Farmer Freeway at the north and eastern extents of the site.

Groundwater levels also indicate an overall downward gradient from the Fill into the SCD near the middle of the peninsula and a reversal of this gradient (i.e. overall upward gradient) in close proximity to the Swan River.

The tidal influence of the Swan River may change the flow direction in close proximity to the Swan River and the River-fed Lake. On a rising tide a localised reversal of flow direction may be observed.

5.4.3 Hydraulic Properties

Hydraulic properties for the three main geological units comprising the Superficial Aquifer were obtained based on hydraulic testing (slug tests), particle size distribution, literature and professional experience with similar materials both on the Burswood Peninsula and in the greater Perth Metro area.

The range of hydraulic conductivity values for each of the three geological units within the Superficial Aquifer that are considered applicable based on examination of the above sources are presented in Table 1.

Table 1: Summary of Slug Test Results

Material Type	Approximate Hydraulic Conductivity (m/day)		
	Min	Max	Mean
Fill (Unit 1)	1	30	9
SRA (Unit 2)	0.001	0.015	0.008
SCD (Unit 3)	0.5	70	12

Some of the slug tests completed in the Fill and SCD units recovered at such a fast rate that estimation of hydraulic conductivity was not possible using that test methodology, indicating very high hydraulic conductivity (upper range).

The range in hydraulic conductivity suggest that it may be required to undertake additional hydraulic testing at the specific dewatering location to obtain more accurate dewatering rate estimations.

5.5 Groundwater Quality

Groundwater samples were collected from a network of groundwater wells installed in the Fill, SRA and SCD across the site (Figure 4) and submitted to a NATA accredited laboratory for analysis. Groundwater samples were collected in June 2012 from 14 wells installed for the geotechnical investigation screened in the Fill, SRA and SCD. A second round of sampling was conducted in August/September 2012 from the 14 geotechnical wells and an additional 21 wells screened in the Fill for the Stage 1 DSI investigation (Golder 2013a).

The groundwater quality results were compared to the following criteria:

- ANZECC 2000 Freshwater 95%
- ANZECC 2000 Marine 95%
- ANZECC Estuaries in South West Australia
- Swan River Trust Trigger Values (Draft 2012).

Appendix A presents a summary of the groundwater quality results for selected analytes. The groundwater quality results are presented in full in the DSI (Golder 2013b).

The groundwater quality results indicate:

- Metals including aluminium, boron, cadmium, copper, iron, manganese, nickel, selenium, and zinc were reported marginally above guideline levels in some samples.
- Nutrients including ammonia, nitrates, phosphorus and total nitrogen were detected at concentrations above assessment guidelines in groundwater. Concentrations of total nitrogen and ammonia are highest in the SRA. Ammonia concentrations exceeded the ANZECC 2000 guideline for estuarine, marine and freshwater environments in the majority of samples. Total nitrogen and total phosphorus concentrations exceeded the SRT guideline in the majority of samples.
- Hydrocarbon (TRH) and naphthalene were detected in some groundwater wells. The site history does not suggest the use of hydrocarbon fuels at the site and the DSI report (Golder 2013b) suggests a non-petroleum source (i.e. natural organic matter, organic rich waste, drilling mud) for the observed TRH concentrations in groundwater.

Results indicated groundwater samples were below detection limits for volatile organic compounds, PCBs, organochlorine and organophosphorus pesticides, selected herbicides, monocyclic aromatic hydrocarbons, phenols, and halogenated phenols. Polycyclic aromatic hydrocarbons were not reported above detection limits with the exception of naphthalene as discussed above.

Groundwater salinity (Total Dissolved Solids) at the site varies across the three main geological units and with distance from the Swan River, with varying degrees of saline groundwater intrusion:

- **Fill**: Average = 3 400 mg/L with ranges from 600 mg/L to 15 200 mg/L
- **SRA**: Average = 9 200 mg/L with ranges from 1 500 mg/L to 17 000 mg/L
- **SCD**: Average = 2 000 mg/L with from 400 mg/L to 4 700 mg/L.

The above values indicate that the SCD has the lowest salinity and that groundwater in the fill is relatively fresh as well. Groundwater within the SRA had widely variable salinity.

Consideration has also been made of the DER guidelines (DEC 2011) for groundwater acidification vulnerability (groundwater buffering capacity) and chemical criteria that indicate whether groundwater is being, or has already been affected by oxidation of sulfides. The groundwater results indicate that approximately 40% of the wells were greater than the guideline, though none of the other criteria (pH<5 and total aluminium > 1 mg/L) were exceeded. The groundwater quality indicates that more than 90% of the wells have a pH>6.5 and a Total Alkalinity > 180, which classifies the groundwater as “very high alkalinity” and “adequate to maintain acceptable pH level in the future”.

5.6 Acid Sulfate Soils

The Landgate ASS maps indicate that the site is located in an area with a high to moderate risk of disturbing ASS material occurring generally at depths greater than 3 m. However, given the low lying nature of some areas within the Project area, it is likely that these may in fact be high risk areas.

Previous investigations have confirmed that ASS is present in areas of the Burswood Peninsula. The high risk natural materials detailed in the DER risk maps at this site are correlated to shallow expressions of the SRA. These river alluvials are known to be sulfidic across the metropolitan area in locations close to the Swan River. The underlying SCD is also potentially ASS; the clay layers more so than the sands as the clays have a lower hydraulic conductivity thus anoxic conditions conducive to sulfide production are more likely. The higher conductivity sands may have groundwater with higher oxygen content so the presence of sulfide is less likely.

The Fill within the landfill areas has also been identified as ASS, except for the yellow and orange sand in the sand Fill (Unit 1a). ASS conditions may have been generated due to the organic rich nature of the waste, which is conducive to sulfide generation. It is relevant to note that all materials below RL 0 m AHD are considered to be ASS and if disturbed during construction activities should be managed according to the procedures present in the CSMP (Golder 2012f). ASS at site will be managed by the Lead Contractor(s) according to the CSMP and their CEMP.

6.0 SITE DEWATERING

Project dewatering may be required during both the Construction Phase and the Operating Phase of the Project as outlined in the following sections.

6.1 Dewatering Requirements

The dewatering requirements have not yet been fully identified at this stage. Potential dewatering requirements are outlined in below sections for each phase.

6.1.1 Preconstruction Site Works

Potential dewatering during PCS Works could be required for:

- **Excavations -** Short-term construction dewatering in some locations to facilitate shallow excavation to clear obstructions for installation of wick drains and stone columns, if this cannot be carried out in wet conditions.
- **Local groundwater abstraction -** If groundwater monitoring indicates contaminated “hot” spots, to prevent or minimise further mobilisation of contaminated water due to changes in groundwater flow.
- **Surcharging (Groundwater Interception) -** The surcharging will result in pore water being squeezed from the SRA into the Fill and SCD as fill is placed on the site, resulting in a temporary increase in groundwater levels and flow. Groundwater quality results and groundwater modelling has indicated that groundwater management could be required to minimise or prevent any increase in the groundwater nutrient load into Swan River from the surcharge area (Golder 2013a). The purpose of the groundwater interception is therefore to abstract groundwater (dewater) between the surcharge area and the Swan River to minimise or prevent any increase in the groundwater nutrient load into Swan River from the surcharge area.
- **Surcharging (Daylighting of groundwater) -** The groundwater model results indicate that the groundwater level rise should not cause groundwater to daylight at the surcharge area (Golder 2013a). Nevertheless, a contingency plan should be developed as part of the surcharge operation, to allow for dewatering, should this occur.

6.1.2 Stadium Construction Works

In additional to those listed for PCS Works, potential local dewatering during Stadium Works could also be required for:

- **Underground services –** Installation of underground services, such as sewer, stormwater and water pipes into the site.
- **Sewer pump station –** Excavation for installation of a sewer pump station
- **Construction –** Construction of pile caps and deeper sections of structure such as lift over-run pits

6.1.3 Operating Phase

Dewatering during the Operating Phase is not expected to be required except if underground services would need to be repaired.

6.2 Dewatering Method

6.2.1 General

The dewatering methodology would depend on the dewatering operation and would therefore have to be designed for each specific dewatering operation. However, it is likely that the following dewatering methods, or a combination thereof, could be utilised:

- Drilled dewatering wells – likely to be used if a larger area or deeper excavation requires dewatering.
- Dewatering spears – likely to be used for localised and/or elongated dewatering. Pre-drilling for installation of dewatering spears is likely to be required due to obstructions in the uncontrolled fill.
- In-pit sump pumps – for localised dewatering inside pits. This is the likely dewatering method for removing obstructions in the Fill.
- Trenches – for elongated dewatering, e.g. interception of groundwater.

The dewatering method would have to be specified in the specific Dewatering and Groundwater Management Plan(s).

6.2.2 Surcharging – Groundwater Interception

The following groundwater abstraction options have been identified for the groundwater interception between the surcharge area and the Swan River:

- ***Interception trench.*** An interception trench could be excavated between the surcharge area and the Swan River to below the current groundwater level along a groundwater level contour line. During surcharging the groundwater level would rise within the trench and the excess groundwater would be pumped out. The average surface elevation along the trench alignment should be approximately RL 3 m AHD with the trench likely requiring excavation to a minimum RL 0.5 m AHD. This gives a trench about 2.5 m deep, and approximately 6 m wide.
- ***Line of Dewatering Spears.*** A line of dewatering spears could be installed into the Fill, between the surcharge area and the Swan River. Given the close spacing between dewatering spears, a line of dewatering spears would produce a similar result as the interception trench. The bottom of the Fill is at approximately RL -1.5 m AHD, and the dewatering spears would therefore be approximately 4.5 m deep.
- ***Line of Abstraction Wells.*** A line of abstraction wells could be installed into the Fill, between the surcharge area and the Swan River. The spacing between wells would generally be greater than between spears, which would provide less effective interception. The discharge rate of the wells would be restricted by the depth of the Fill.

Alternative methods, such as capturing the expelled groundwater as close to the wick drain source as possible, could also be considered during the design phase of the PCS works. The closer to the source of the expelled SRA water the less mixing with the groundwater in the Fill and the less groundwater requiring management. However, this approach may not be practicable due to the associated infrastructure of the surcharge work.

The groundwater modelling results (Golder 2013a) indicate that groundwater abstraction between the surcharge area and the Swan River followed by treatment or off-site disposal is a feasible and effective management measure for reducing the otherwise additional nutrient load to the Swan River during the PCS Works. Of the described options, Golder considers that dewatering spears or wells are better options to abstract groundwater than an interception trench, because an interception trench will only remove groundwater from the top of the Fill and would therefore be less effective in “capturing” nutrients, as nutrient concentrations in the Fill may have the greatest concentrations at the base of the Fill.

6.3 Dewatering Schedule

6.3.1 General

The duration of the dewatering would depend on the specific dewatering operation and the specific Dewatering and Groundwater Management Plan(s) should outline the period over which dewatering is likely to be required. This will be used by the regulators for issuing necessary regulatory approvals. An indicative Project schedule is outlined in Table 2.

Table 2: Indicative Project Schedule

Part 1 Project Phase	Estimated Commencement	Estimated Completion
Construction Phase:		
■ Preconstruction Site Works (PCS Works):	■ Mid 2013	■ Late 2014
■ Stadium Construction Works (Stadium Works):	■ Mid 2014	■ Late 2017
Operating Phase:		
■ Transition to Opening	■ March 2016	■ March 2018

The dewatering rate and volume depends on the location, extent and depth of the excavation that would require dewatering. The dewatering rates and volume therefore have to be calculated for the specific Dewatering and Groundwater Management Plan(s).

6.4 Dewatering Rate and Volume

The dewatering rate and volume would depend on the specific dewatering operation, which would depend on the location, extent and depth of the excavation that would require dewatering. The dewatering rates and volume would therefore have to be calculated for the specific Dewatering and Groundwater Management Plan(s). To aid with the dewatering estimation a 3D hydrogeological model has been developed on behalf of the State.

6.4.1 Preconstruction Site Works

6.4.1.1 Excavations and Local Groundwater Abstraction

Dewatering rates and volumes would have to be estimated for the specific dewatering operation based on location, extent, depth, and dewatering period.

6.4.1.2 Surcharging – Groundwater Interception

The ground improvement works is currently being progressed by the State as a design and construct contract with the tendering process underway. The details of the PCS Works and the Stadium design and construction details are therefore currently unknown. To assist in understanding the potential impact on groundwater, Golder has prepared a preliminary conceptual ground improvement design (Golder Associates, 2012d), which details installation of wick drains and surcharging across the area (40 000 m^2) of the stadium playing field and the in-filled irrigation lake with wick drains penetrating through the SRA into the SCD. The groundwater model and nutrient mass balance results (Golder 2013a) was based on this conceptual design, and therefore form the basis for the dewatering volume calculations.

The groundwater modelling and nutrient mass balance results (Golder 2013a) indicate that to maintain the current nutrient load into the Swan River, approximately 225 kg of nutrients require removal from the groundwater during the surcharge year, prior to discharge into the Swan River.

The required dewatering volume would depend on the discharge disposal option (the higher the concentration in the groundwater being removed, the smaller the volume would be required to reach the 225 kg):

- ***Sewer*** - If the dewater is discharged to the sewer, the total nutrient concentration in the water will be removed from the site (e.g. if the groundwater contains a total nitrogen concentration of 12 mg/L, a total of 12 mg/L will be removed from the site when discharge into the sewer);
- ***River-fed Lake or Stormwater system -*** If the dewater is treated and discharged to the River-fed Lake or Stormwater system, it is only the difference between pre and post treatment concentrations that will be removed (e.g. if the groundwater contains a total nitrogen concentration of 12 mg/L, and the groundwater is treated on site to 1 mg/L (criteria for disposal to Swan River), a total of 11 mg/L will be removed. If dewater is proposed to be discharged into the River-fed Lake or the stormwater system, then approval will be sought from SRT.
- ***Re-infiltration, Irrigation, Construction Use -*** If the dewater is treated and discharged onsite, it is only the difference between pre and post treatment concentrations that will be removed (e.g. if the groundwater contains a total nitrogen concentration of 12 mg/L, and the groundwater is treated onsite to 4 mg/L (current background concentration to allow for on-site use), a total of only 8 mg/L will be removed.

Table 3 presents the dewatering volumes required for different dewatering disposal options and indicates that the required dewatering volume will range between approximately 20 000 kL and 30 000 kL assuming an average total nitrogen concentration of 12 mg/L during the surcharge year. The dewatering volume is likely to be abstracted over a period of up to 6 to 12 months, which would result in a dewatering rate ranging from approximately 0.6 L/s to 1.8 L/s.

Table 3: Estimated Dewatering Volume for Different Disposal Options

Disposal Options *	Dewatering Volume (kL)
Disposal to Sewer (no treatment for nutrients)	19 000
Disposal to the River-fed Lake or Stormwater system (dewatering discharge treated onsite to 1 mg/L)	20 500
Re-infiltration/Irrigation/Construction Use (dewatering discharge treated onsite to 4 mg/L)	28 000

* Assuming an average total nitrogen concentration of 12 mg/L

Given that the volume estimations are based on assumptions, it is proposed that the 5C licence to abstract water should be sought for a volume of 50 000 kL, which should negate the need to apply for a licensed volume increase during the surcharge operation.

Given the low required groundwater abstraction rate, in reality the abstraction system is likely to only pump for a limited time each day (albeit at a higher rate).

6.4.2 Stadium Construction Works

Dewatering rates and volumes would have to be estimated for the specific dewatering operation based on location, extent, depth, and dewatering period.

7.0 EFFECT OF DEWATERING

7.1 Area of Influence

7.1.1 General

When details are available for the dewatering requirements, the specific Dewatering and Groundwater Management Plan(s) will contain information on the extent of groundwater drawdown from the dewatering location to address the area of influence in the context of groundwater sensitive vegetation, water bodies and nearby structures that could be affected. In addition this section of the Dewatering and Groundwater

Management Plan(s) must address the area of influence in the context of ASS, with reference to Appendix A of the CSMP (Golder 2012f).

7.1.2 Surcharging – Groundwater Interception

The groundwater model results indicate that the groundwater level drawdown from abstracting the 30 000 kL within 6 to 12 months is less than 0.3 m, with a lateral extent of the groundwater drawdown of approximately 200 m. The model also indicates that the groundwater abstraction would not reverse the flow direction towards the Swan River (i.e. there would always be a flow toward the Swan River). The area of influence is therefore limited and will not affect other groundwater uses.

7.2 Groundwater Quality

Dewatering activities have the potential to impact groundwater quality by altering the natural groundwater regime. Changes in groundwater quality could occur by mobilising groundwater of lesser quality (contaminated or natural) towards the cone of depression from the surrounding area or from deeper parts of the aquifer. The potential for this groundwater quality issue would need to be considered in the specific Dewatering and Groundwater Management Plan(s).

The salinity in the groundwater in the Fill is currently artificially low (fresh) due to irrigation at the site. Once the irrigation ceases, the salinity will start increasing and eventually a new “natural” equilibrium will be established. It is estimated that this process will likely take years.

The surcharging proposed during PCS Works is likely to cause an increase in salinity, similar to the nutrient concentrations as the groundwater in the SRA is more saline than that in the Fill. This would mean that the new equilibrium is likely to be reached sooner. The groundwater model indicates that the potential groundwater withdrawal related to the surcharging should not reverse the groundwater flow resulting in saline water intrusion from the Swan River.

Short-term dewatering for other purposes would need to be assessed for the specific dewatering operation based on location, dewatering requirement and duration. However, this is currently expected to be short-term, minor and generally restricted to within the close vicinity of the dewatering location. This would need to be assessed during the preparation of the site specific DMP.

It should be noted that there is currently no identified groundwater users within the Fill and the increase in salinity is therefore not expected to affect any users.

Given that the salinity in the groundwater in all hydrogeological units (Fill, SRA and SCD) are below the receiving environment (Swan River) there should not be a need for establishing a trigger value for infiltration.

The contractor would need to specify a trigger value for re-use for compaction, if applicable.

Groundwater management measures are outlined in the Contaminated Site Management Plan (Golder 2012f) and the Project EMP (Golder 2012e) and reference to these documents should be made in the specific Dewatering and Groundwater Management Plan(s). Reference should also be made to Appendix A of the CSMP (Golder 2012f) for ASS considerations.

7.3 Surface Water

The closest surface water features include the Swan River and the artificial lakes contained within the Project area. Given the large water volume available in the Swan River, the environmental stress on the river resulting from the abstraction of groundwater at site is considered to be negligible. Similarly with the River-fed Lake, which is connected to the Swan River, abstraction of groundwater is not anticipated to cause a lowering of lake levels. The artificial lakes to the south of the site are lined and topped up with irrigation water and not directly connected to the groundwater. Therefore, levels in these lakes should not be affected by dewatering activities.

A water quality monitoring program will be established for the site (refer to Project EMP Golder 2012e and CSMP Golder 2012f), which will also include monitoring of water quality from the River-fed Lake and the Swan River. If the dewatering site is located in close vicinity (within 100 m) of the Swan River or the River-fed Lake, specific monitoring of the water bodies will also be required.

7.4 Ecological and Habitat

The specific Dewatering and Groundwater Management Plan(s) will need to include an assessment as to whether the magnitude, extent and period of drawdown is expected to impact on ecology and habitat due to the physical act of lowering the groundwater level. Due to the proximity of the Swan River and increasing salinity with depth, consideration should be given to the possibility of increasing salinity in the shallow groundwater from changes to the groundwater regime during dewatering. Temporary salinity increase could cause stress to vegetation within the cone of depression. However, given that the site is generally going to be cleared during the Construction Phase, the vegetation within the cone of depression is limited. Furthermore, should vegetation within the cone of depression show signs of stress, they could be irrigated with water from the on-site irrigation bore.

The Project area is of local value for some fauna and waterbirds that rely on the network of artificial lakes. The greatest value of the site for non-avian fauna is considered to be estuarine fish and invertebrates using the River-fed Lake. Due to its proximity to the construction activities, effects on the River-fed Lake must be considered in any proposed dewatering works.

7.5 Settlement of Structures

The specific Dewatering and Groundwater Management Plan(s) must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. This is not considered to be an issue if the Construction Phase dewatering requirements are of limited depth and duration. Proximity to nearby infrastructure including the Graham Farmer Freeway and the railway line will need to be assessed on a case by case basis.

7.6 Local Bore Users

A search of the DoW borehole database (WIN) was carried out to identify any registered bores within close proximity of the site. The Burswood Park Board (BPB) operates a bore field comprising seven production bores, two from Leederville and five from the KPF. In addition the Belmont racecourse has a licensed bore screened in the Leederville Aquifer for irrigation of turf. The closet known operational well in the superficial aquifer (SCD) is a BPB irrigation well (Bore 9) located approximately 1.5 km south-east of the site. Given the limited and shallow potential dewatering in the Superficial Aquifer and that the identified bores are abstracting water from deeper aquifers, it is unlikely that these bores will be affected by the dewatering.

Regardless the Phase specific Dewatering and Groundwater Management Plan(s) will need to address potential affect to local bore users.

8.0 DEWATERING DISPOSAL AND TREATMENT OPTIONS

The dewatering disposal options will depend on the dewatering rates and the abstracted water quality.

The currently available groundwater quality results for the site indicate that levels of some metals and nutrients exceed the DER and SRT guidelines (refer to Section 5.5). The discharge is therefore likely to require some treatment prior to disposal to ensure that it does not have an adverse effect on the receiving environment. The trigger values for treatment will depend on the chosen disposal option.

Table 4 presents the currently identified disposal options, in order of preference, and applicable trigger value guidelines to use.

Table 4: Disposal Options and Guidance Trigger Levels

Option	Applicable Trigger Value Guideline
On-site re-use as construction water or irrigation	Baseline and trends
Re-infiltration	Baseline and trends
Discharge into Sewer	Water Corporation (One-off discharge criteria)
Stormwater/Swan River	Swan River Trust (refer to Project EMP)

The chosen option(s) will have to be identified and outlined in the specific Dewatering and Groundwater Management Plan(s) based on the estimated rates and total volumes of dewatering required. The following sections provide some information on each potential disposal option.

8.1.1 Re-use as Construction Water

Some of the dewatering discharge may be used as on-site construction water, such as for dust suppression, moisture conditioning for fill compaction and irrigation. The re-use of water would depend on water quality, which is likely to be brackish to saline and potentially contain some metals (e.g. iron). Some treatment could be required which would typically be achieved using a standard on-site "treatment system". Treatment could include lime dosing, aeration and settling/filtering to remove metals and capture suspended solids. Additional treatment for nutrients and other contaminants may be required, depending on the use of the water.

Re-use of water could be combined with other disposal options where similar or more extensive treatment would be required (e.g. infiltration or disposal to stormwater system).

8.1.2 Re-infiltration

Re-infiltration on site is considered a feasible dewatering discharge disposal option, if suitable area is available. The required infiltration area would depend on the dewatering rates/volume and the infiltration capacity and depth to groundwater level, which would need to be investigated and estimated for the specific dewatering operation.

Re-infiltration to groundwater would typically be achieved using a standard on-site "treatment system" or mobile treatment units. Treatment could include lime dosing, aeration and settling/filtering to remove metals and capture suspended solids before being discharged into an infiltration basin. Additional treatment for contaminants may be required, depending on the specific dewatering operation.

Infiltration into the SCD below the SRA or into the deeper aquifers using infiltration/injection wells is not considered a feasible option because significant treatment would be required to prevent iron bacteria clogging up the wells (biofouling), reducing the efficiency of the system. Even with treatment, uncertainty exists as to how efficient the re-injection system would be over time. It is expected that significant maintenance of the wells would be required, even if water is treated prior to infiltration.

In the case of the groundwater interception from the Fill during the surcharge operation, where the purpose of the groundwater interception is to abstract and treat groundwater for nutrients, the abstracted water would need to be treated to minimum background concentrations before it can be re-infiltrated back on site.

8.1.3 Sewer

Disposal to the sewer is considered to be a feasible option, however, the following should be considered:

- Approval would be required from the Water Corporation by lodging a "one-off discharge of industrial waste". Early discussions with the Water Corporation have indicated the feasibility of this solution but detailed discussions would be required to confirm water quality, quantity and timing.
- Proximity to current sewer locations suitable for discharge will need to be considered and discussed with the Water Corporation.

- Disposal is normally restricted by the sewer capacity, which would need to be discussed with the Water Corporation and would therefore depend on the expected discharge rates and volumes. This could, therefore, be a limitation as dewatering rates may be higher than the available capacity.
- This option is likely to require limited on-site treatment, which is envisaged to potentially be pH adjustment and removal of Total Suspended Solids (TSS).
- This option would require limited dewatering discharge monitoring during the dewatering operation.
- There is a per unit cost for disposal to sewer, which would depend on the water quality.

Discharge to sewer may also be considered as a contingency measure as a backup to other selected disposal option(s).

8.1.4 Stormwater System

Disposal to the stormwater system is also considered a feasible option; however, the following should be considered:

- The stormwater system at the site discharges into the Swan River. The water quality would therefore need to meet DER marine water criteria as well as specific criteria set by the SRT.
- Approval would be required from the asset owner of the stormwater drain point, DoW, DER and SRT.
- This option is likely to require the most treatment, which may in addition to pH adjustment and removal of metals also include the removal of nutrients. Additional treatment for contaminants may be required, depending on the specific dewatering operation.
- Though there may be some capacity restrictions based on the capacity of the stormwater pipes, this is unlikely to be an issue due to the expected relatively low dewatering rates. However, the capacity would need to be investigated and discussed and agreed with the asset owner.
- Depending on treatment process, disposal of waste water from the treatment unit may be required, which could require access to the sewer.
- There is normally no per unit cost for disposal to the stormwater.

Discharge to stormwater may also be considered as a contingency measure as a backup to other selected disposal option, e.g. should dewatering rates be higher than expected.

9.0 MONITORING

Monitoring of the groundwater (using monitoring wells) and dewatering discharge is required by Lead Contractor(s) during dewatering. The monitoring will have to commence prior to dewatering activities and continue after the cessation of dewatering. Details of the proposed monitoring will be dependent on the nature and extent of dewatering and will need to be outlined in the Phase specific Dewatering and Groundwater Management Plan(s). The following sections outline likely monitoring requirements based on the guidelines from DoW (2006) and DER (DEC, 2011).

This section outlines monitoring to be undertaken by the Lead Contractor(s).

9.1 Groundwater

A groundwater monitoring well network has been established as part of the geotechnical and environmental investigation (refer to Figure 4). A series of groundwater wells will need to be installed along the eastern side of the River-fed Lake and the network will be monitored as part of the Project EMP (Golder 2012e). This network should be utilised as part of the groundwater monitoring for any dewatering operation. It may be necessary to increase the monitoring frequency in some of the closer monitoring wells to the dewatering area. Furthermore, it may be necessary to drill additional temporary monitoring wells closer to the

dewatering site prior to dewatering. The requirement for new monitoring well locations would need to be assessed during the preparation of the specific Dewatering and Groundwater Management Plan(s).

9.1.1 Field Monitoring

Groundwater level, pH, electrical conductivity, TTA and total alkalinity will be measured every second day. The monitoring should commence one week prior to start of dewatering and continue throughout the dewatering period until one week after completion of dewatering.

If the dewatering ceases due to unforeseen events for a period of less than 14 days, measurement of groundwater level should continue during this period. If the dewatering hiatus is greater than 14 days, the groundwater level monitoring could cease during this period.

The measured groundwater levels in the surcharge area during the surcharge operation should be compared to estimates from the groundwater modelling to provide early indication of the likelihood that groundwater levels could daylight.

9.1.2 Laboratory Analysis

Groundwater samples will be collected from the monitoring wells for laboratory analysis prior to commencement and then at fortnightly intervals during the dewatering operation depending on the dewatering duration. The groundwater quality results from the laboratory should be compared with the background water quality results obtained prior to start of the dewatering activities.

The groundwater quality results from groundwater samples taken during the environmental investigation will be used as background groundwater quality.

The proposed analytes to test for are presented in Table 5. Field pH, electrical conductivity, dissolved oxygen, redox potential, TTA and temperature should be measured in the field when collecting the water samples.

Table 5: Required Analytes for Laboratory Suite for Groundwater

Category	Parameters
Field parameters	Groundwater level, pH, electrical conductivity, total titratable acidity and total alkalinity
Miscellaneous parameters	total acidity, total alkalinity, pH, total dissolved solids, turbidity
Major ions	Cations: calcium, magnesium, sodium, potassium Anions: chloride, sulfate, bicarbonate, sulfide
Dissolved metals	arsenic, boron, cadmium, chromium, copper, nickel, lead, zinc, aluminium, selenium, iron, mercury, molybdenum, manganese, tin
Total metals	arsenic, boron, cadmium, chromium, copper, nickel, lead, zinc, aluminium, selenium, iron, mercury, molybdenum, manganese, tin
Nutrients	ammonia as N, total nitrogen, total oxidised nitrogen, reactive phosphorous, total phosphorous
Contaminants of Concern	PAHs (including naphthalene) and organochlorine and organophosphate pesticides

The groundwater sampling, including quality control and quality assurance procedures, will be undertaken as described in the SAP *(*Golder 2012g).

9.2 Dewatering Discharge

The following field minimum monitoring is required for the dewatering discharge.

9.2.1 Dewatering Volume

Flow meters will be installed on all dewatering discharge streams to record discharge rates and cumulative volumes and read daily.

9.2.2 Monitoring in Accordance with ASS Guidelines

In accordance with the DER guidelines pH, electrical conductivity, TTA, and total alkalinity will be measured in the field once per day, pre and post any treatment (if required) in accordance with Table 6, which presents triggers, actions and monitoring for the dewatering discharge obtained from "Treatment and management of soils and water in acid sulfate soil landscapes" (DEC, 2011). The trigger levels apply to the dewatering discharge prior to any treatment (i.e. untreated). If water quality has not improved after treatment, additional treatment will be necessary.

Table 6: Dewatering Discharge Trigger Levels, Actions and Monitoring

	Trigger	Action	Monitoring
1a	**Total titratable acidity <40 mg/L** pH > 6	Continue daily field measurements of pH and total titratable acidity.	**Daily** - field measurement: pH, electrical conductivity (EC), Dissolved Oxygen (DO), Redox Potential (Eh), Total Titratable Acidity (TTA), total alkalinity **Fortnightly** - laboratory analysis: total acidity, total alkalinity, pH
2a	**Total titratable acidity <40 mg/L** pH in range 4 to 6	Undertake neutralisation treatment (liming),	**Daily** - field measurement: pH, EC, DO, Eh, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH
3a	**Total titratable acidity in range 40 mg/L to 100 mg/L** pH > 6	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	**Daily** - field measurement: pH, EC, DO, Eh, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH
4a	**Total titratable acidity in range 40 mg/L to 100 mg/L** pH in range 4 to 6	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	**Daily** - field measurement: pH, EC, DO, Eh, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - laboratory analysis *

	Trigger	Action	Monitoring
5a	**Total titratable acidity >100 mg/L** or **pH < 4** or **total alkalinity < 30 mg/L**	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Increase neutralisation treatment (liming) rate. Advise Strategic Projects (SP). SP may advise appropriate action which may include ceasing dewatering.	**Twice daily -** field measurement: pH, EC, DO, Eh, TTA, total alkalinity **Weekly -** laboratory analysis * May be needed to undertake investigations to determine the size of the 'acidic footprint' created and manage this impact appropriately.

* Required analytes Laboratory Suite is presented in Table 7.

Table 7: Required Analytes for Laboratory Suite for Dewatering Effluent

Type	Analyte
Inorganics	total acidity, total alkalinity, pH, EC, TDS, TSS, hydrogen sulfide*
Major Ions	Cl, Na, SO_4
Dissolved Metals	Al, Fe, Mn
Total Metals	As, Cd, Cr, Ni, Zn, Al, Mn, Se, Fe
Nutrients	ammonical nitrogen, total nitrogen, reactive phosphorous, total phosphorus

* Only needed if when discharging to the stormwater system

Table 6 indicates that weekly or fortnightly sampling for laboratory analysis of the dewatering discharge will be required pre and post-treatment.

9.2.3 Other Monitoring

Additional contaminants of concern may be required to be monitored based on the nature and location of the dewatering program.

Additional monitoring would also depend on the chosen disposal option. If the dewatering discharge would be disposed to the stormwater system, the following additional monitoring would be required:

- Total nitrogen – trigger level would be 1.0 mg/L;
- Total phosphorus – trigger level would be 0.1 mg/L.
- Total iron – trigger level would be 1.0 mg/L.
- Total Aluminium – trigger level would be 0.15 mg/L
- Odours and colours - No objectionable odours or visible colour.
- Floatable matter - No visible floating oil, grease, scum, litter or other objectionable material.

It is proposed that photos are taken regularly of the dewatering effluent to document the visual quality of the water.

9.3 Settling Effects

The specific Dewatering and Groundwater Management Plan(s) must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. This is not considered to be an issue if the construction dewatering requirements are of limited depth and duration. Proximity to nearby infrastructure including the Graham Farmer Freeway and the railway line will need to be assessed on a case by case basis.

The requirement for a monitoring and management strategy should therefore be assessed based on actual dewatering requirements. If settlement is considered a risk, survey points will need to be installed on adjacent structures with a minimum of two points per structure. These points should be surveyed prior to dewatering activities commencing and then at fortnightly intervals during the dewatering period. Survey data should be recorded and reviewed and the reasons for any changes or movements identified.

10.0 REPORTING

The monitoring data should be collected and tabulated by the Lead Contractor(s) in such a way as to facilitate presentation or reporting to the regulators as required (i.e. including record of date, time and parameters measured). Records and results of the monitoring program should be retained by the Lead Contractor(s) and be provided to SP in the monthly compliance report or as it requests, including for inspection or reporting on request by regulatory agencies.

After completion of the dewatering operation the Lead Contractor(s) must prepare and submit to SP an Environmental Completion Compliance Report which collates all the monitoring data and details management measures undertaken at the site.

11.0 CONTINGENCY PLAN

Contingency plans will be developed for the specific Dewatering and Groundwater Management Plan(s) to address actions to be undertaken where performance criteria are not met or unforeseen events occur. Contingency plans should consider, but not be limited to, implementation of the measures outlined in the Project EMP and CSMP (where applicable) and the below points, if required. Non-conformance, environmental incidents and public complaints related to the dewatering operation shall be reported in accordance with the procedure outlined in the Project EMP (Golder 2012e).

11.1 Dewatering Discharge Disposal

The dewatering discharge should be contained within basins and trenches at all times and not be allowed to flood the site. In the event of any flooding, the dewatering operation should be ceased (if safe to do so) until proper storage or disposal options have been arranged.

11.2 Dewatering Discharge Water Quality

In the event that the dewatering discharge quality results indicate a deteriorating trend during the dewatering activities, the monitoring intensity would be increased and actions outlined in Table 6 strictly followed (advice SP to discuss actions). Additional actions could be to install strategically placed monitoring wells to monitor groundwater quality off-site.

11.3 Dewatering Volume

In the event that discharge rates or dewatering periods are greater than estimated, which would result in exceeding the licensed dewatering volume, SP is to be advised. The Lead Contractor is then responsible for obtaining approval to increase discharge rates or periods in consultation with the DoW as per their licence.

11.4 Groundwater Level

In the event that the groundwater level monitoring in monitoring wells indicates greater than expected drawdown or greater than expected groundwater mounding (from surcharging indicating that groundwater may daylight), a groundwater specialist should review the results and the monitoring frequency should be increased to daily groundwater level measurements. Additional strategically placed monitoring wells could be installed and monitored daily, depending on the outcome of the review of the results.

Depending on the outcome of the review, relevant authorities may need to be advised (through SP) of the review and implemented measures.

11.5 Groundwater Quality

In the event that the groundwater quality results from the monitoring wells indicate a deteriorating trend of the groundwater quality during the dewatering activities, a groundwater specialist or environmental scientist should review the results and make necessary changes to the monitoring schedule and frequency (i.e. weekly laboratory analysis or inclusion of additional analytes to be tested). Additional strategically placed monitoring wells may be required to be installed and monitored in accordance with the revised monitoring schedule to gain a better understanding of the cause.

Depending on the outcome of the review, relevant authorities may need to be advised (through SP) of the review and implemented measures.

11.6 Settlement

In the case that survey of adjacent structures shows any settlement or abnormalities, the dewatering operation should cease immediately, if safe to do so. A geotechnical specialist should be employed to review the data and propose appropriate measures. The relevant authorities should be advised (through SP) of the results of the investigation and proposed actions.

Further applicable contingency measures are outlined in the Project EMP and CSMP.

12.0 SCHEDULE OF CONTRACTUAL RESPONSIBILITIES

As part of the specific Dewatering and Groundwater Management Plan(s) the roles and responsibilities will be outlined to ensure procedures are followed throughout the dewatering program. Figure 5 shows the overall communication line between the Lead Contractor, SP and the Regulatory Authorities (Golder 2012e), particularly with reference to reporting environmental incidents.

Figure 5: Organisational Structure of Reporting Responsibilities

Table 8 presents an example of the individual responsibilities for the dewatering program.

Table 8: Proposed Responsibilities

Party	Responsibilities
Lead Contractor	Excavation and overseeing entire Construction Phase of the Project
	Preparation of site-specific Dewatering and Groundwater Management Plan
Dewatering Contractor	Installation of dewatering system
	Operation of dewatering activities
	Monitoring of groundwater discharge volumes
Dewatering Contractor or Water Treatment Contractor	Treatment of abstracted groundwater
Dewatering Contractor or Groundwater Professional	Monitoring of groundwater levels
	Field monitoring of groundwater quality
Lead Contractor's Groundwater Professional	Groundwater Sampling for Laboratory Analysis
	Review of monitoring data
	Inspection of Dewatering Activities
	Preparation of Environmental Completion Compliance Reports

13.0 REFERENCES

Davidson, W.A. (1995) - *Hydrogeology and groundwater resources of the Perth Region*, Western Australia, Western Australian Geological Survey, Bulletin 142.

DEC (2011) - *Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes*. July 2011

Golder Associates (2012a). *Geotechnical Factual Report, Masterplan Study Phase, New Perth Stadium and Sports Precinct, Burswood.* (127642046-002-R-Rev1). October 2012.

Golder Associates (2012b). *Geotechnical Interpretive Report, Masterplan Study Phase, New Perth Stadium and Sports Precinct, Burswood.* (127642046-003-R-Rev0). October 2012.

Golder Associates (2012c). *Preliminary Hydrogeological Report, New Perth Stadium and Sports Precinct, Burswood.* (127642046-008-R-Rev2). October 2012.

Golder Associates (2012d). *Conceptual Design of Ground Improvement, Preconstruction Site Works, Proposed New Perth Stadium and Sports Precinct, Burswood.* (127642088-001-R-Rev0). October 2012.

Golder Associates (2012e). *New Perth Stadium Environmental Management Plan.* (127643077-036-R-Rev0). July 2013.

Golder Associates (2012f). *New Perth Stadium Contaminated Site Management Plan.* (127643077-041-R-Rev0). July 2013.

Golder Associates (2012g). *Sampling and Analysis Plan and Data Quality Objectives – Environmental Investigation Proposed Perth Major Stadium* (117643077-006-R-Rev3). July 2012.

Golder Associates (2013a). *New Perth Stadium Groundwater Modelling Report* (127643056-029-R-Rev1). July 2013.

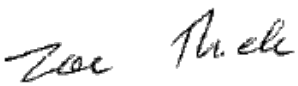
Golder Associates (2013b). *New Perth Stadium Stage 1 Detailed Site Investigation Interpretive Site Contamination Report* (127643056-010-R-Rev0). July 2013.

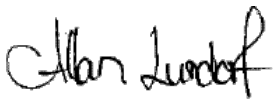
Perth Groundwater Atlas (1997). Water and Rivers Commission. October 1997.

Perth Groundwater Atlas (2004). Second Edition. Perth: Department of Environment. December 2004.

Report Signature Page

GOLDER ASSOCIATES PTY LTD





Zoe Thiele
Environmental Engineer

Allan Lundorf
Senior Water Resources Engineer

ZT/AL,IYK/eh

Endorsed

Public Transport Authority Environmental Manager

Endorsed

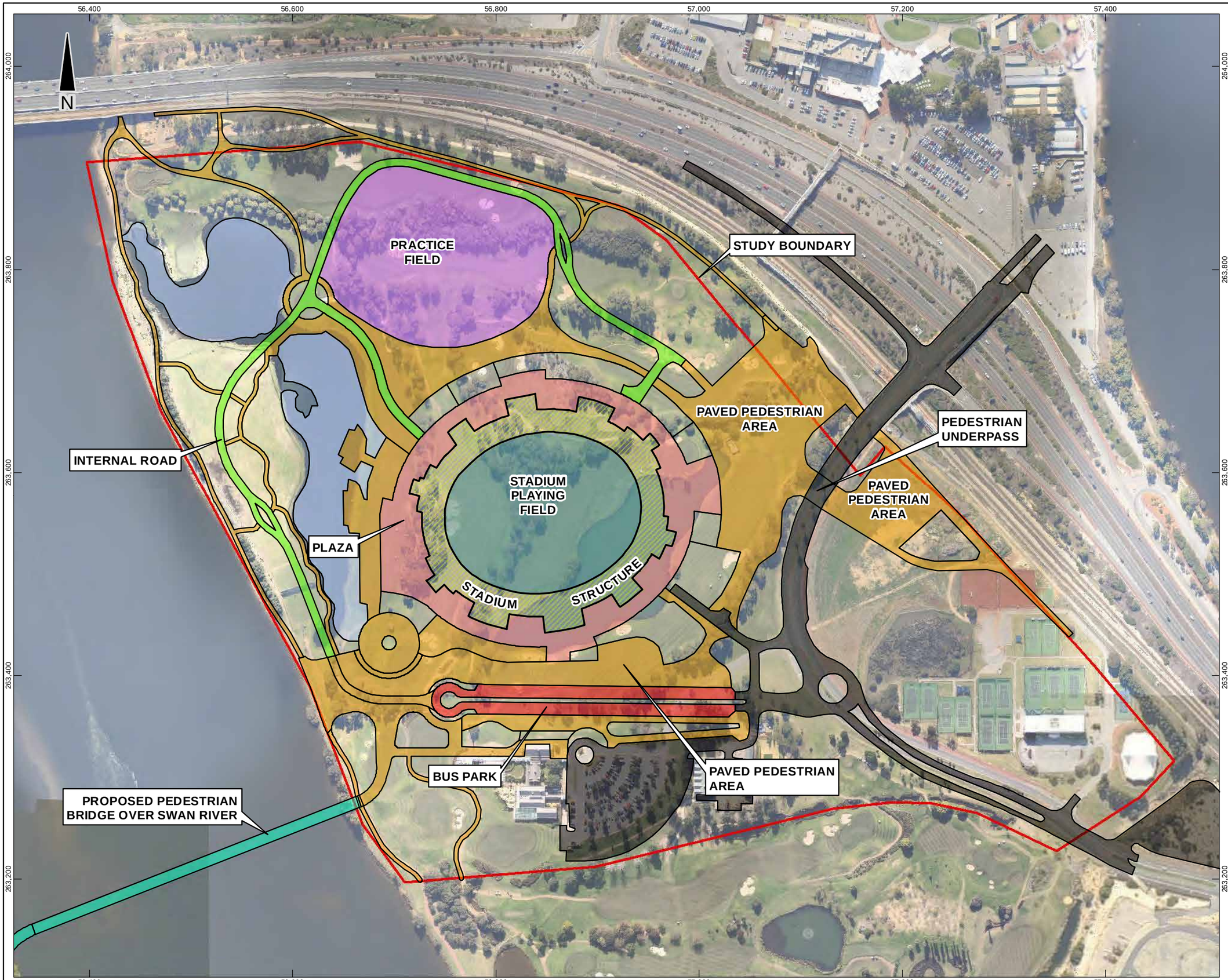
Manager Planning, Department of Treasury Strategic Projects

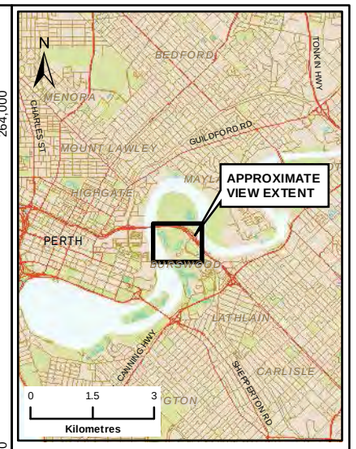
Approved

Principal Project Director, Strategic Projects,

A.B.N. 64 006 107 857

\\pth1-s-file01\jobs\env\2011\117643077 - pta desktop review burswood\correspondence out\040-dmp\rev1\117643077-040-r-rev1 dmp.docx





NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Development layout traced from Burswood Major Stadium Master Plan Preliminary Concept Plan - Short Term Dated May 2012, provided by client.
Aerial imagery © Nearmap (2012).

0 30 60 90 120 150
metres

SCALE (at A3) 1:3,500

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-040-R-Rev1
DATE	23 Jul 2014
COMPILED	JRP/ LD / SR
APPROVED	IYK

New Perth Stadium Dewatering Management Plan

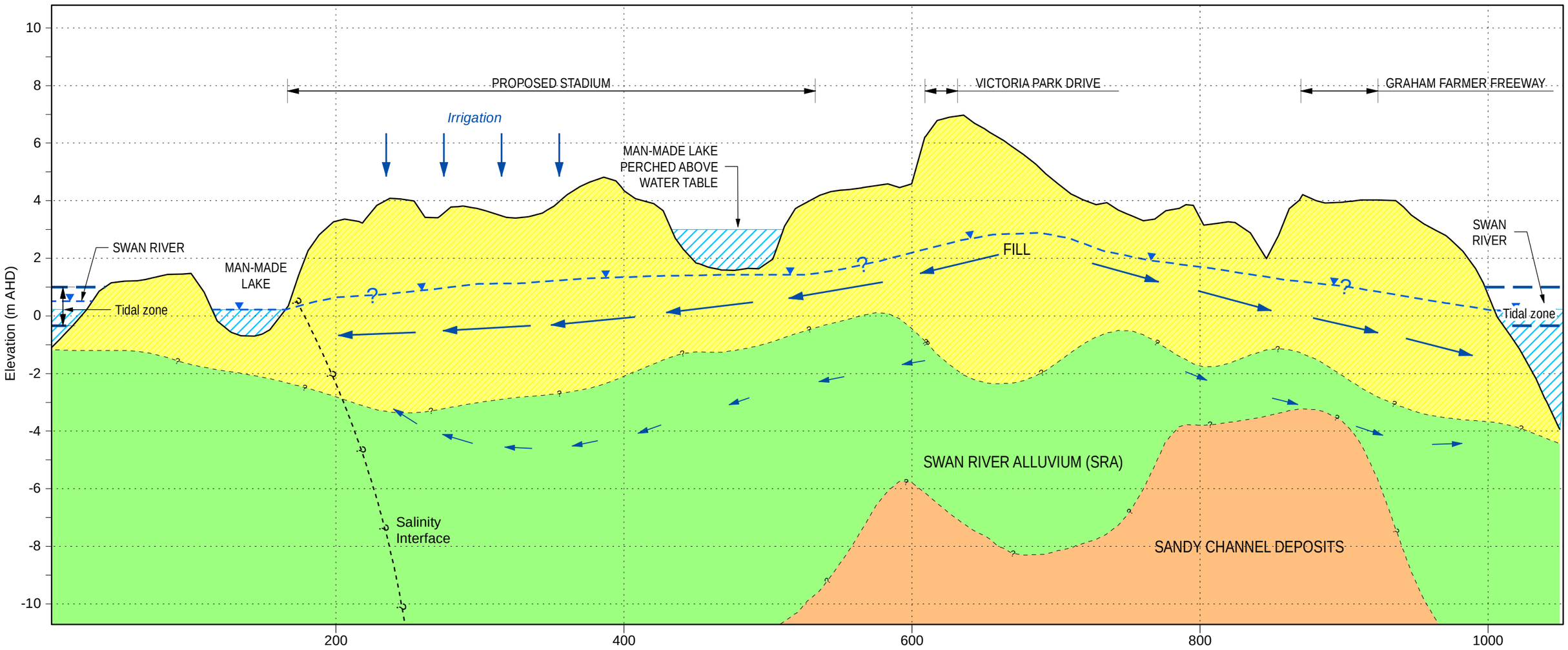
DEVELOPMENT LAYOUT

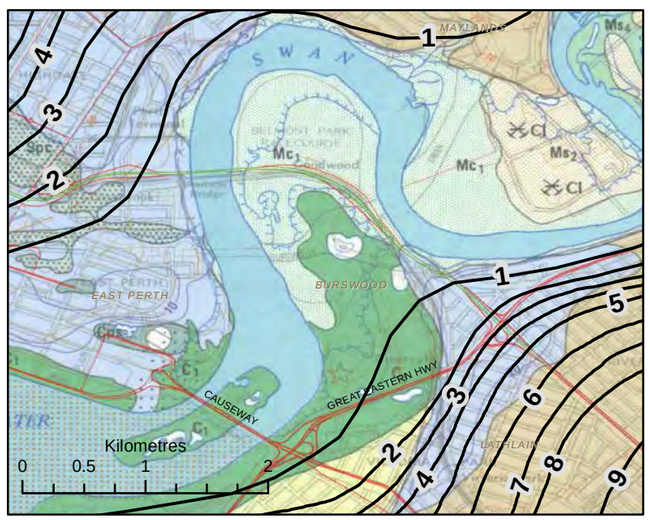
FIGURE 1

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R40\Rev1\117643077-040-R-F001-Rev1.mxd

WEST

EAST





Estimated Groundwater Flow Path

Groundwater Level

Groundwater Contour (May 2003)

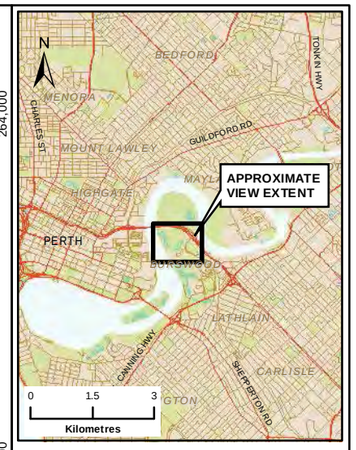
Section Location

COPYRIGHT

Inset plan based on MapstreePro v9.4 data and 1:50,000 Geological Series.
Groundwater contours sourced from the Department of Environment and Conservation - Groundwater Atlas (2005).

Golder Associates	CLIENT: Public Transport Authority		PROJECT: New Perth Stadium, Dewatering Management Plan
	DRAWN: SR	DATE: 23 Jul 2014	TITLE: **GROUNDWATER LEVELS**
	APPROVED: IYK		
	SCALE: A3	PROJECT No: 117643077-040-R-REV1	**FIGURE 3**

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117642087\Projects\Working\117642087_SK022_Section_Geology_regionalx25z.mxd



LEGEND

- Monitoring well
- Project area

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Development layout traced from Burswood Major Stadium Master Plan Preliminary Concept Plan - Short Term Dated May 2012, provided by client. Aerial imagery © Nearmap (2012).

0 30 60 90 120 150
metres

SCALE (at A3) 1:3,500

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-040-R-Rev1
DATE	23 Jul 2014
COMPILED	JRP/ LD / GGW
APPROVED	IYK

New Perth Stadium Dewatering Management Plan

GROUNDWATER MONITORING WELL LOCATIONS

FIGURE 4

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R40\Rev1\117643077-040-R-F004-Rev1.mxd

APPENDIX A

Summarised Groundwater Quality Results

Appendix A - Groundwater Quality Results

Field ID	Q6553-05	Q6560-02	Q6553-03	Q6560-04	Q6553-04	Q6560-03	Q6553-01	Q6559-03	Q6551 - 10	Q6559-02	Q6551 - 08	Q6557-01	Q6557-03	Q6558 - 01	Q6553-08	Q6561-02	Q6553-06
Location	BH01 FILL	BH01 FILL	BH01 SRA	BH01 SRA	BH01 SCD	BH01 SCD	BH02 FILL	BH02 FILL	BH02 SRA	BH02 SRA	BH02 SCD	BH02 SCD	BH02 SCD	BH02-SCD	BH03 FILL	BH03 FILL	BH03 SRA
Sampled Date	26/06/2012	10/08/2012	26/06/2012	10/08/2012	26/06/2012	10/08/2012	26/06/2012	9/08/2012	12/06/2012	9/08/2012	12/06/2012	8/08/2012	8/08/2012	8/08/2012	26/06/2012	13/08/2012	26/06/2012
Screened Unit	FILL	FILL	SRA	SRA	SCD	SCD	FILL	FILL	SRA	SRA	SCD	SCD	SCD	SCD	FILL	FILL	SRA

Chem Group	Chem Name	output unit	LOR	ANZECC 2000 Freshwater 95%	ANZECC 2000 Marine 95%	*Swan River Trust*	ANZECC Estuaries In South West Australia														
Sample Quality Parameters	pH (Lab)	pH Units	0.01			*6.5-8.5*	7.5-8.5	7.62	8	7.24	7.5	7.27	7.5	7.97	8	6.84	6.7	7.85	7.8	7.8	7.83	7.4	7.4	7.66
	Total Dissolved Solids @180°C	mg/L	10					998	3200	10,200	17,000	4660	4600	1270	1400	1530	1600	2000	2200	2100	2220	2500	2800	10,800
	Sodium (Filtered)	mg/L	0.5					780	760	3290	5200	848	820	370	420	408	440	511	580	600	497	575	800	3630
	Potassium (Filtered)	mg/L	0.1					57	44	185	230	66	51	22	23	28	46	30	33	34	29	39	48	193
	Calcium (Filtered)	mg/L	0.2					241	180	245	330	330	290	91	94	46	66	58	76	78	70	147	170	148
	Magnesium (Filtered)	mg/L	0.1					71	59	364	600	256	240	31	29	22	27	80	96	98	88	60	74	415
	Chloride	mg/L	1					1230	1600	6520	9200	1900	2400	586	650	542	670	570	590	560	580	1070	1600	6830
	Sulphate (as SO4)	mg/L	1					252	85	839	990	629	480	57	7	152	120	298	520	250	338	82	92	109
	Chloride/Sulphate ratio		Calculated			*<2**		5	19	8	9	3	5	10	93	4	6	2	*1*	*2*	*2*	13	17	63
	Bicarbonate Alkalinity (as CaCO3)	mg/L	1					613	-	523	-	261	-	341	-	323	-	574	-	-	666	424	-	860
	Bicarbonate Alkalinity as (HCO3)	mg/L	5					-	810	-	760	-	280	-	420	-	470	-	820	820	-	-	550	-
	Carbonate Alkalinity (as CaCO3)	mg/L	1					<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	-	<1	<1	-	<1
	Carbonate Alkalinity (as CO3)	mg/L	1					-	<1	-	<1	-	<1	-	<1	-	<1	-	<1	<1	-	-	<1	-
	Hydroxide Alkalinity (as CaCO3)	mg/L	1					<1	-	<1	-	<1	-	<1	-	<1	-	<1	-	-	<1	<1	-	<1
	Total Alkalinity (as CaCO3)	mg/L	1					613	660	523	630	261	230	341	350	323	390	574	680	670	666	424	450	860
	Alkalinity/sulphate ratio		Calculated			*<5**		*2.4*	7.8	*0.6*	*0.6*	*0.4*	*0.5*	6.0	50.0	*2.1*	*3.3*	*1.9*	*1.3*	*2.7*	*2.0*	5.2	*4.9*	*7.9*
	Acidity (as CaCO3)	mg/L	1			*40*		*41*	-	*80*	-	*44*	-	4	-	*43*	-	14	-	-	-	22	-	*47*
	Nitrate (as N)	mg/L	0.01					<0.01	-	<0.01	-	<0.01	-	<0.01	-	<0.1	-	<0.01	-	-	<0.01	<0.05	-	<0.05
	Nitrate (as NO3-)	mg/L	0.05					-	<0.05	-	<0.05	-	0.08	-	<0.05	-	<0.05	-	<0.05	<0.05	-	-	<0.05	-
	Nitrite (as N)	mg/L	0.01					<0.01	-	<0.01	-	<0.01	-	<0.01	-	0.03	-	<0.01	-	-	<0.01	<0.01	-	<0.01
	Nitrite (as NO2-)	mg/L	0.05					-	<0.05	-	0.27	-	0.06	-	<0.05	-	<0.05	-	<0.05	<0.05	-	-	<0.05	
	Nitrogen (Total Oxidised)	mg/L	0.005				0.045	<0.01	<0.005	<0.01	0.064	<0.01	0.036	<0.01	<0.005	<0.1	<0.005	<0.01	<0.005	<0.005	<0.01	<0.05	<0.005	<0.05
	Ammonia (as N)	mg/L	0.01				0.049	4.39	-	15.3	-	5.93	-	1.14	-	6.21	-	0.51	-	-	0.21	3.32	-	31.8
	Ammonia	mg/L	0.005	0.9	**0.91**			-	**5.7**	-	**27**	-	**7.4**	-	**1.9**	-	**11**	-	0.19	0.18	-	-	**5.3**	-
	Total Kjeldahl Nitrogen (as N)	mg/L	0.05					7.6	5.6	16.9	21	6	5.8	2.5	2	9.7	10	0.8	1.6	1.5	1.1	3.3	4.4	32.5
	Nitrogen (Inorganic)	mg/L	0.05					-	4.7	-	22	-	6.1	-	1.5	-	9.5	-	0.16	0.15	-	-	4.3	-
	Nitrogen (Total)	mg/L	0.05			*1*	0.75	*7.6*	*5.6*	*16.9*	*21*	*6*	*5.9*	*2.5*	*2*	*9.7*	*10*	0.8	*1.6*	*1.5*	*1.1*	*3.3*	*4.4*	*32.5*
	Cyanide (total)	mg/L	0.004	0.007	**0.004**			-	**<0.004**	-	**<0.004**	-	**<0.004**	-	**<0.004**	-	**<0.004**	-	**<0.004**	<0.004	<0.004	-	**0.017**	-
	Reactive Phosphorus (as P)	mg/L	0.002				0.005	0.2	0.002	<0.01	<0.002	<0.05	<0.002	0.02	0.058	<0.2	<0.002	0.03	0.045	0.045	0.04	<0.02	<0.002	0.78
	Phosphorus	mg/L	0.01			*0.1*	0.03	*0.61*	*0.75*	*0.15*	*0.48*	0.01	0.04	0.05	0.06	*0.1*	*0.49*	0.07	*0.11*	0.09	0.07	0.05	*0.11*	*0.99*
	Sulphide	mg/L	0.1					-	<0.1	-	0.8	-	0.8	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
	Total Suspended Solids	mg/L	5					36	-	58	-	40	-	12	-	122	-	13	-	-	-	20	-	16
	Hardness (as CaCO3) (Filtered)	mg/L	5					-	700	-	3300	-	1700	-	350	-	280	-	580	600	537	-	740	-
	Thiocyanate	mg/L	0.1					-	0.5	-	0.9	-	0.3	-	0.3	-	0.5	-	0.2	0.2	0.2	-	0.2	-
Physical	Turbidity (Field Observation)	NTU	0.1					32.1	-	47.8	-	60.5	-	3.2	-	227	-	5	-	-	-	70.3	-	16.4
Heavy Metals	Aluminium	mg/L	0.005	0.055		*1*		0.02	-	0.26	-	0.05	-	0.02	-	0.1	-	0.02	-	-	-	<0.01	-	0.18
	Aluminium (Filtered)	mg/L	0.005	0.055		*0.015*		0.01	-	<0.01	-	<0.01	-	<0.01	-	<0.01	-	-	-	-	-	<0.01	-	<0.01
	Arsenic	mg/L	0.001					0.005	-	0.004	-	0.002	-	0.002	-	0.024	-	0.003	-	-	-	0.003	-	0.004
	Arsenic (Filtered)	mg/L	0.001					0.005	0.002	0.003	<0.005	<0.001	<0.001	0.001	<0.001	0.023	0.004	0.003	0.003	0.003	0.0027	<0.001	<0.001	0.004
	Boron (Filtered)	mg/L	0.005	0.37				-	0.25	-	1.7	-	0.41	-	0.077	-	0.51	-	0.21	0.19	0.175	-	0.24	-
	Cadmium	mg/L	0.0001	0.0002	**0.0055**			<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	-	-	0.0006	-	<0.0001
	Cadmium (Filtered)	mg/L	0.0001	0.0002	**0.0055**			0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001					0.001	-	0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	-	-	0.002	-	0.002
	Chromium (Filtered)	mg/L	0.001					0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.001	<0.001	<0.001
	Chromium (hexavalent) (Filtered)	mg/L	0.01	0.001	**0.0044**			-	-	-	-	-	-	**<0.01**	-	-	-	**<0.01**	-	-	-	**<0.01**	-	**<0.01**
	Copper	mg/L	0.001	0.0014	**0.0013**			**0.002**	-	**0.006**	-	**0.004**	-	<0.001	-	**0.002**	-	**0.004**	-	-	-	**0.002**	-	<0.001
	Copper (Filtered)	mg/L	0.001	0.0014	**0.0013**			**0.002**	<0.001	**0.006**	**<0.005**	**0.005**	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	**0.002**	0.001	<0.0005	<0.001	<0.001	**0.003**
	Iron (ferric) (Filtered)	mg/L	0.05					-	-	-	-	-	-	<0.05	-	-	-	<0.05	-	-	-	<0.05	-	0.05
	Iron (ferrous)	mg/L	0.05					9.43 - 9.65	-	14.1 - 14.4	-	11.6 - 11.8	-	2.53 - 2.79	-	75.5 - 77.6	-	1.68 - 1.71	-	-	-	8.69 - 8.76	-	0.52 - 0.89
	Iron	mg/L	0.005			*1*		*9.15*	-	*13.8*	-	*11.9*	-	*2.43*	-	*72.1*	-	*1.6*	-	-	-	*7.75*	-	0.79
	Iron (Filtered)	mg/L	0.05					8.13	-	12.4	-	10.5	-	2.25	-	58.8	-	1.52	-	-	-	8.37	-	0.58
	Lead	mg/L	0.001	0.0034	**0.0044**			<0.001	-	<0.001	-	<0.001	-	0.002	-	<0.001	-	-	-	-	-	0.002	-	<0.001
	Lead (Filtered)	mg/L	0.001	0.0034	**0.0044**			<0.001	<0.001	<0.001	**<0.005**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9				0.406	-	0.634	-	1.28	-	0.13	-	0.796	-	0.146	-	-	-	0.235	-	0.276
	Manganese (Filtered)	mg/L	0.001	1.9				0.368	0.39	0.598	1.3	1.15	1.3	0.127	0.11	0.717	0.94	0.145	0.15	0.14	0.137	0.23	0.31	0.278
	Mercury	mg/L	0.00005	0.0006	**0.0004**			<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.00005	-	<0.0001	<0.00005	<0.0001
	Mercury (Filtered)	mg/L	0.0001	0.0006	**0.0004**			<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	-	<0.0001	<0.0001	-	<0.0001
	Molybdenum (Filtered)	mg/L	0.001					-	0.006	-	0.01	-	0.01	-	0.007	-	0.006	-	0.006	0.005	0.0064	-	0.006	-
	Nickel	mg/L	0.001	0.011	**0.07**			0.002	-	0.005	-	0.005	-	<0.001	-	0.003	-	0.004	-	-	-	0.004	-	0.006
	Nickel (Filtered)	mg/L	0.001	0.011	**0.07**			0.002	0.001	0.006	<0.005	0.005	0.003	0.001	<0.001	0.003	0.001	0.003	0.003	0.003	0.0024	0.002	0.001	0.006
	Selenium	mg/L	0.01	0.011				<0.01	-	<0.01	-	<0.01	-	<0.01	-	<0.01	-	<0.01	-	-	-	<0.01	-	<0.01
	Selenium (Filtered)	mg/L	0.002	0.011				<0.01	<0.002	<0.01	<0.01	<0.01	<0.002	<0.01	<0.002	<0.01	<0.002	<0.01	<0.002	<0.002	0.0003	<0.01	<0.002	<0.01
	Tin (Filtered)	mg/L	0.001					-	<0.001	-	<0.005	-	<0.001	-	<0.001	-	<0.001	-	<0.001	<0.001	<0.0002	-	<0.001	-
	Zinc	mg/L	0.005	0.008	**0.015**			**0.278**	-	0.014	-	0.008	-	**0.081**	-	0.007	-	0.006	-	-	-	<0.005	-	0.011
	Zinc (Filtered)	mg/L	0.001	0.008	**0.015**			**0.279**	**0.035**	**0.019**	<0.005	<0.005	0.005	**0.042**	0.008	0.012	0.009	0.008	0.004	0.002	<0.001	0.007	0.014	0.008
PAH	Naphthalene	mg/L	0.00002	0.016	**0.07**			-	0.01 - 0.039	-	.0013 - 0.008	-	0.0005 - 0.01	**0.0575 - 0.188**	0.056 - 0.063	-	0.036 - 0.044	**0.194 - 0.374**	**0.19 - 0.25**	**0.19 - 0.28**	**0.208 - 0.281**	<0.001	<0.00002	0.0028 - 0.007
Total recoverable hydrocarbons	TRH >C10-C16 F2	mg/L	0.06					-	0.35	-	<0.06	-	0.11	0.36	0.44	-	0.28	1.28	1.1	0.76	0.9	<0.1	<0.06	<0.1
	TRH >C16-C34 F3	mg/L	0.1					-	<0.5	-	<0.5	-	<0.5	<0.1	<0.5	-	<0.5	0.42	<0.5	<0.5	<0.1	<0.1	<0.5	<0.1
	TRH >C34-C40 F4	mg/L	0.1					-	<0.5	-	<0.5	-	<0.5	<0.1	<0.5	-	<0.5	<0.1	<0.5	<0.5	<0.1	<0.1	<0.5	<0.1
Total Petroleum Hydrocarbons	Aliphatic Hydrocarbons>C35 -C40	mg/L	0.5					-	<0.5	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	-	-
	TPH C16 - C35 Aromatic	mg/L	0.5					-	<0.5	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	-	-
	TPH C6 - C9 Fraction	mg/L	0.02					-	<0.04	-	<0.04	-	<0.04	<0.02	<0.04	-	<0.04	<0.02	0.083	0.075	<0.02	<0.02	<0.04	<0.02
	TPH C10 - C14 Fraction	mg/L	0.05					-	0.27	-	<0.05	-	0.1	0.39	0.48	-	0.27	1.39	1.1	0.8	1	<0.05	<0.05	0.05
	TPH C15 - C28 Fraction	mg/L	0.1					-	<0.2	-	<0.2	-	<0.2	<0.1	<0.2	-	0.31	0.35	0.24	<0.2	<0.1	<0.1	<0.2	<0.1
	TPH C29 - C36 Fraction	mg/L	0.05					-	<0.2	-	<0.2	-	<0.2	<0.05	<0.2	-	<0.2	0.13	<0.2	<0.2	<0.05	<0.05	<0.2	<0.05
	C6 - C10 Fraction minus BTEX (F1)	mg/L	0.02					-	<0.05	-	<0.05	-	<0.05	0.04	0.072	-	<0.05	0.06	0.18	0.17	0.1	<0.02	<0.05	<0.02
	TPH+C10 - C36 (Sum of total) (Lab Reported)	mg/L	0.05					-	-	-	-	-	-	0.39	-	-	-	1.87	-	-	1	<0.05	-	0.05
	TPH+C10 - C40 (Sum of total) (Lab Reported)	mg/L	0.1					-	-	-	-	-	-	0.36	-	-	-	1.7	-	-	0.9	<0.1	-	<0.1
	C6 - C10 Fraction	mg/L	0.02					-	-	-	-	-	-	0.04	-	-	-	0.06	-	-	0.1	<0.02	-	<0.02
	TPH >C16-C28 Aliphatic	mg/L	0.25					-	<0.25	-	-	-	<0.25	-	<0.25	-	<0.25	-	<0.25	-	-	-	-	-
	TPH >C16-C28 Aromatic	mg/L	0.25					-	<0.25	-	-	-	<0.25	-	<0.25	-	<0.25	-	<0.25	-	-	-	-	-
	TPH >C16-C35 Aliphatic (Sum)	mg/L	0.5					-	<0.5	-	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	-	-	-	-	-
	TPH >C28-C35 Aliphatic	mg/L	0.25					-	<0.25	-	-	-	<0.25	-	<0.25	-	<0.25	-	<0.25	-	-	-	-	-
	TPH >C28-C35 Aromatic	mg/L	0.25					-	<0.25	-	-	-	<0.25	-	<0.25	-	<0.25	-	<0.25	-	-	-	-	-
	TPH >C9-C16 Aliphatic	mg/L	0.15					-	<0.15	-	-	-	<0.15	-	<0.15	-	<0.15	-	<0.15	-	-	-	-	-
	TPH >C9-C16 Aromatic	mg/L	0.15					-	0.2	-	-	-	<0.15	-	0.25	-	<0.15	-	0.55	-	-	-	-	-

Comments
*DEC Groundwater Acidification
LOR: Limit of reporting
Note the limit of reporting may differ for the same analyte due to different laboratory methods and matrix interference

Appendix A - Groundwater Quality Results

Field ID	Q6561-03	Q6553-07	Q6561-04	Q6551 - 01	Q6551 - 02	Q6556-01	Q6551 - 04	Q6556-04	Q6551 - 03	Q6556-03	Q6551 - 05	Q6559-04	Q6551 - 07	Q6559-05	Q10103-01	Q10103-02	Q10103-04
Location	BH03 SRA	BH03 SCD	BH03 SCD	BH04 FILL	BH04 FILL	BH04 FILL	BH04 SRA	BH04 SRA	BH04 SCD	BH04 SCD	BH05 FILL	BH05 FILL	BH05 SRA	BH05 SRA	MW91	MW118	MW116
Sampled Date	13/08/2012	26/06/2012	13/08/2012	11/06/2012	11/06/2012	7/08/2012	11/06/2012	7/08/2012	11/06/2012	7/08/2012	11/06/2012	9/08/2012	11/06/2012	9/08/2012	11/09/2012	11/09/2012	11/09/2012
Screened Unit	SRA	SCD	SCD	FILL	FILL	FILL					FILL	FILL			FILL	FILL	FILL

Chem Group	Chem Name	output unit	LOR	ANZECC 2000 Freshwater 95%	ANZECC 2000 Marine 95%	*Swan River Trust*	ANZECC Estuaries In South West Australia														
Sample Quality Parameters	pH (Lab)	pH Units	0.01			*6.5-8.5*	7.5-8.5	7.7	7.81	7.7	7.75	7.78	7.6	7.68	7.5	7.69	7.3	7.79	7.7	8.03	7.8	7.8	7.6	7.7
	Total Dissolved Solids @180°C	mg/L	10					9700	590	400	3160	2910	2800	13,400	14,000	475	450	2710	2300	11,200	8400	4760	2980	2660
	Sodium (Filtered)	mg/L	0.5					2800	141	110	533	567	660	4260	5000	110	120	512	590	3220	3100	1600	750	610
	Potassium (Filtered)	mg/L	0.1					160	15	12	50	50	49	229	230	16	16	43	48	166	150	64	36	50
	Calcium (Filtered)	mg/L	0.2					120	22	21	244	217	320	106	95	31	36	156	200	100	110	270	220	250
	Magnesium (Filtered)	mg/L	0.1					320	16	16	56	55	62	555	570	14	16	51	52	224	250	180	54	58
	Chloride	mg/L	1					5400	212	180	1060	1070	1300	7790	7200	155	160	1060	1100	6000	5000	2600	1500	1200
	Sulphate (as SO4)	mg/L	1					60	21	3	26	26	55	83	<1	1	<1	<1	<1	134	89	100	210	79
	Chloride/Sulphate ratio		Calculated			*<2**		90	10	60	41	41	24	94	7200	155	160	1060	1100	45	56	26	7	15
	Bicarbonate Alkalinity (as CaCO3)	mg/L	1					-	176	-	681	684	-	2150	-	200	-	546	-	700	-	-	-	-
	Bicarbonate Alkalinity as (HCO3)	mg/L	5					990	-	190	-	-	760	-	3000	-	230	-	670	-	730	800	540	800
	Carbonate Alkalinity (as CaCO3)	mg/L	1					-	<1	-	<1	<1	-	<1	-	<1	-	<1	-	<1	-	-	-	-
	Carbonate Alkalinity (as CO3)	mg/L	1					<1	-	<1	-	-	<1	-	<1	-	<1	-	<1	-	<1	<1	<1	<1
	Hydroxide Alkalinity (as CaCO3)	mg/L	1					-	<1	-	<1	<1	-	<1	-	<1	-	<1	-	<1	-	-	-	-
	Total Alkalinity (as CaCO3)	mg/L	1					810	176	160	681	684	630	2150	2500	200	180	546	550	700	600	660	440	660
	Alkalinity/sulphate ratio		Calculated			*<5**		13.5	8.4	53.3	26.2	26.3	11.5	25.9	2,500.0	200.0	180.0	546.0	550.0	5.2	6.7	6.6	*2.1*	8.4
	Acidity (as CaCO3)	mg/L	1			*40*		-	2	-	6	5	-	*54*	-	3	-	14	-	14	-	-	-	-
	Nitrate (as N)	mg/L	0.01					-	<0.01	-	<0.01	<0.01	-	<0.01	-	0.02	-	<0.01	-	<0.01	-	-	-	-
	Nitrate (as NO3-)	mg/L	0.05					0.12	-	0.15	-	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	1.7	<0.05	1.1	<0.05
	Nitrite (as N)	mg/L	0.01					-	<0.01	-	<0.01	<0.01	-	<0.01	-	<0.01	-	<0.01	-	<0.01	-	-	-	-
	Nitrite (as NO2-)	mg/L	0.05					<0.05	-	<0.05	-	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	0.08	<0.05	0.14	<0.05
	Nitrogen (Total Oxidised)	mg/L	0.005				0.045	0.028	<0.01	0.034	<0.01	<0.01	<0.005	<0.01	<0.005	0.02	<0.005	<0.01	<0.005	<0.01	0.41	<0.005	0.3	<0.005
	Ammonia (as N)	mg/L	0.01				0.049	-	1.5	-	5.14	5.22	-	71.6	-	2.78	-	3.75	-	24.6	-	-	-	-
	Ammonia	mg/L	0.005	0.9	**0.91**			-	-	**1.1**	-	-	**5.8**	-	**68**	-	**2.6**	-	**4.6**	-	**29**	**6.5**	0.14	**6**
	Total Kjeldahl Nitrogen (as N)	mg/L	0.05					-	1.6	1	5	4.7	5.1	71.7	68	2.6	2.4	4.3	4.3	27.9	25	6.2	0.46	5.7
	Nitrogen (Inorganic)	mg/L	0.05					48	-	0.93	-	-	4.8	-	56	-	2.1	-	3.8	-	24	5.4	0.42	4.9
	Nitrogen (Total)	mg/L	0.05			*1*	0.75	-	*1.6*	*1.1*	*5*	*4.7*	*5.1*	*71.7*	*68*	*2.6*	*2.4*	*4.3*	*4.3*	*27.9*	*25*	*6.2*	0.76	*5.7*
	Cyanide (total)	mg/L	0.004	0.007	**0.004**			**<0.004**	-	**<0.004**	-	-	**0.038**	-	**<0.004**	-	**<0.004**	-	**<0.004**	-	**<0.004**	**0.027**	**<0.004**	**0.029**
	Reactive Phosphorus (as P)	mg/L	0.002				0.005	1.5	0.07	0.043	<0.01	<0.01	<0.002	1.34	2	0.06	0.11	<0.01	<0.002	0.35	0.7	0.015	0.004	0.014
	Phosphorus	mg/L	0.01			*0.1*	0.03	*1.6*	0.09	0.08	0.07	*0.33*	0.05	*2.09*	*2.6*	*0.25*	*0.21*	*0.14*	*0.1*	*0.7*	*0.78*	*0.11*	0.07	*0.13*
	Sulphide	mg/L	0.1					0.8	<0.1	<0.1	-	-	1	-	0.3	-	<0.1	-	<0.1	0.1	<0.1	<0.5	<0.5	<0.5
	Total Suspended Solids	mg/L	5					-	14	-	<5	<5	-	18	-	<5	-	9	-	33	-	-	-	-
	Hardness (as CaCO3) (Filtered)	mg/L	5					1600	-	120	-	-	1100	-	2600	-	160	-	720	-	1300	1400	770	870
	Thiocyanate	mg/L	0.1					1	-	0.2	-	-	0.3	-	0.2	-	0.2	-	0.3	-	1.2	<0.1	<0.1	<0.1
Physical	Turbidity (Field Observation)	NTU	0.1					-	1.7	-	10.5	10.3	-	16.9	-	13.3	-	72.3	-	20.3	-	-	-	-
Heavy Metals	Aluminium	mg/L	0.005	0.055		*1*		-	0.03	-	0.02	0.02	-	0.44	-	0.12	-	<0.01	-	0.44	-	-	-	-
	Aluminium (Filtered)	mg/L	0.005	0.055		*0.015*		-	<0.01	-	<0.01	<0.01	-	*0.03*	-	<0.01	-	<0.01	-	<0.01	-	-	-	-
	Arsenic	mg/L	0.001					-	0.002	-	<0.001	<0.001	-	0.064	-	0.001	-	0.003	-	0.005	-	-	-	-
	Arsenic (Filtered)	mg/L	0.001					<0.005	0.001	<0.001	<0.001	<0.001	<0.001	0.039	<0.001	0.001	<0.001	0.003	<0.001	0.03	<0.005	0.002	<0.001	<0.001
	Boron (Filtered)	mg/L	0.005	0.37				2.4	-	0.1	-	-	0.2	-	0.28	-	0.081	-	0.17	-	1.7	0.54	0.029	0.41
	Cadmium	mg/L	0.0001	0.0002	**0.0055**			-	0.0002	-	<0.0001	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	-	-	-
	Cadmium (Filtered)	mg/L	0.0001	0.0002	**0.0055**			<0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001					-	<0.001	-	<0.001	<0.001	-	0.003	-	<0.001	-	<0.001	-	0.002	-	-	-	-
	Chromium (Filtered)	mg/L	0.001					<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001
	Chromium (hexavalent) (Filtered)	mg/L	0.01	0.001	**0.0044**			-	**<0.01**	-	-	-	-	-	-	-	-	-	-	**<0.01**	-	-	-	-
	Copper	mg/L	0.001	0.0014	**0.0013**			-	<0.001	-	<0.001	<0.001	-	**0.002**	-	<0.001	-	<0.001	-	**0.018**	-	-	-	-
	Copper (Filtered)	mg/L	0.001	0.0014	**0.0013**			**<0.005**	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	**0.016**	**0.002**	<0.001	<0.001
	Iron (ferric) (Filtered)	mg/L	0.05					-	<0.05	-	-	-	-	-	-	-	-	-	-	0.25	-	-	-	-
	Iron (ferrous)	mg/L	0.05					-	0.54 - 0.56	-	1.38	1.34 - 1.36	-	1.43	-	2.67 - 2.68	-	8.5 - 8.56	-	0.24 - 0.47	-	-	-	-
	Iron	mg/L	0.005			*1*		-	0.5	-	*1.24*	*1.27*	-	*1.79*	-	*2.55*	-	*9.01*	-	0.84	-	-	-	-
	Iron (Filtered)	mg/L	0.05					-	0.48	-	1.18	1.14	-	0.82	-	2.09	-	7.48	-	0.49	-	-	-	-
	Lead	mg/L	0.001	0.0034	**0.0044**			-	<0.001	-	<0.001	<0.001	-	<0.001	-	<0.001	-	<0.001	-	0.001	-	-	-	-
	Lead (Filtered)	mg/L	0.001	0.0034	**0.0044**			**<0.005**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**<0.005**	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9				-	0.073	-	0.148	0.147	-	0.171	-	0.099	-	0.23	-	0.074	-	-	-	-
	Manganese (Filtered)	mg/L	0.001	1.9				0.33	0.072	0.066	0.142	0.14	0.1	0.146	0.02	0.093	0.11	0.208	0.24	0.072	0.2	0.2	0.089	0.37
	Mercury	mg/L	0.00005	0.0006	**0.0004**			<0.00005	<0.0001	<0.00005	<0.0001	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.00005
	Mercury (Filtered)	mg/L	0.0001	0.0006	**0.0004**			-	<0.0001	-	<0.0001	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	-	-	-
	Molybdenum (Filtered)	mg/L	0.001					<0.005	-	0.003	-	-	<0.001	-	<0.001	-	0.001	-	<0.001	-	0.01	0.004	<0.001	0.001
	Nickel	mg/L	0.001	0.011	**0.07**			-	0.001	-	<0.001	<0.001	-	0.008	-	<0.001	-	<0.001	-	0.008	-	-	-	-
	Nickel (Filtered)	mg/L	0.001	0.011	**0.07**			<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.006	0.002	0.001	0.002
	Selenium	mg/L	0.01	0.011				-	<0.01	-	<0.01	<0.01	-	0.26	-	<0.01	-	<0.01	-	<0.01	-	-	-	-
	Selenium (Filtered)	mg/L	0.002	0.011				<0.01	<0.01	<0.002	<0.01	<0.01	<0.002	0.15	<0.002	<0.01	<0.002	<0.01	<0.002	0.12	<0.01	<0.002	<0.002	<0.002
	Tin (Filtered)	mg/L	0.001					<0.005	-	<0.001	-	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.005	<0.001	<0.001	<0.001
	Zinc	mg/L	0.005	0.008	**0.015**			-	<0.005	-	<0.005	<0.005	-	0.009	-	<0.005	-	<0.005	-	0.01	-	-	-	-
	Zinc (Filtered)	mg/L	0.001	0.008	**0.015**			0.008	0.01	0.005	<0.005	0.005	0.005	0.012	<0.001	<0.005	0.004	<0.005	0.006	0.006	**0.015**	0.006	0.003	0.012
PAH	Naphthalene	mg/L	0.00002	0.016	**0.07**			0.0023 - 0.003	0.0096 - 0.010	0.0005 - 0.001	-	-	<0.00002	-	<0.00002	-	<0.00002	-	0.0003 - 0.000	0.0214 - 0.066	0.005 - 0.00	<0.00002	0.0005 - 0.000	<0.00002
Total recoverable hydrocarbons	TRH >C10-C16 F2	mg/L	0.06					<0.06	<0.1	<0.06	-	-	<0.06	-	<0.06	-	<0.06	-	<0.06	0.6	0.17	<0.06	<0.06	<0.06
	TRH >C16-C34 F3	mg/L	0.1					<0.5	<0.1	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	0.35	<0.5	<0.5	<0.5	<0.5
	TRH >C34-C40 F4	mg/L	0.1					<0.5	<0.1	<0.5	-	-	<0.5	-	<0.5	-	<0.5	-	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons	Aliphatic Hydrocarbons>C35 -C40	mg/L	0.5					-	-	-	-	-	-	-	-	-	-	-	<0.5	-	<0.5	-	-	-
	TPH C16 - C35 Aromatic	mg/L	0.5					-	-	-	-	-	-	-	-	-	-	-	<0.5	-	<0.5	-	-	-
	TPH C6 - C9 Fraction	mg/L	0.02					<0.04	<0.02	<0.04	-	-	<0.04	-	<0.04	-	<0.04	-	<0.04	<0.02	<0.04	<0.04	<0.04	<0.04
	TPH C10 - C14 Fraction	mg/L	0.05					<0.05	0.08	<0.05	-	-	<0.05	-	<0.05	-	<0.05	-	0.054	0.57	0.21	<0.05	<0.05	<0.05
	TPH C15 - C28 Fraction	mg/L	0.1					<0.2	<0.1	<0.2	-	-	<0.2	-	<0.2	-	<0.2	-	<0.2	0.39	0.24	<0.2	<0.2	<0.2
	TPH C29 - C36 Fraction	mg/L	0.05					<0.2	<0.05	<0.2	-	-	<0.2	-	<0.2	-	<0.2	-	<0.2	0.07	<0.2	<0.2	<0.2	<0.2
	C6 - C10 Fraction minus BTEX (F1)	mg/L	0.02					<0.05	<0.02	<0.05	-	-	<0.05	-	<0.05	-	<0.05	-	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05
	TPH+C10 - C36 (Sum of total) (Lab Reported)	mg/L	0.05					-	0.08	-	-	-	-	-	-	-	-	-	-	1.03	-	-	-	-
	TPH+C10 - C40 (Sum of total) (Lab Reported)	mg/L	0.1					-	<0.1	-	-	-	-	-	-	-	-	-	-	0.95	-	-	-	-
	C6 - C10 Fraction	mg/L	0.02					-	<0.02	-	-	-	-	-	-	-	-	-	-	<0.02	-	-	-	-
	TPH >C16-C28 Aliphatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	<0.25	-	<0.25	-	-	-
	TPH >C16-C28 Aromatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	<0.25	-	<0.25	-	-	-
	TPH >C16-C35 Aliphatic (Sum)	mg/L	0.5					-	-	-	-	-	-	-	-	-	-	-	<0.5	-	<0.5	-	-	-
	TPH >C28-C35 Aliphatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	<0.25	-	<0.25	-	-	-
	TPH >C28-C35 Aromatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	<0.25	-	<0.25	-	-	-
	TPH >C9-C16 Aliphatic	mg/L	0.15					-	-	-	-	-	-	-	-	-	-	-	<0.15	-	<0.15	-	-	-
	TPH >C9-C16 Aromatic	mg/L	0.15					-	-	-	-	-	-	-	-	-	-	-	<0.15	-	<0.15	-	-	-

Comments
*DEC Groundwater Acidification
LOR: Limit of reporting
Note the limit of reporting may differ for the same analyte due to different laboratory methods and matrix interference

Appendix A - Groundwater Quality Results

Field ID	Q10103-05	Q10103-07	Q10104-01	Q10104-02	Q10104-04	Q10104-05	Q10104-07	Q10105-01	Q9649-01	Q9649-03	Q9650-01	Q9650-02	Q9650-04	Q9701-01	Q9701-02	Q9701-03	Q9701-05	Q9701-06
Location	MW46	MW28	MW70	MW84	MW02	MW04	MW07	MW20	MW109	MW79	MW125	MW128	MW99	MW38	MW22	MW75	MW14	MW10
Sampled Date	11/09/2012	11/09/2012	12/09/2012	12/09/2012	12/09/2012	12/09/2012	12/09/2012	13/09/2012	10/09/2012	10/09/2012	11/09/2012	11/09/2012	11/09/2012	12/09/2012	12/09/2012	12/09/2012	12/09/2012	12/09/2012
Screened Unit	FILL	FILL	FILL	FILL	FILL	FILL	FILL	FILL	FILL	SRA	FILL	FILL	FILL	FILL	FILL	FILL	FILL	FILL

Chem Group	Chem Name	output unit	LOR	ANZECC 2000 Freshwater 95%	ANZECC 2000 Marine 95%	*Swan River Trust*	ANZECC Estuaries In South West Australia																
Sample Quality Parameters	pH (Lab)	pH Units	0.01			*6.5-8.5*	7.5-8.5	7.6	7.1	6.9	7.5	7.5	6.8	7	7.6	7.8	7.4	7.2	7.6	7.8	6.8	6.9	7.8	7.6	7.3
	Total Dissolved Solids @180°C	mg/L	10					1880	4180	10,500	2530	6100	4050	4830	825	604	3750	2130	2060	4080	4120	15,200	2240	2350	2080
	Sodium (Filtered)	mg/L	0.5					410	900	1900	660	1700	1200	1000	170	21	620	400	420	1100	910	3900	460	570	570
	Potassium (Filtered)	mg/L	0.1					30	51	150	30	76	64	65	17	21	100	30	32	64	95	160	31	45	39
	Calcium (Filtered)	mg/L	0.2					170	250	440	210	360	120	280	47	160	360	250	240	180	340	440	170	240	180
	Magnesium (Filtered)	mg/L	0.1					39	82	230	60	190	140	110	38	14	120	54	50	110	91	410	39	50	62
	Chloride	mg/L	1					830	1700	4500	1000	3200	2000	2100	400	41	870	930	840	2200	1900	8400	990	1000	760
	Sulphate (as SO4)	mg/L	1					2	64	240	170	400	180	610	5	50	560	110	140	86	250	760	13	1	310
	Chloride/Sulphate ratio		Calculated			*<2**		415	27	19	6	8	11	3	80	*1*	2	8	6	26	8	11	76	1000	2
	Bicarbonate Alkalinity (as CaCO3)	mg/L	1					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bicarbonate Alkalinity as (HCO3)	mg/L	5					610	700	860	840	590	600	600	170	490	1600	590	620	730	810	940	630	790	400
	Carbonate Alkalinity (as CaCO3)	mg/L	1					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Carbonate Alkalinity (as CO3)	mg/L	1					<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Hydroxide Alkalinity (as CaCO3)	mg/L	1					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total Alkalinity (as CaCO3)	mg/L	1					500	580	700	690	490	490	490	140	400	1300	480	510	600	660	770	510	650	330
	Alkalinity/sulphate ratio		Calculated			*<5**		250.0	9.1	*2.9*	*4.1*	*1.2*	*2.7*	*0.8*	28.0	8.0	*2.3*	*4.4*	*3.6*	7.0	*2.6*	*1.0*	39.2	650.0	*1.1*
	Acidity (as CaCO3)	mg/L	1			*40*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrate (as N)	mg/L	0.01					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrate (as NO3-)	mg/L	0.05					0.11	0.06	<0.05	<0.05	0.05	0.07	1.5	<0.05	4.6	85	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
	Nitrite (as N)	mg/L	0.01					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrite (as NO2-)	mg/L	0.05					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.2	0.09	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Nitrogen (Total Oxidised)	mg/L	0.005				0.045	0.025	0.014	<0.005	<0.005	0.024	0.016	0.35	<0.005	1.1	19	0.05	0.016	<0.005	<0.005	<0.005	0.011	<0.005	0.015
	Ammonia (as N)	mg/L	0.01				0.049	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ammonia	mg/L	0.005	0.9	**0.91**			**2.5**	**6.1**	**17**	**3.8**	**2.3**	**5.5**	0.87	**3.9**	0.2	**8.8**	**4.5**	0.47	**6.1**	**15**	**7.1**	**3.6**	**3.2**	**2.8**
	Total Kjeldahl Nitrogen (as N)	mg/L	0.05					2.4	6	15	5	2.8	5.2	1.9	3.1	0.54	7.9	4.5	0.74	5.8	12	6.4	4.6	3.2	2.7
	Nitrogen (Inorganic)	mg/L	0.05					2.1	5.1	14	3.1	1.9	4.6	1.1	3.2	1.2	26	3.8	0.41	5	12	5.9	3	2.6	2.3
	Nitrogen (Total)	mg/L	0.05			*1*	0.75	*2.4*	*6*	*15*	*5*	*2.8*	*5.2*	*2.3*	*3.1*	*1.6*	*27*	*4.6*	0.75	*5.8*	*12*	*6.4*	*4.6*	*3.2*	*2.8*
	Cyanide (total)	mg/L	0.004	0.007	**0.004**			**<0.004**	**<0.004**	**<0.004**	**<0.004**	**<0.004**	**<0.004**	**<0.004**	**<0.004**	**<0.004**	0.004	**<0.004**	**<0.004**	**<0.004**	**0.008**	**<0.004**	**<0.004**	**0.079**	**0.006**	**<0.004**
	Reactive Phosphorus (as P)	mg/L	0.002				0.005	0.015	0.01	<0.002	0.019	0.013	0.028	0.024	0.017	0.009	0.026	0.018	0.012	0.014	<0.002	0.003	0.017	0.019	0.014
	Phosphorus	mg/L	0.01			*0.1*	0.03	*0.15*	*0.15*	*0.33*	*0.32*	0.09	*0.11*	0.06	0.06	0.01	*0.16*	0.05	*0.1*	*0.24*	<0.01	0.06	*0.18*	*0.39*	0.04
	Sulphide	mg/L	0.1					<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.2	<0.5	<0.5	<0.5	<0.5	<0.5
	Total Suspended Solids	mg/L	5					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Hardness (as CaCO3) (Filtered)	mg/L	5					590	960	2000	770	1700	880	1200	270	450	1400	850	790	900	1200	2800	580	810	710
	Thiocyanate	mg/L	0.1					<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Physical	Turbidity (Field Observation)	NTU	0.1					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heavy Metals	Aluminium	mg/L	0.005	0.055		*1*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Aluminium (Filtered)	mg/L	0.005	0.055		*0.015*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Arsenic	mg/L	0.001					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Arsenic (Filtered)	mg/L	0.001					0.004	0.001	<0.005	0.041	<0.005	0.002	0.002	0.001	0.001	0.007	<0.001	0.001	0.001	0.006	<0.01	0.001	0.021	0.001
	Boron (Filtered)	mg/L	0.005	0.37				0.078	0.55	0.49	0.11	0.29	1.4	0.56	0.1	0.042	0.14	0.41	0.076	0.35	0.43	0.97	0.15	0.15	0.28
	Cadmium	mg/L	0.0001	0.0002	**0.0055**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cadmium (Filtered)	mg/L	0.0001	0.0002	**0.0055**			<0.0001	<0.0001	<0.0005	0.0002	<0.0005	0.0003	0.0003	<0.0001	<0.0001	<0.0001	0.0003	0.0002	<0.0001	<0.0002	<0.001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chromium (Filtered)	mg/L	0.001					<0.001	<0.001	<0.005	0.001	<0.005	0.006	0.031	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.01	0.002	0.002	<0.001
	Chromium (hexavalent) (Filtered)	mg/L	0.01	0.001	**0.0044**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Copper	mg/L	0.001	0.0014	**0.0013**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Copper (Filtered)	mg/L	0.001	0.0014	**0.0013**			<0.001	**0.002**	**<0.005**	<0.001	**<0.005**	**<0.002**	**<0.002**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**<0.002**	**<0.01**	<0.001	<0.001	0.001
	Iron (ferric) (Filtered)	mg/L	0.05					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Iron (ferrous)	mg/L	0.05					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Iron	mg/L	0.005			*1*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Iron (Filtered)	mg/L	0.05					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lead	mg/L	0.001	0.0034	**0.0044**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lead (Filtered)	mg/L	0.001	0.0034	**0.0044**			<0.001	<0.001	**<0.005**	<0.001	**<0.005**	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	**<0.01**	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Manganese (Filtered)	mg/L	0.001	1.9				0.34	0.9	0.53	0.13	0.32	0.43	4.3	0.21	0.057	0.42	2.3	0.44	0.13	0.74	1.2	0.23	0.47	0.23
	Mercury	mg/L	0.00005	0.0006	**0.0004**			<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
	Mercury (Filtered)	mg/L	0.0001	0.0006	**0.0004**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Molybdenum (Filtered)	mg/L	0.001					0.002	0.002	<0.005	0.008	<0.005	0.017	0.006	0.003	0.002	0.004	0.008	0.014	0.002	0.004	<0.01	<0.001	0.005	0.008
	Nickel	mg/L	0.001	0.011	**0.07**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nickel (Filtered)	mg/L	0.001	0.011	**0.07**			0.003	0.003	0.01	0.002	0.006	0.013	0.047	<0.001	0.003	0.005	0.005	0.005	0.003	0.016	0.013	0.004	0.006	0.003
	Selenium	mg/L	0.01	0.011				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Selenium (Filtered)	mg/L	0.002	0.011				<0.002	<0.002	<0.01	<0.002	<0.01	<0.004	<0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.02	<0.002	<0.002	<0.002
	Tin (Filtered)	mg/L	0.001					<0.001	<0.001	<0.005	<0.001	<0.005	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.01	<0.001	<0.001	<0.001
	Zinc	mg/L	0.005	0.008	**0.015**			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Zinc (Filtered)	mg/L	0.001	0.008	**0.015**			**0.015**	0.01	0.013	**0.042**	<0.005	**0.022**	**0.18**	0.013	0.01	**0.067**	0.005	0.004	0.003	**0.025**	<0.01	**0.021**	**0.016**	**0.019**
PAH	Naphthalene	mg/L	0.00002	0.016	**0.07**			<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Total recoverable hydrocarbons	TRH >C10-C16 F2	mg/L	0.06					<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
	TRH >C16-C34 F3	mg/L	0.1					<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.2	<0.5	<1.2	<0.5	<0.5	<0.5	<0.5	<0.5
	TRH >C34-C40 F4	mg/L	0.1					<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.2	<0.5	<1.2	<0.5	<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons	Aliphatic Hydrocarbons>C35 -C40	mg/L	0.5					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH C16 - C35 Aromatic	mg/L	0.5					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH C6 - C9 Fraction	mg/L	0.02					<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	TPH C10 - C14 Fraction	mg/L	0.05					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	TPH C15 - C28 Fraction	mg/L	0.1					<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.2	<0.4	<0.2	<0.2	<0.2	<0.2	<0.2
	TPH C29 - C36 Fraction	mg/L	0.05					<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.9	<0.2	<0.9	<0.2	<0.2	<0.2	<0.2	<0.2
	C6 - C10 Fraction minus BTEX (F1)	mg/L	0.02					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	TPH+C10 - C36 (Sum of total) (Lab Reported)	mg/L	0.05					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH+C10 - C40 (Sum of total) (Lab Reported)	mg/L	0.1					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C6 - C10 Fraction	mg/L	0.02					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C16-C28 Aliphatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C16-C28 Aromatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C16-C35 Aliphatic (Sum)	mg/L	0.5					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C28-C35 Aliphatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C28-C35 Aromatic	mg/L	0.25					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C9-C16 Aliphatic	mg/L	0.15					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TPH >C9-C16 Aromatic	mg/L	0.15					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Comments
*DEC Groundwater Acidification
LOR: Limit of reporting
Note the limit of reporting may differ for the same analyte due to different laboratory methods and matrix interference

Created By: ZT 26/3/13
Checked By: HOB 26/3/13

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Pty Ltd
Level 3, 1 Havelock Street
West Perth, Western Australia 6005
Australia
T: +61 8 9213 7600

Golder Associates

APPENDIX E

Contaminated Site Management Plan

July 2014
Report No. 117643077-036-R-Rev1

July 2014

GOVERNMENT OF WESTERN AUSTRALIA

NEW PERTH STADIUM

Contaminated Site Management Plan

REPORT

Report Number. 117643077-041-R-Rev1

Distribution:

1 Electronic Copy - Public Transport Authority
1 Electronic Copy - Department of Treasury Strategic Projects
1 Electronic Copy - Golder Associates Pty Ltd

Golder Associates

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Overview

Golder Associates Pty Ltd (Golder) has been engaged to prepare a Contaminated Site Management Plan (CSMP) for the construction of the new Perth Stadium (the Project) on the Burswood Peninsula in Western Australia. This document has been prepared using information available at the time of preparation, including that of the acid sulfate soils (ASS) investigation carried out at the site in conjunction with the contamination assessment. This document should be read in conjunction with the Project EMP (Golder, 2013a) and updated as additional information becomes available.

The Project is to design, construct, operate and maintain a new Perth Stadium contained within a new "Sports Precinct" within the Burswood Peninsula, Western Australia.

For planning purposes the Project is to be delivered in three parts:

- **Part 1**: the construction of the Stadium and associated Sports Precinct. This will be undertaken in two phases:
  - Construction Phase, which includes:
    - Preconstruction Site Works (PCS Works) - The objective of the PCS Works is to prepare some parts of the site in advance of the main construction contract so that long term ground movements in those designated areas are within prescribed limits and to facilitate timely construction of the Stadium and associated works. This will necessitate ground treatment such as surcharge, dynamic compaction and/or stone columns so that upon completion of the PCS Works, construction of the Stadium can commence without undue delay caused by site preparation works.
    - Stadium Construction Works (Stadium Works) - Includes the construction of the Stadium, its plaza and associated infrastructure on the pre-treated site and will necessitate the use of deep piles to support the Stadium structure. Construction of surrounding infrastructure, such as pedestrian access ways, roads, bridges, services and site rehabilitation will also be completed during the Stadium Works.
  - Operating Phase - Transition to Operation: the commissioning of the internal fit-out of the Stadium facilities are undertaken with the identified Operating Phase Lead Contractor. Ongoing environmental monitoring of the site and management of site facilities will continue during this phase.
- **Part 2**: the construction of the transport infrastructure including the rail works, the rail station upgrade and Victoria Park Drive road bridge upgrades.
- **Part 3:** the construction of the new pedestrian bridge over the Swan River, including bus and pedestrian facilities at Gloucester Park.

Delivery of the Project, including Parts 1, 2 and 3, has potential environmental and social impacts and has required referral to the Environmental Protection Authority (EPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (EP Act). Referral applications have been lodged for Parts 1, 2 and 3, with the EPA determining that the proposals did not require formal assessment.

Delivery of the two phases within Part 1 of the Project is required by 2018. This requires that the PCS Works commence by mid-2013 to allow Stadium Works of the Stadium to commence in 2014, facilitating completion by 2018.

1.2 Contaminated Site Management Plan Scope

The scope of this CSMP is concerned with the Construction Phase and Operating Phase of Part 1 of the Project. It focuses on the development of the Stadium and Sports Precinct including the:

- Stadium and its plaza
- Bus hub
- Pedestrian access ways and the Stadium ring road
- Parklands.

This CSMP excludes the following components which are discussed in separate documentation:

- Swan River pedestrian bridge
- Train station
- Rail realignment
- Road upgrades to Victoria Park Drive.

1.3 Contaminated Site Management Plan Objectives

The Project area is classified by the Department of Environment and Conservation ((DEC) now Department of Environment Regulation (DER)) as “Possibly Contaminated – Investigation Required”, due to historic land uses and landfill activities on the Burswood Peninsula. Site contamination will require management during development of the Project, to minimise impacts to sensitive receptors that may arise from disturbance of the areas of contamination.

This CSMP has therefore been prepared to allow for appropriate management of site contamination and ASS disturbance. This document contains environmental management and mitigation measures and monitoring procedures developed to manage potential soil, water and air contamination risks. The objectives of the CSMP are as follows:

- Outline the measures related to the management of contamination and ASS that the Department of Treasury Strategic Projects (SP) and its Lead Contractor(s) are to follow to minimise impact on sensitive receptors and the environment during the Construction Phase of the Project.
- Describe the management measures and controls required in order to minimise environmental impact arising from the Construction Phase of the Project.
- Describe the management measures and controls required in the instance that unknown contaminated soil or water is encountered during the Construction Phase of the Project.
- Outline the measures related to the management of contaminated sites that the Operating Phase Lead Contractor and its contractors/operators are to follow to minimise impact on sensitive receptors and the environment during the Operating Phase of the Project.

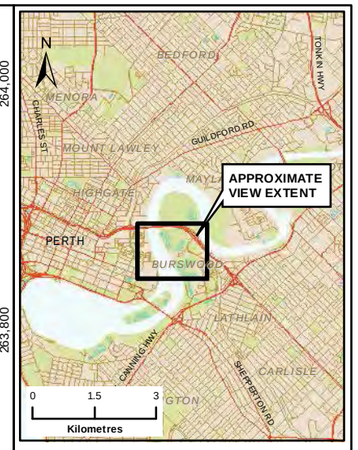
The Lead Contractors for PCS Works and Stadium Works will be responsible for preparing a CEMP/OEMP which incorporates the requirements of the CSMP where it applies to their proposed works.

1.4 Project Location and History

The Project will be located on the northern nine holes of the Burswood Park Golf Course and State Tennis Centre located on the Burswood Peninsula in Perth Western Australia. The Project area is shown in Figure 1 and highlighted by the solid red border and will be referred to as the "Project area" throughout this document. The Project area is bounded by the Swan River to the west; the Graham Farmer Freeway to the north and east; and the remainder of the Burswood Park Golf Course to the south.

Included within the Project area is the Sports Precinct, which includes the Stadium structure, bus hub, pedestrian access ways and other associated infrastructure. The pedestrian bridge, train station and road upgrades are, for the most part, contained outside the Project area and are discussed in separate documentation.

An environmental preliminary site investigation (PSI) conducted in accordance with the DER Contaminated Sites Management Series Guidelines and reviewed by the Contaminated Site Auditor has identified that the Project area is historically the location of a waste disposal site. It is considered that the Project area has been impacted as a result of previous use as a landfill facility. Further, leachate and landfill gas may have generated over time and be contained beneath the ground surface. An environmental detailed site investigation (DSI) has been completed in accordance with the DER Contaminated Sites Management Series Guidelines. Summaries of the current environmental status of soil, sediment, groundwater, surface water and ground gas based on the results of the DSI have been included in the relevant section relating to the current status of the site (Sections 10.1.3, 10.2.1 and 10.3.1).



LEGEND

Concept design (Aug 2012)

Project area

NOTES

Coordinate System: Perth Coastal Grid (PCG 94)

COPYRIGHT

Aerial imagery © Nearmap (2012).
Development layout (Aug 2012) traced from concept design plan provided by client.

0 40 80 120 160 200
metres

SCALE (at A3) 1:5,000

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-041-R-Rev1
DATE	23 Jul 2014
COMPILED	JRP/ LD / GGW / SAR
APPROVED	IYK

New Perth Stadium CSMP

PROJECT LAYOUT

FIGURE 1

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R41\Rev1\117643077-041-R-F001-Rev1.mxd

2.0 PROJECT SCOPE

2.1 Preconstruction Site Works

The PCS Works are necessary to prepare the site for construction and in particular, to treat the underlying ground conditions which currently give rise to differential settlement across the site. The main components of the PCS Works are site preparation, such as fencing and clearing and ground treatment such as compaction of uncontrolled fill, surcharging with the installation of wick drains and the installation of stone columns.

2.2 Stadium Construction Works

The Stadium Works will commence following completion of the PCS Works, however, some components may occur in parallel, with the Stadium structure being the main element of the Construction Phase. The development loads associated with the Stadium structure itself are significant and will require to be supported through the use of piles which transfer these loads to stronger materials beneath the Swan River Alluvium (SRA) layer.

2.3 Operation

The Operating Phase of Part 1 of the Project involves the transition of the Stadium from construction to operation and being opened to the public. The Operating Phase will include the commissioning of the internal fit-out of the Stadium facilities and ongoing environmental management of the Sports Precinct by the Operating Phase Lead Contractor.

3.0 APPLICABLE LEGISLATION

Relevant environmental legislation applicable to the Project includes:

- ***Environmental Protection Act 1986*** (EP Act) - Part IV of the EP Act governs the environmental impact assessment process, administered by the Western Australian Environmental Protection Agency (EPA). Approval under Part V of the EP Act is not applicable as the Project is not considered prescribed premises; however, a works approval and licence may be required at a later date if a water treatment facility is required. The EP Act imposes various general environmental protection obligations.

- ***Rights in Water and Irrigation Act 1914*** (RIWI Act) - Licenses are required for the removal of water from a watercourse or groundwater aquifer in a proclaimed area. The Burswood Peninsula is within the Perth Groundwater Proclaimed Area and therefore a request for a license to take groundwater must be made to the Department of Water (DoW) under the RIWI Act if groundwater abstraction is required. As ASS is present on site and may be disturbed by dewatering activities this CSMP has been prepared to assist with management of such materials.

- ***Contaminated Sites Act 2003*** - The proposed site is a contaminated site classified as "*Possibly Contaminated -Investigation Required*". The basic summary of records search response from the DER database indicates that "*landfill material has been identified beneath the site including impacts to soil, groundwater and sediment*". A DER Accredited Contaminated Site Auditor has been appointed and all environmental matters (including the individual management plans) related to the project will be reviewed by him from a contaminated sites perspective prior to implementation.

- ***Occupational Safety and Health Act 1984*** - Construction of the new Perth Stadium as well as any plants/facilities designed to remediate contaminated material on site must be in accordance with the Occupation Safety and Health Regulations. This legislation is administered by WorkSafe Western Australia and compliance is required with the Act and Regulations to ensure operations meet standards of workplace safety and protection.

A more detailed list of legislation potentially applicable to the Project is outlined in the Project EMP (Golder, 2013a).

3.1 Guidance Literature

The CSMP has been prepared following guidance included in the DER Contaminated Sites Management Guidelines Series, including the following:

- Landfill Waste Classification and Waste Definitions 1996
- Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC, July 2011)
- A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated site remediation and other related activities (DEC, March 2011)
- Ambient Air Quality Guidelines, 2004
- Odour Methodology Guideline, 2002
- Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia, 2009
- National Environment Protection (Assessment of Site Contamination) Measure, 1999.

4.0 ENVIRONMENTAL MANAGEMENT STRATEGY

This CSMP has been prepared as part of an Environmental Management Strategy to ensure that SP establishes and maintains best practice controls to manage potential environmental and social impacts during the Project. The structure of the Environmental Management Strategy is outlined in Figure 2. The position of this document within the structure is highlighted in red text.

The CSMP has been prepared by SP and reviewed by the Contaminated Site Auditor in consultation with the relevant regulating agencies and may be submitted with any licence or permit applications required. The CSMP will be provided to the Lead Contractor(s) to implement and ensure specific environmental management of the Project. References in this CSMP to the Lead Contractor(s) being responsible for certain tasks also extend to subcontractors where engaged by the Lead Contractor(s).

For detailed information on the Environmental Management Strategy refer to the Project EMP (Golder, 2013a).

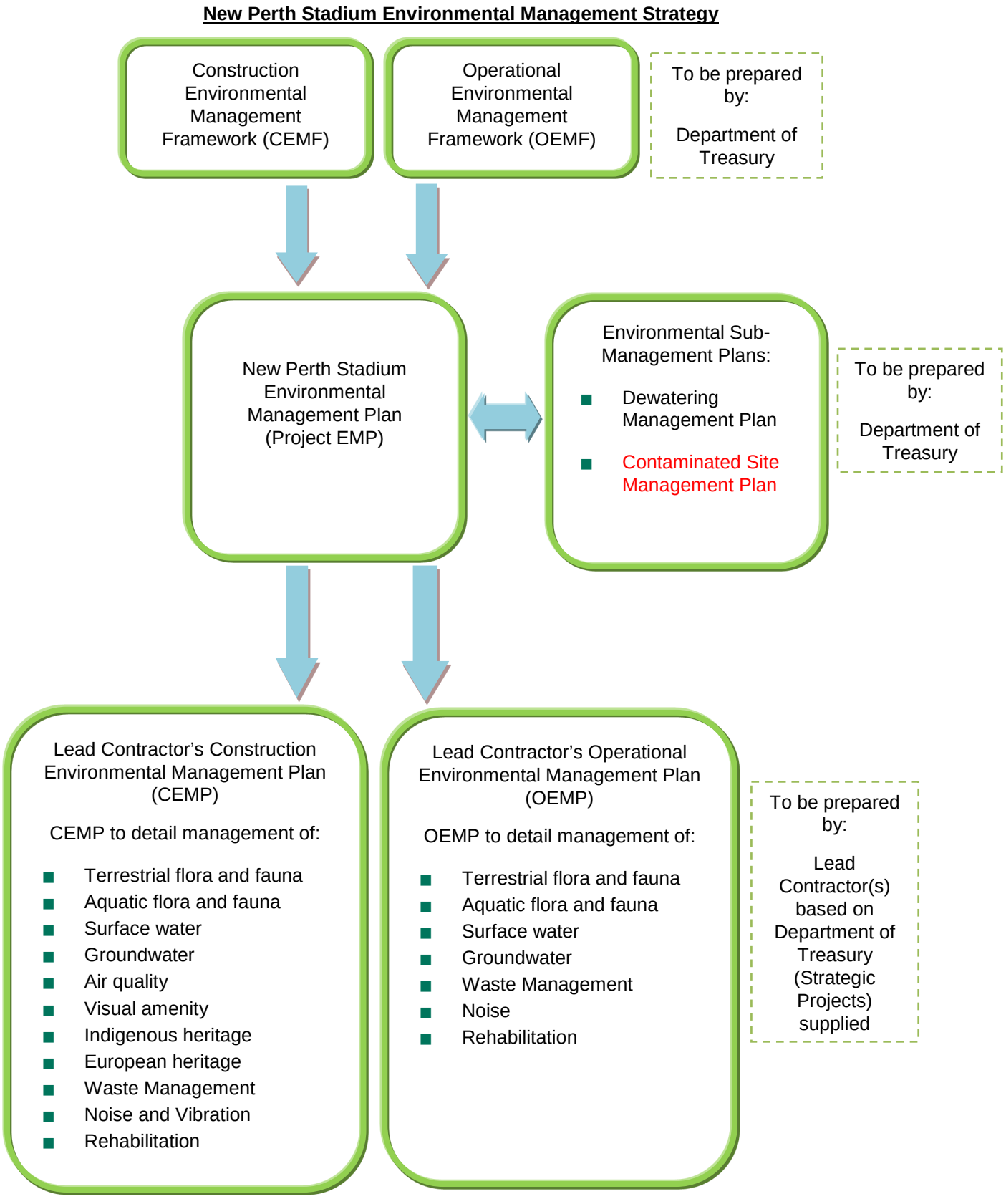


Figure 2: Environmental Management Strategy Structure

5.0 ROLES AND RESPONSIBILITIES

Roles and responsibilities for all personnel involved in the Project are outlined in the Project EMP (Golder, 2013a), including the:

- Strategic Projects General Project Management Team
- Strategic Projects Environmental Manager
- Lead Contractor General Project Management Team
- Lead Contractor's Construction Manager
- Lead Contractor's Environmental Representative.

A DER accredited Contaminated Site Auditor has been appointed for the Project. The Contaminated Site Auditor's role is to review and provide feedback on the contamination investigation and management of the site in accordance with the *Contaminated Sites Act 2003*. All contamination non-conformance issues are to be managed as per Section 15 of the Project EMP (Golder, 2013a). SP is to report non-conformances or environmental incidents to the Contaminated Sites Auditor as outlined in Section 15 of the Project EMP (Golder, 2013a). The Contaminated Site Auditor will have the power to stop work on site if the environment or sensitive receptors are at risk and can review parameters required to rectify the environmental non-conformance. Information (e.g. site records, registers and monitoring results etc.) must be made available to the Contaminated Site Auditor at his request. Monthly soil and water quality data monitoring results will be provided to the Contaminated Site Auditor for review. The Contaminated Site Auditor's role has also been extended to include the review of any ASS investigation and management of the site.

If ground disturbance works are in an area where contamination and/or ASS has been identified or are suspected it will be managed by the above-mentioned personnel.

The key responsibilities for the Lead Contractor's Construction Manager include:

- Supervising the on-site construction workforce.
- Ensuring that the appropriate level of training has been provided to all site staff to minimise environmental impacts from contamination and ASS.
- Informing SP's Environmental Manager(s) of any environmental incidents.
- Ensuring the Lead Contractor's workforce has responded to environmental incidents and implemented the contingencies and recommendations appropriately following incidents.
- Stopping work where it is deemed necessary to do so in order to prevent/manage an environmental incident or injury.
- Ensuring that the requirements of the CSMP are met, including the management measures.
- Ensuring the strategies and procedures prescribed in the CSMP are implemented at the site in accordance with the specified performance criteria.
- Maintaining a non-conformance register which should include as a minimum:
  - A description of the non-conformance.
  - Summary of monitoring results, where applicable.
  - Anticipated cause assigned to the non-conformance and relation to other non-conformances.
  - Any contingencies implemented or proposed to be implemented.

- Reporting details, including date and who the non-conformance was reported to.

The key responsibilities for the Lead Contractor's Environmental Representative include:

- Identifying and reporting environmental incidents to the Lead Contractor's Construction Manager.
- Working with the Lead Contactor's Construction Manager to implement the CSMP.
- Communicating environmental issues with SP's Environmental Manager where required.
- Stopping work where it is deemed necessary to do so in order to prevent/manage an environmental incident or injury.

For further information on roles and responsibilities refer to the Project EMP (Golder, 2013a).

6.0 MATERIAL TRACKING SYSTEM

A Material Tracking System (MTS) shall be prepared and implemented by the Lead Contractor(s) to document all materials brought onto the site and all stockpiling, placement of all materials (whether clean or unacceptable) on the site and the placement and movement of all materials (whether clean or unacceptable) going off-site and quantities. The MTS should include updating of site figures, where relevant to show the location of material storage. The MTS must be documented by the Lead Contractor(s) and provided to SP for approval by SP's Environmental Manager and the Contaminated Sites Auditor.

A copy of the MTS records must be retained on site and be provided on request by the Lead Contractor(s) at any time. The MTS shall be in place for all incoming materials, excavated soil and dewatered material. Any soil or water arriving on or leaving the site as a minimum will need to have documentation indicating the environmental condition of the material and its suitability for use on site.

Any material leaving site as a minimum will need to include the following:

- Details of area excavated or dewatered, including location, actual volumes, dimensions, date removed etc.
- Details of location of where material (soil or water) is stored and details of location and volume of where the material has been placed.
- Details of any treatment undertaken on site.
- If material is disposed of to landfill or treatment facility, weighbridge dockets and receipts from the landfill facility.
- Reference to analytical results, including quality control results and waste classification category if available.

If there is any uncertainty due to poor record keeping, it is up to the Lead Contractor(s) to demonstrate material movements and source. Additional laboratory testing may be a requirement to demonstrate fill quality brought onto the site.

7.0 ENVIRONMENTAL RECEPTORS

Potential receptors in the vicinity of the Project are considered to be as follows:

- Residents occupying the Mirvac Burswood Peninsula development and the adjacent townhouses off Victoria Park Drive, which are located approximately 1 km from the Project.
- Swan River (which extends to include the River-fed Lake) which borders the Burswood Peninsula to the west, north and east.

- Terrestrial and aquatic flora and fauna contained within the landscaped Burswood Park Golf Course and the Swan River.
- Groundwater system and the respective users of the system.
- The public using public recreational areas such as the parks and River foreshore.

8.0 POTENTIAL ENVIRONMENTAL IMPACTS

8.1 Construction Phase Work Items

The Construction Phase of the Project includes the following work items which may affect contamination on site:

- Encountering contamination and/or ASS as part of works during site construction and work associated with remediation
- Excavation of potentially contaminated material and/or ASS
- Storage and stockpiling of potentially contaminated material and/or ASS on site
- Drainage of potentially contaminated groundwater from excavated soils (including acid generation from disturbed ASS and stockpiles)
- Inappropriate management of ASS material and dewatering of potentially contaminated groundwater.
- Inappropriate management of reused waste soils.
- Importation of fill material to site
- Ground improvement methods which use wick drains to aid surcharging.
- Ground improvement methods stone columns or rigid inclusions to reduce settlement and increase overall strength of the ground.
- Installation of piles to support structures.
- Reuse of excavated fill material on site.

8.2 Potential Impacts of the Construction Phase

Potential impacts associated with the above mentioned Construction Phase processes include:

- Release of contaminated groundwater; generated through dewatering activities of *in situ* or *ex situ* soils to the surrounding environment including leachate from on-site stockpiles.
- Vertical movement of groundwater from the SRA to the Fill material during surcharging activities.
- Disturbance of contaminated material or ASS through:
  - excavation activities including installation of wick drains, stone columns and piles
  - dewatering activities.
- Generation of dust from potentially contaminated soils stockpiled on site.
- Generation of dust from excavation activities.

- Generation of vapours from potentially contaminated soils or groundwater, including release of ground gas from the former landfill and Swan River Alluvium.
- Inappropriate reuse of excavated fill material on site.

9.0 COMMUNICATION OF ENVIRONMENTAL MATTERS

"Toolbox" meetings shall be held daily by the Lead Contractor(s) during the Construction Phase of the Project as outlined in the Project EMP (Golder, 2013a). Discussion of the following contaminated site items should be included in the meetings:

- Concerns and/or questions raised by personnel.
- Previous environmental incidents that have occurred.
- New information, environmental management procedures or controls which are to be implemented.
- New areas of contamination which may have been encountered during construction works.
- Review of the non-conformance register and discussion of non-conformances that have occurred to identify trends and/or more than one occurrence in a seven day period.
- Reiteration of specific environmental management procedures which have already been communicated to site personnel.

Regular meetings between the Lead Contractor's Environmental Representative and SP's Environmental Manager should be undertaken. These meetings will cover the progress and schedule of the construction works and discuss any environmental issues which require attention.

10.0 IMPLEMENTATION OF THE CSMP FOR THE CONSTRUCTION PHASE

This section contains separate management plans for soil, water and air to be implemented during the Construction Phase of the Project to manage contamination. Each respective management plan section outlines the following:

- Potential environmental disturbance and impacts
- Proposed management objectives, targets and key performance indicators
- Proposed management measures
- Proposed monitoring procedures
- Proposed contingencies.

The purpose of the targets and key performance indicators are to provide measurable indicators in order to assess whether the management measures are being achieved and are suitably protecting sensitive receptors and the environment. Contingencies are to be implemented where management measures are not being achieved.

10.1 Soil Management Plan

10.1.1 Soil Conditions

The Project area is located on generally low-lying ground of the Burswood Peninsula located within an ox-bow bend of the Swan River. Based on the results of the DSI completed, all materials likely to be disturbed during construction works with the exception of the yellow to orange sandy Fill material are considered to be an ASS. Management procedures are outlined in Section 10.1.6, and are presented in full detail in Appendix A.

The levels across the planned Sports Precinct site vary as follows:

- Ground surface generally between about RL 2 and RL 5 m AHD across the grass fairways and greens, with localised higher and lower points, sloping down to about RL 0 m AHD adjacent to the western lake (the River-fed Lake), sloping up to about RL 5 m AHD around the southern and eastern margins of the golf course.
- Ground surface generally between about RL 0.5 and RL 1 m AHD across a practice fairway located between the western lake (the River-fed Lake) and the Swan River.
- Ground surface generally between about RL 2 and RL 6 m AHD across the open area to the east of Victoria Park Drive.
- Road surface on Victoria Park Drive generally between about RL 3 and RL 8 m AHD, grading up towards the bridge over the railway.
- Water level in the eastern clay-lined irrigation lake (the Irrigation Lake)at about RL 3 m AHD.
- Water level in the western unlined lake at about (the River-fed Lake) RL 0 m AHD.

The topography of the Burswood Peninsula has changed dramatically over the years due to the importation of various types of fill material. Surface elevation has generally increased due to the placement of this fill material. The eastern bank of the Swan River drops sharply approximately 1 m to the water's edge, while the western bank comprises intermittent fringing reed systems.

In chronological order from youngest to oldest, the four principal geological units have been assigned as follows:

- Unit 1 - Fill.
  - Unit 1a – Sand Fill material which contains no waste material and was placed as a capping material
  - Unit 1b – Waste Fill material which contains uncontrolled fill material including rubbish
- Unit 2 - Swan River Alluvium (SRA), consisting of alluvial deposits silty clay layers.
- Unit 3 - Sandy Channel Deposits (SCD).
- Unit 4 - Kings Park Formation; Mullaloo Sandstone Member (KPF).

Further to the west, the ground surface drops and most of the lower area comprises an alluvial floodplain.

Further detail on the composition of the above units is described in the Conceptual Design of Ground Improvement report (Golder, 2012a).

At least two ancient river channels (palaeochannels) run beneath the site. The most recent of these channels is infilled with soft, highly compressible SRA. This recent palaeochannel is up to about 32 m in depth below the ground surface, with relatively steep side slopes in parts. An older palaeochannel is infilled with the SCD.

10.1.2 Acid Sulfate Soils

10.1.2.1 ASS Risk Map

The Landgate ASS maps present ASS risk areas across specific regions of Western Australia. These maps present a broad-scale indication of the areas where ASS is likely to occur. The majority of these ASS risk maps are based on reviews of existing geomorphological, geological and hydrological information for the region.

The Project area was found to be located in an area with a high to moderate disturbance risk of actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) occurring generally at depths greater than 3 m. Figure 3 illustrates the risk for ASS in the Project area.

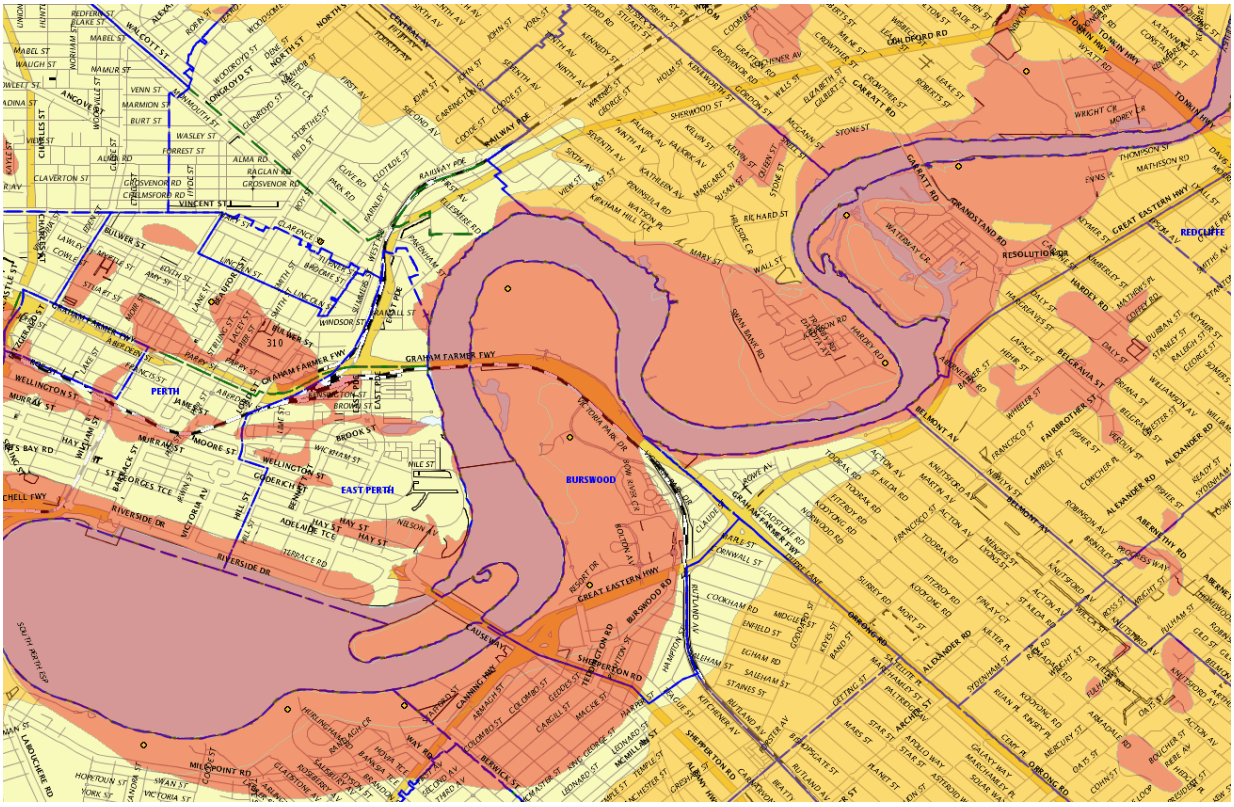


Figure 3: Risk for ASS in the Project Area

However, given the low lying nature of some areas within the Project area, it is likely that these may be in fact high risk areas.

Note that the ASS risk maps are designed to be used for broad-scale planning purposes and are not intended to provide site specific ASS information.

10.1.2.2 Summary of Previous Findings

A number of reports have been reviewed by Golder and are summarised in the PSI (Golder 2012b). Additional studies have been undertaken as part of the DSI and provide further details on the nature and extent of the materials that may be considered potentially acid generating. The key findings that relate to the potential presence of ASS at the site are:

- Investigations carried out in 2008 (Golder, 2012b) identified landfill materials at depths of up to 8.0 m deep in locations, landfill materials observed included:
  - solid wastes

- asbestos
- industrial waste
- cinder ash
- bio solids
- medical wastes
- general putrescibles wastes.

- Of these materials the putrescible material could become sulfidic if the right geochemical conditions were generated: a low oxygen environment with a source of iron and sulfate, and a pH of 4 or above.
- Leachability studies on contaminated soils have demonstrated that some contaminants (i.e. nickel) may mobilise and enter the underlying groundwater due to acidic groundwater and soil conditions; however, this is considered a low risk as the metals recorded in the soils are likely to be well bound and would be difficult to release in the current groundwater environment.

These findings suggest there is the potential for these conditions to be exacerbated through the mismanagement of ASS disturbance at the site.

Due to the presence of ASS in almost all lithologies (the exception being yellow and orange sandy Fill) and the inability to visually distinguish ASS from non-ASS, Golder has compared the confirmed ASS via laboratory analysis against the total number of samples tested. From the table below (Table 1), it is noted that the likelihood of encountering ASS at the site increases with depth, however, this cannot be considered an accurate representation of conditions at the site and should only be used as a general indicator.

Table 1: Summary of ASS Results

Material Type	Number of Samples Tested	Number of Exceedances	Percentage (%)
Fill: Sand/Clay	30	14	47
Fill: Waste	40	24	60
Natural	52	41	79

Previous investigations have confirmed that ASS is present in areas of the Burswood Peninsula. The high risk natural materials detailed in the DER risk maps at this site are correlated to shallow expressions of the SRA. These river alluviums are known to be sulfidic across the metropolitan area in locations close to the Swan River. The underlying SCD is also potentially ASS; the clay layers more so than the sands as the clays have a lower hydraulic conductivity thus anoxic conditions are more likely. Such conditions are conducive to sulfide production. The higher conductivity sands may have groundwater with a higher oxygen content and thus under these more dynamic conditions the presence of sulfide is less likely.

The fill within the landfill areas has also been identified as ASS. ASS conditions may have been generated due to the putrescible nature of the waste which is conducive to sulfide generation. It is relevant to note that all materials which do not consist of yellow or orange sandy Fill material are considered to be ASS and if disturbed during construction activities should be managed according to the procedures present in Appendix A. It is advised that material above the water table which consists of yellow and orange sandy Fill material can be placed elsewhere on site without active ASS management provided the management measures outlined in Section 10.1.6 are followed.

ASS at site will be managed by the Lead Contractor(s) according to this CSMP and their CEMP.

10.1.2.3 Potential Impacts of Surcharging on the Stability of ASS

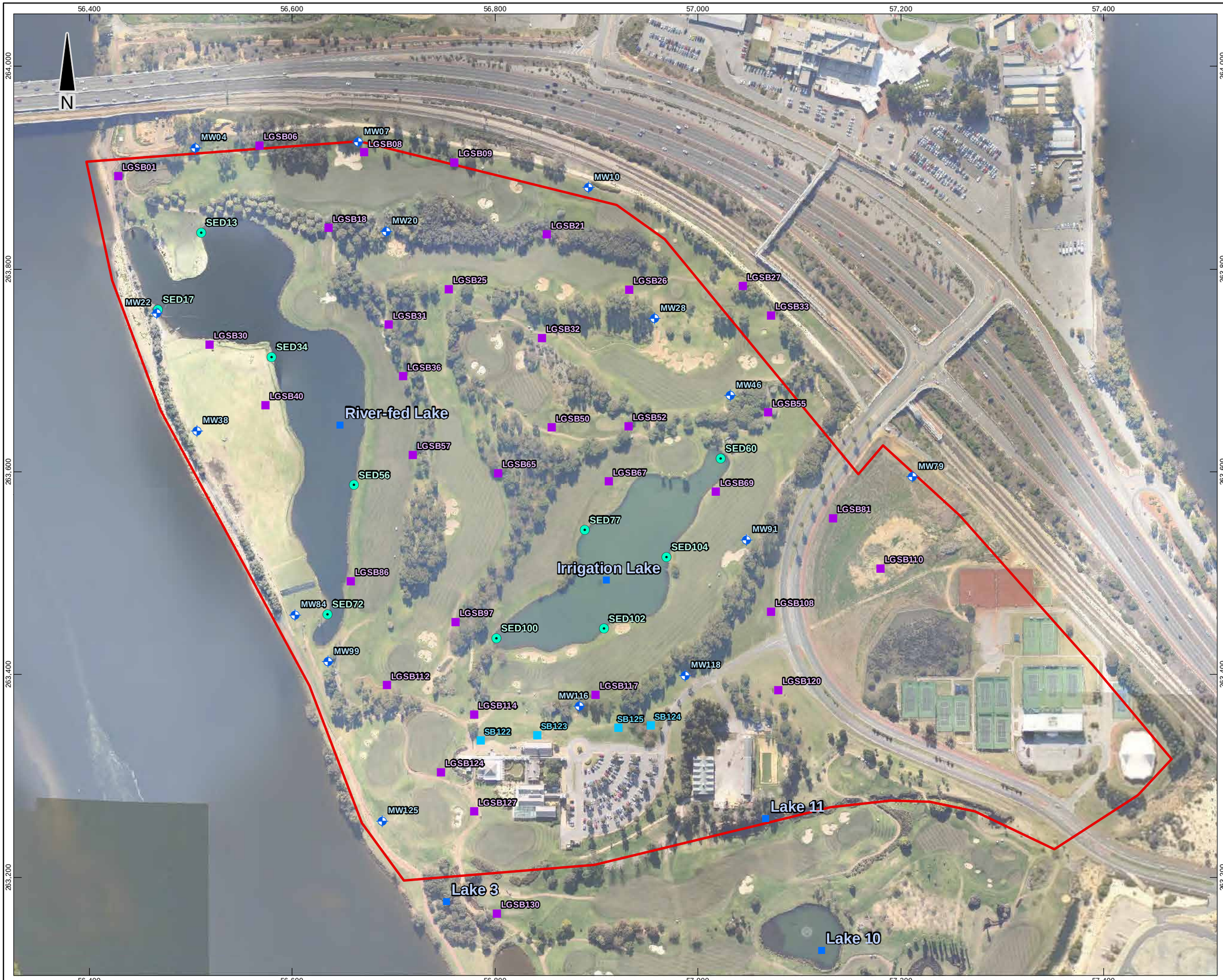
The importance of knowing if stratification exists within the aquifer is important with respect to the stability of the ASS materials. As the proposed surcharging activities earmarked to be undertaken at the location of the Stadium playing field will potentially move the ASS materials of the SRA approximately 1.5 m deeper into the aquifer. If these materials are moved from a fresh/brackish water environment to a more saline one, there exists the potential for ion exchange to occur. This ion exchange may result in the release of acidity and the mobilisation of metals from these soils to the groundwater.

The site investigation to date has recorded fresh water conditions within the fill (average 4 mS/cm) and fresh to brackish conditions in the SRA (3-18 mS/cm). The wick drains will likely cause the groundwater underneath the surcharge area to mix to a value between these two values. The redox conditions in both the fill aquifer and the SRA are both reducing. In light of these data, it is likely that the surcharge of the ASS materials will not cause the ASS to move in to conditions that are dissimilar to the environment in which they are currently situated. Thus there should be no recordable impact from their surcharge.

Should dewatering be required, dewatering requirements for surcharge are covered in the DMP (Golder, 2013c).

10.1.3 Contaminated Soils

A DSI was undertaken by Golder (2013b) and included the collection of a number of test pits, soil bores and sediment samples from across the site. The locations are presented in Figure 4. The results suggest that the capping sandy fill material is not uniform across the site and varying depths of Sand Fill and Waste Fill material were observed during the investigation. Based on the borehole logs the thickest waste profiles were inferred to be within the northern end of the site (LGSB06); west of the River-fed Lake (LGSB30 and LGSB40); within the proposed Stadium footprint development (LGSB50, LGSB52, LGSB57, LGSB67, LG44, LG54 and LG55) and within the undeveloped area north of the Tennis Centre (LGSB110 and LG111). The shallowest waste material was noted in LGSB06 at 0.2 m bgl.



LEGEND

- MW: Soil bore converted into monitoring well
- SB: Soil bore
- LGSB: Soil bore converted into ground gas monitoring well
- Sediment sample location
- Project area

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Aerial imagery © Nearmap (2012).

0 50 100 150
Metres

SCALE (at A3) 1:3,500

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-041-R-Rev1
DATE	23 Jul 2014
COMPILED	MS
APPROVED	IYK

New Perth Stadium CSMP

DSI SOIL & SEDIMENT INVESTIGATION LOCATIONS

FIGURE 4

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R41\Rev1\117643077-041-R-F004-Rev1.mxd

A summary of the exceedances of DER Ecological Investigation Levels (EIL) in soil samples collected during the DSI has been included as Table 2. A summary of the exceedances of the DER Health Investigation Levels (HIL D) has been provided in Table 3. Additionally asbestos was detected in nine samples collected from the Waste Fill material and sand Fill, results have been provided in Table 6 and therefore the presence of asbestos at other locations cannot be precluded.

Table 2: Locations of EIL Exceedances

Contaminant of Concern	Location and Depth (m bgl)
Arsenic	LGSB25 (2.8-3), LGSB112 (5.5-5.9), LGSB120 (5.5-5.8), MW46 (1.6-1.8), MW79 (4.7-5.1)
Cadmium	LGSB09 (2.3-2.9), LGSB120 (5.5-5.8), TP02 (1.1-1.3), (TP005 1-1.1)
Copper	LGSB06 (0.8-1), LGSB36 (2.5-2.8), LGSB50 (1.8-2.5), LGSB112 (3-3.5), LGSB112 (5.5-5.9), MW04 (2.7-3), TP005 (1-1.1)
Lead	LGSB112 (5.5-5.9), MW91 (0.5-1), TP005 (1-1.1)
Manganese	LGSB120 (5.5-5.8)
Mercury	LGSB112 (5.5-5.9), MW84 (3.2-3.6)
Nickel	LG80 (0.4-1.2), LGSB120 (5.5-5.8)
Tin	LGSB112 (5.5-5.9), MW91 (0.5-1), TP005 (1-1.1)
Zinc	LG80 (0.4-1.2), LGSB09 (2.3-2.9), LGSB32 (4-4.5), LGSB33 (2.4-2.8), LGSB50 (2.6-3), LGSB50 (4.5-6), LGSB52 (4.3-5.2), LGSB57 (1.8-2), LGSB65 (3.5-4.5), LGSB69 (0.6-0.9), LGSB112 (3-3.5), LGSB112 (5.5-5.9), MW79 (4.7-5.1), MW84 (2-2.5), MW91 (2.5-3), TP002 (1.1-1.3), TP005 (1-1.1), TP005 (1.8-1.9), TP005 (2.1-2.2)
Benzo(a)pyrene	LGSB01 (0.5-0.8), MW46 (1.2-1.5), LGSB30 (0.6-1)
Fluoranthene	LGSB30 (0.6-1)
Phenanthrene	LGSB30 (0.6-1)
Pyrene	LGSB30 (0.6-1)
Dieldrin	LGSB08 (2.3-2.8), LGSB65 (1.3-1.5), MW84 (2-2.5)

Table 3: Location of HIL D Exceedances

Contaminant of Concern	Location and Depth (m bgl)
Copper	TP005 (1-1.1)
Lead	MW91 (0.5-1), TP005 (1-1.1)
Benzo(a)pyrene	LGSB30 (0.6-1)
Total PAHs	LGSB30 (0.6-1)

Sediment samples were compared to both the ISQG low and high guidelines. A summary of sediment samples which exceeded these guidelines are summarised in Table 4 and Table 5, respectively. It should be noted that all exceedances were only noted in the River-fed Lake.

Table 4: Location of ISQG Low Exceedances

Contaminant of Concern	Location
Copper	SED34
Lead	SED13, SED17, SED34
Mercury	SED34
Nickel	SED34
Zinc	SED34

Table 5: Location of ISQG High Exceedances

Contaminant of Concern	Location
Nickel	SED34
Zinc	SED34

Table 6: Positive Detections of Asbestos in Soil Samples

Sample ID (QA/QC sample)	Asbestos Form#	Asbestos Type	Location ID	Lithology	Depth of Lithology where asbestos was detected (m bgl)
Q6692-06	Fibre cement piece (ACM) present	Chrysotile	LGSB55	Fill: Waste SAND	2.8-3.2
Q6695-04/ Q6695-05 (Duplicate sample)	2 small fibre bundles present	Crocidolite	MW99	Fill: Waste Gravelly SAND	1.9-2.5
Q6696-05	Fibre bundle present	Chrysotile	LGSB112	Fill: Waste SAND	3-3.5
Q9186-08	3 pieces of ACM present	Amosite, Chrysotile	LGSB108	Fill: SAND	1.4-1.8
Q9186-11	ACM present	Amosite, Chrysotile	LGSB108	Fill: CLAY	5.6-6.0
Q9618-05	ACM present	Chrysotile, Crocidolite	LGSB26	Fill: Waste SAND	2.7-3.0
*Q10110-04	Fibre bundles attached to rocks and fibres in soil present	Unknown fibre	TP03	Fill: Waste SAND	1.1-1.2
Q10107-04	**	Chrysotile	TP01***	Fill: Waste SAND	0.6-0.9
Q10108-02 (Triplicate sample of Q10109-03)	Fibres in soil present	Amosite, Chrysotile, Crocidolite	TP02	Fill: SAND	1.10-1.30

Observations based on notes made by the laboratory chemist

* Sample Q10110-04 reported that organic fibres were detected however, it was not possible to determine if the sample were asbestos or not. The laboratory reported the presence of asbestos as “Unknown” and therefore it is being included in the summary table for conservatism.

** Laboratory notes are in archive and were not available at the time of writing this report however; organic fibres were detected by the laboratory.

*** denotes detection is taken from field duplicate data due to QA/QC issues.

10.1.4 Potential Environmental Disturbance and Impacts

Aspects of the Construction Phase of the Project that may have the potential to disturb contaminated soil and ASS are as follows:

- Excavation of material for installation of underground services
- Excavation of material for installation of piles
- Pre boring of fill material for installation of wick drains, stone columns and piles
- Excavation of obstructions in fill material for installation of wick drains, stone columns and piles.

The potential impacts of contaminated soil and ASS disturbance on the environment include:

- Release of contaminants and/or acidity into the groundwater and the Swan River
- Release of contaminants into the air through volatilisation and dust generation.

10.1.5 Construction Phase Management Objectives, Targets and Key Performance Indicators

Table 7: Management Objectives, Targets and Key Performance Indicators for Soil Management

Management Objectives	Target	Key Performance Indicator
Minimise amount and duration of soils stockpiled on site	Stockpiles identified for disposal off-site are to be sampled within three days following their final placement and shall not remain on site for longer than three days (72 hours) after receipt of analytical results if they are to be disposed off site.	Site inspection and MTS detailing stockpiles
Prevent adverse impacts to sensitive receptors as a result of excavation or stockpiling of contaminated soil.	No runoff (including leachate) from stockpiled soil	All stockpiled material to be in bunded areas as per Procedure B (Appendix A)
		Runoff (including leachate) to be managed as per Procedure D (Appendix A)
		Site inspection and validation
	Minimise impact on groundwater or surface water from potentially contaminated soil	Groundwater monitoring results as per Section 10.2
	Minimise impacts on air quality	Air monitoring results as per the air quality results Section 10.3
Prevent adverse impacts to sensitive receptors as a result of excavation or stockpiling of ASS	Groundwater acidity does not increase near the disturbed areas	Groundwater monitoring results as per Section 10.2 and Procedure D (Appendix A)
		Management of water as per Procedure D (Appendix A)
Appropriately reuse excavated material, where possible.	Minimise impact to sensitive receptors due to soil reuse.	All reused soil to be managed as per Section 10.1.6.

10.1.6 Management Measures

This section outlines soil management measures (including reuse) to be undertaken by the Lead Contractor(s) including the management of ASS.

As outlined in Section 10.1.3, there were five exceedances of DER Health Investigation Levels for the nominated screening level (HIL D – Residential with minimal opportunities for soil access). None of the HIL D or EIL exceedances were noted within the yellow and orange sandy Fill material which has been placed on top of the waste Fill material. Based on the information contained in the DSI, soil management must meet the following guidelines:

- Yellow and orange sandy Fill material above the water table which is not contaminated can be placed elsewhere on site without active ASS or contaminated soils management, provided it remains above the water table.
- Material other than yellow and orange sand Fill (such as dark brown to black sandy Fill or waste Fill) should be viewed as ASS material and potentially contaminated.
    - If this material is disturbed from below the water table, it should not be reused on site as fill or placed back below the groundwater fluctuation zone from an ASS point of view. A procedure in line with the requirements of the treatment or landfill facility should be prepared by the Lead Contractor(s) for the management of this material.
    - If material is above the water table and the material does not meet criteria for Clean Fill (i.e. above EIL or is an ASS), but does meet the criteria for the intended land use (i.e. meets DER HIL E or HIL F), it can be reused above the water table without active ASS management. Due to the presence of ACM and asbestos fibre in soil and other rubble within the fill, it is also recommended that these materials not be reused at or near the surface during surcharging or ground improvement or be placed at a level which will become in the future the final design level.

Any material considered for reuse on site must meet geotechnical requirements.

ASS materials to be disposed of would require treatment either on or off site prior to disposal off site (refer to Section 10.1.6.2). A layer of Clean Fill is required over areas of the site as specified below:

- In areas where proposed services will be present (which will require future access, repair and maintenance), Clean Fill is to be used to back fill above the service corridor to surface and extend to a minimum of 0.5 m below the services.
- In areas which are open and accessible to the public, cut material is not to be re-used at or near the surface and a 0.5 m layer of Clean Fill will be required.
- In areas where the re-used cut material will be ultimately covered by buildings or structures effectively capping the cut material, SP is to ensure that the re-used cut material is recorded on ‘as-constructed’ plans and documented in the certificate of title as a memorial along with the continuation to manage access/permits of contractor plans/works within the Project area.

A proposed cut and fill plan and a soil management procedure (to be included in the Lead Contractor(s)’ CEMP) must be submitted to SP’s Environmental Manager for review in line with the Lead Contractor(s)’ proposed earthworks and endorsed by the Auditor prior to commencement. The Lead Contractor(s) for PCS Works and Stadium Works are also required to provide an earthworks plan and unexpected finds work procedure as part of their CEMP which will be reviewed and endorsed by SP and the Contaminated Sites Auditor.

Provided the soil management meets the guidelines provided above, there are no requirements to carry out further testing of materials for on-site reuse. However, the Lead Contractor(s) must demonstrate that the material remaining on the surface of the final design levels meet the requirements of the Contract (which is to maintain a layer of clean fill at the final design level). The Lead Contractor(s) must maintain the MTS as per Section 6.0.

All excavated soils within the groundwater zone will need to be stockpiled in order to facilitate draining of water from the soil prior to appropriate waste classification (as outlined in Table 8) and removal to a landfill. These stockpiles should not remain on site for more than three days after the receipt of analytical results and all efforts should be made to minimise the amount and duration of stockpiled soil on site. Stockpiles must be managed in accordance with Procedure B (Appendix A) and water drained from the soil must be managed in accordance with Procedure D (Appendix A). When not in use and if feasible, stockpiles should remain covered or be sufficiently managed to minimise dust generation. Soil intended for stockpiling should be tested *in situ* to show that there is not contamination with asbestos. A process flow chart for the appropriate management and treatment of excavated material which requires off-site disposal has been included in Procedure B (Appendix A). It is preferred that materials impacted by asbestos are not treated on site due to the potential for asbestos fibres to be mobilised during mixing of aglime. As a result, excavated materials not proposed for reuse, which are either ASS or deemed contaminated are to be transported to a suitably licensed treatment and/or waste disposal facility. However, if asbestos is not present, material may be treated on site.

If feasible, ASS should be separated from non-putrescible building rubble and steel structures prior to removal to a licensed facility. As a minimum, a Class II Landfill facility should be used for all ASS materials, however, should contaminated exceedances exist this classification may need to be reviewed. Tip dockets are to be collected and included in the final Environment Completion Compliance Report. Records of waste types, volumes and disposal locations for all excavated materials are to be maintained as per the MTS outlined in Section 6.0.

Management measures related to address these issues are presented in Appendix A and include:

- Procedure A: Identification of ASS
- Procedure B: Management Options
- Procedure C: Treatment of Excavated Contaminated Material and ASS
- Procedure D: Dewatering Management and Monitoring of Water Quality

Further detail is provided below to better understand the information provided in each procedure.

10.1.6.1 Procedure A: Identification of ASS

This procedure is to inform site personnel of currently identified ASS materials and provides measures for characterisation of other similar materials that may be encountered outside of designated ASS zones ("suspected ASS materials"). Should suspected ASS materials be exposed during excavations at the site, then Procedure A (Appendix A) shall be followed to confirm the material status (and treatments required).

All ASS materials shall be excavated and stockpiled separately from overlying non-ASS materials and collected for treatment/disposal.

10.1.6.2 Management Options

Procedure B (Appendix A) is provided for the preparation of a bunded stockpile area on site and the specifics for stockpiling of material on site. This procedure includes a decision tree related to the selection of management and treatment options for contaminated material and ASS and its removal to an approved licensed treatment and disposal facility.

10.1.6.3 Verification of Excavated Contaminated Material and ASS

Procedure C (Appendix A) is provided for the management and on-site treatment of confirmed ASS materials encountered during site excavations.

10.1.6.4 Dewatering Management and Monitoring of Water Quality

Procedure D (Appendix A) is provided to monitor and manage runoff collection from stockpile areas.

10.1.7 Monitoring Procedures

This section outlines monitoring procedures to be undertaken by the Lead Contractor(s).

The required minimum monitoring for contaminated material and ASS management is shown in Table 8. The objective of the monitoring is to provide warnings such that adverse impacts on the existing sensitive environment as a result of site works involving the Pre-Construction or Construction Phases of the Project can be prevented.

The management of leachate from the processes of dewatering and soil draining is detailed in Procedure D in Appendix A and should also be used to ensure compliance with the necessary requirements.

Where appropriate, collection of samples should be undertaken as per the Sampling and Analysis Plan (Golder 2012c) for the DSI (Golder 2013b).

Table 8: Monitoring Required to Achieve Soil Management Targets and Key Performance Indicators

Objective	Parameters	Frequency	Location	Responsibility
Ensure proper reuse of excavated materials on site while preventing spread of contaminated material	Ensure soil reuse meets the guidelines provided in Section 10.1.6. Soil movement is tracked in MTS (Section 6.0).	Ongoing	Visual monitoring *in situ* prior to excavation and reuse	Lead Contractor's Environmental Representative
Ensure proper disposal of excavated material while minimising impact of stockpiled soil on receptors	Landfill disposal suite[1]	Within 3 days of material being excavated	Stockpile	Lead Contractor's Environmental Representative
		Number of samples based on volume excavated[2]	Stockpile	
	Daily observations throughout stockpile period[3]		Stockpile	Lead Contractor's Environmental Representative
Ensure that groundwater and the Swan River are not impacted by stockpiled soils	Covered as part of the Water Management Plan, Section 10.2			
	Contaminants of concern from Table 2 and Table 3	Once when stockpiles have been removed	Beneath Stockpile	Lead Contractor's Environmental Representative
Air quality (dust, ground gases, odours) is not impacted	Covered as part of the Air Management Plan, Section 10.3			

[1] *Landfill disposal suite includes: total cyanide, total fluoride, polycyclic aromatic hydrocarbons, phenols, total petroleum hydrocarbons (C_6-C_{36}), volatile organic compounds, monocyclic aromatic hydrocarbons, organochlorine pesticides, organophosphate pesticides, polychlorinated biphenyls, metals (silver, arsenic, beryllium, chromium, cadmium, copper, molybdenum, nickel, lead, selenium and zinc), leachable metals (silver, arsenic, beryllium, chromium, cadmium, copper, molybdenum, nickel, lead, selenium and zinc).*

[2] *Number of samples required for landfill disposal are outlined in Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*

[3] *Indicators of contaminated soil in the stockpile may include presence of odours of visual staining.*

10.1.8 Contingencies

Potential contingency actions for managing key performance targets which are not achieved are outlined in Table 9. The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0 of the Project EMP (Golder, 2013a)) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor where required, by Section 15.0 of the Project EMP (Golder, 2013a).

Table 9: Contingency Actions for the Soil Management Plan

Trigger	Potential Actions
Runoff occurring from stockpiles	■ Stop runoff from occurring by increasing bund height (outlined in Procedure B, Appendix A) ■ Have stockpiles removed to a licensed off-site disposal location ■ Confirm water quality of runoff based on laboratory analysis ■ Monitor receiving environment for negative impacts
Stockpile remains on site for longer than 3 days after the receipt of analytical results	■ Have stockpiles removed to a licensed off-site disposal location
Groundwater acidity increases near excavation activities[1]	■ Stop excavation activities in area of increased acidity ■ Confirm status of groundwater by undertaking laboratory analysis ■ Monitor downgradient locations for increased acidity
Groundwater acidity increase near stockpiles[2]	■ Have stockpiles removed to a licensed off-site disposal location ■ Prior to re-use of bunded area, check lining/limestone pad for defects
Soil samples from beneath the stockpile area indicate concentrations of contaminants of concern above HIL F	■ Excavation of impacted material, classify and remove off site to a licensed off-site disposal location ■ Validation of *in situ* material
Monitoring results indicate elevated dust levels associated with excavation of potentially contaminated material	■ Stop work if workers or receptors are being exposed to elevated dust levels ■ Implement additional dust suppression measures as per the Contractor's CEMP
Monitoring results indicate elevated dust levels associated with on-site stockpiled contaminated material	■ Stop work if workers or receptors are being exposed to elevated dust levels. ■ Implement additional dust suppression measures as per the Contractor's CEMP ■ Have stockpiles removed to a licensed off-site disposal location
Monitoring results indicate elevated vapour concentrations	■ Ensure health and safety measures for on-site workers are suitable. ■ Implement additional suppression such as water sprays as per the Contractor's CEMP ■ Stop site activities until wind conditions are favourable to minimise risk to sensitive receptors (Additional information in Section 10.3)

[1] *Additional contingency actions are detailed in the Water Management Plan in Section 10.2.*
[2] *Additional contingency actions are detailed in the Air Management Plan in Section 10.3.*

If the above points do not resolve the issues SP is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.2 Water Management Plan

Environmental impacts to groundwater and surface water during the Construction Phase will be managed in accordance with this CSMP, the DMP (Golder, 2013c) and the Project EMP (Golder, 2013a).

10.2.1 Current Understanding

The DSI was undertaken by Golder (2013b) and included collection of surface water samples from the two on-site lakes (Lakes 1 and 2) and groundwater samples from various groundwater bores on site screened in the fill material, SCD and SRA formations. These locations are presented in Figure 5. Both groundwater and surface water results from the DSI were compared to Swan River Trust Guidelines and the following criteria within DER guidance (DEC, 2010):

- Freshwater quality guidelines (ANZECC, 2000a)
- Marine water guidelines (ANZECC, 2000a)
- Estuaries in South West Australia guidelines (ANZECC, 2000a)
- Domestic non-potable uses of recycled water in Western Australia guidelines (Department of Health, 2011)
- Long-term irrigation water guidelines (ANZECC, 2000b).
- DER Drinking Waters AV and HV, however these are not considered to be applicable with respect to the CSMP as no drinking of groundwater is to occur during site work and therefore have not been considered.

LEGEND

- BH: Golder geotechnical bore converted into groundwater well
- MW: Golder soil bore converted into groundwater well
- MW: Aurora well
- Surface water sample location
- Project area

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Aerial imagery © Nearmap (2012).

0 50 100 150
Metres

SCALE (at A3) 1:3,500

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-041-R-Rev1
DATE	23 Jul 2014
COMPILED	MS
APPROVED	IYK

New Perth Stadium CSMP

DSI GROUNDWATER & SURFACE WATER INVESTIGATION LOCATIONS

FIGURE 5

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R41\Rev1\117643077-041-R-F005-Rev1.mxd

A summary of the locations of groundwater exceedances per contaminant of concern is presented in Table 10. If should be noted that exceedances were also noted for pesticides and other polycyclic aromatic hydrocarbons (PAHs) however they were below the Limit of Reporting (LOR) and therefore have not been included in this table. It is recommended that pesticides and PAHs be considered as potential contaminants of concern at the site as these were detected in soil at site at concentrations above criteria.

Table 10: Location of Groundwater Exceedances

Contaminants of Concern	Location
Boron	BH01 SCD, BH01 SRA, BH02 SRA, BH03 SRA, BH05 SRA, MW04, MW07, MW116, MW125, MW22, MW28, MW38, MW70, MW91
Cadmium	MW04, MW07, MW125
Copper	BH02 SCD, BH05 SRA, MW28, MW91
Manganese	BH01 Fill, BH01 SCD, BH01 SRA, BH02 SRA, BH03 Fill, BH03 SRA, BH04 Fill, BH04 SCD, BH05 Fill, BH05 SRA, MW02, MW04, MW07, MW10, MW116, MW125, MW128, MW14, MW20, MW22, MW28, MW38, MW46, MW70, MW75, MW79, MW91
Molybdenum	BH01 SCD, BH01 SRA, BH05 SRA, MW04
Nickel	MW04, MW128, MW22, MW38
Zinc	BH01 Fill, BH02 Fill, BH02 SRA, BH03 Fill, BH03 SRA, BH05 SRA, MW04, MW07, MW10, MW109, MW116, MW14, MW20, MW28, MW38, MW46, MW70, MW75, MW79, MW84
Naphthalene	BH01 Fill, BH01 SCD, BH02 SRA, BH02 Fill, BH02 SCD
Malathion	BH01 SCD
pH	BH01 Fill, BH01 SCD, BH01 SRA, BH02 Fill, BH02 SCD, BH02 SRA, BH03 Fill, BH03 SCD, BH03 SRA, BH04 Fill, BH04 SCD, BH04 SRA, BH05 Fill, BH05 SRA, MW02, MW04, MW07, MW10, MW109, MW116, MW118, MW125, MW128, MW14, MW20, MW22, MW28, MW38, MW46, MW70, MW75, MW79, MW84, MW91, MW99
Chloride	BH01 SRA, BH03 SRA, BH04 SRA, BH05 SRA, MW02, MW22, MW70, MW91
Nitrate (as NO3)	BH05 SRA, MW07, MW109, MW118, MW79
Nitrogen (Total Oxidised)	BH01 SCD, BH01 SRA,BH03 SCD, BH03 SRA, BH05 SRA, MW02, MW04, MW07, MW10, MW109, MW118, MW125, MW128, MW79, MW28, MW46, MW75
Ammonia	BH01 Fill, BH01 SCD, BH01 SRA, BH02 Fill, BH02 SCD, BH02 SRA, BH03 Fill, BH03 SCD, BH03 SRA, BH04 Fill, BH04 SCD, BH04 SRA, BH05 Fill, BH05 SRA, MW02, MW04, MW10, MW109, MW116, MW118, MW125, MW128, MW14, MW20, MW22, MW28, MW38, MW46, MW70, MW75, MW79, MW84, MW91, MW99
Nitrogen (Total)	BH01 Fill, BH01 SCD, BH01 SRA, BH02 Fill, BH02 SCD, BH02 SRA, BH03 Fill, BH03 SCD, BH03 SRA, BH04 Fill, BH04 SCD, BH04 SRA, BH05 Fill, BH05 SRA, MW02, MW04, MW10, MW109, MW116, MW118, MW125, MW128, MW14, MW20, MW22, MW28, MW38, MW46, MW70, MW75, MW79, MW84, MW91, MW99
Cyanide (total)	BH03 Fill, BH04 Fill, MW116, MW14, MW75, MW79, MW91, MW99
Reactive Phosphorus (as P)	BH02 Fill, BH02 SCD, BH03 SCD, BH03 SRA, BH04 SCD, BH04 SRA, BH05 SRA, MW02, MW04, MW07, MW10, MW109, MW116, MW125, MW128, MW14, MW20, MW28, MW46, MW75, MW79, MW84, MW91, MW99
Phosphorus	BH01 Fill, BH01 SCD, BH01 SRA, BH02 Fill, BH02 SCD, BH02 SRA, BH03 Fill, BH03 SCD, BH03 SRA, BH04 Fill, BH04 SCD, BH04 SRA, BH05 Fill, BH05 SRA, MW02, MW04, MW07, MW10, MW116, MW118, MW125, MW128, MW14, MW20, MW22, MW28, MW46, MW70, MW75, MW79, MW84, MW91, MW99

A summary of the locations of surface water exceedances per contaminant of concern is presented in Table 11. With the exception of pH all the exceedances were noted to be only in the River-fed Lake.

Table 11: Location of Surface Water Exceedances

Contaminants of Concern	Location
Boron (filtered and unfiltered)	River-fed Lake: SW24, SW35, SW41, SW82, SW62, SW16
Zinc (filtered)	Irrigation Lake: SW88, SW101
pH	River-fed Lake: SW41, SW82, SW16 Irrigation Lake: SW105, SW88, SW68, SW103, SW101
Chloride	River-fed Lake: SW24, SW35, SW41, SW62, SW16
Nitrogen (Total Oxidised)	River-fed Lake: SW24, SW35, SW62
Nitrogen (Total)	River-fed Lake: SW24, SW35, SW62
Phosphorus	River-fed Lake: SW24, SW35, SW62
Dissolved Oxygen	River-fed Lake: SW24, SW35, SW62
Aluminium	River-fed Lake: SW24, SW35, SW62
Iron (total)	River-fed Lake: SW24, SW62

The following sections outline the water management requirements for the purpose of the CSMP.

10.2.2 Potential Environmental Disturbance and Impacts

Due to the known presence of contamination and ASS at site the following impacts to water may result during the Construction Phase of the Project:

- Potential release of acidity and contaminants from stockpile soils into groundwater and the Swan River.
- Potential release of contaminants into groundwater from current *in situ* unsaturated soils becoming saturated due to surcharging activities.
- Potential vertical movement of groundwater from the SRA to the Fill or SCD material due to ground improvement activities, such as surcharging with wick drains and piling..
- Potential for an increase in the mass flux of contamination to the environment and the Swan River due to surcharging activities.
- Potential change in contaminant plume shape and flow direction due to surcharging activities.
- Potential release of contaminants into the air through volatilisation from water.
- Potential mobilisation of groundwater of lesser quality towards areas of dewatering.

10.2.3 Construction Phase Management Objectives, Targets and Performance Indicators

The management objectives, targets and performance indicators relevant to water management at site are outlined in Table 12.

Table 12: Management Objectives, Targets and Key Performance Indicators for Water Management

Management Objectives	Target	Key Performance Indicator
Prevent adverse impacts to sensitive receptors as a result of extracted groundwater	No release of contaminated dewatering effluent to the surrounding environment	Monitoring results as outlined in the DMP (Golder 2013c) and summarised in Table 11
		Site inspection and validation
	Low impact of volatiles from dewatering effluent into the air	Air monitoring results, refer to Project EMP (Golder 2013a)/Lead Contractor's CEMP
Prevent adverse impacts to sensitive receptors as a result of contaminated surface water	No release of contaminated surface water to the surrounding environment	Monitoring results as outlined in the Project EMP/Lead Contractor's CEMP
		Site inspection and validation
Prevent mobilisation of contamination from *in situ* unsaturated soils	Minimise increase in concentrations of contaminants of interest in the groundwater	Weekly groundwater monitoring for the first three months of surcharging activities then re-evaluate
Prevent adverse impacts due to increase in mass flux of contaminants to the environment and Swan River	Minimise increase in mass flux of contamination to the environment and Swan River	Hydraulic gradient calculated via measurements at various groundwater monitoring wells
		Weekly groundwater monitoring for contaminants of concern for the first three months of surcharging activities then re-evaluate

10.2.4 Management Measures

This section outlines management measures to be undertaken by the Lead Contractor(s).

As presented in Section 10.2.1 previous investigations have indicated that ground disturbance may influence groundwater quality in such a way that it may have adverse impacts on the receiving environment. As a result, extracted groundwater from *in situ* or *ex situ* soils must be managed to ensure discharge does not have any adverse impacts on the surrounding environment. All waters collected from excavated contaminated material will need to be included on the MTS as outlined in this CSMP. Any temporary storage of water on site should be within an appropriately bunded area as prescribed in Procedure D (Appendix A).

Additionally, the act of surcharging will alter subsurface conditions such as porosity, geologic stratigraphy and depth to groundwater and therefore the flow direction and mass flux of *in situ* contamination may be affected. Three dimensional (3D) groundwater flow modelling has been undertaken to evaluate the impact surcharging may have on the groundwater flow at site and the potential change in nutrient loading to the Swan River (Golder 2013d). The modelling was based on surcharge (with wick drains) of an approximate 40 000 m^2 area which includes the Stadium playing field and the Irrigation Lake. Results were based on the flow of groundwater across a 240 m long section of the site which borders the Swan River.

The results of the modelling indicate that the current annual nutrient load into the Swan River over the 240 m long section is approximately 136 kg/yr. Following the cessation of irrigation of the golf course the nutrient loading would be reduced by 40% to approximately 83 kg/yr. The modelling indicates that surcharging of an approximate 40 000 m^2 area will expel 75 000 kL of groundwater from the SRA over one year and that approximately 25% will flow into the Fill through the wick drains while 75% will flow into the SCD. This will result in a temporary increase in groundwater towards the Swan River with the peak flow occurring during

the first month however it will decrease to below the initial groundwater flow rate within 3 months of completing placement of surcharge fill and will further decrease due to the effect of ceasing the golf course irrigation.

As the nutrient concentration in the SRA is higher than that of the Fill the surcharging will temporarily increase the nutrient concentrations in the Fill. The nutrient load into the Swan River over the 240 m long section was modelled and showed an increase from 136 kg/yr to an average of 319 kg/yr during the surcharge year. In the year following the surcharge the yearly nutrient load will still be slightly higher (43 kg) than the current load however after two years from the start of surcharging the yearly nutrient load will decrease to below the current load indicating a long-term improvement of nutrient loads into the Swan River.

Particle tracking within the 3D model also found that the groundwater from the SRA which is expelled into the SCD would only have moved a few hundred metres after four years within the SCD and therefore will not have left site. Based on this information nearby receptors are not likely to be impacted and no management of groundwater in the SCD is likely to be required, but this should be confirmed through groundwater monitoring.

The 3D model investigated potential management measures including abstraction via dewatering spears or wells followed by treatment and/or disposal which was found to be feasible and a sheet pile wall which was found to not be effective. However, Golder recommends that revised modelling is carried out during the design phase to optimise the most likely method of abstraction and treatment and/or disposal.

It is important that the groundwater at site is monitored during surcharging activities and during any management measures to ensure that changes in concentrations of potential contaminants and their mass flux to potential receiving environments such as the Swan River are not adversely affected.

The management of water relating to dewatering and excavation of ASS material from within the groundwater level should be done in accordance with Procedure D (Appendix A) and the DMP.

Groundwater management measures not specific to contamination are outlined in the Project EMP (Golder 2013a).

10.2.5 Monitoring Procedures

This section outlines monitoring procedures to be undertaken by the Lead Contractor(s). As mentioned in the above section, the DMP and Procedure D (Appendix A) - Dewatering Management and Monitoring of Water Quality should be used to assist with appropriate management of effluent at the site. Where appropriate, collection of samples should be undertaken as per the Sampling and Analysis Plan (SAP) (Golder 2012c) for the DSI (Golder 2013b).

10.2.5.1 Dewatering Discharge

Field monitoring of groundwater discharge is to include the following:

- Flow meters will be installed on all dewatering discharge streams to record discharge rates and cumulative volumes and read daily.
- pH, electrical conductivity, total titratable acidity (TTA) and total alkalinity will be measured in the field once per day, pre and post any treatment (if required) during the dewatering operations.
- Metals, nutrients, PAHs and organochlorine and organophosphate pesticides which were identified as contaminants of concern based on results of the DSI (2013b) and location of the dewatering being undertaken.

If groundwater is found to be contaminated treatment on site and/or disposal off-site is required and should be undertaken as discussed in the DMP (Golder 2013c). Water requiring discharge to the Swan River, the River-fed Lake must be below the trigger values outlined in Table 13. Water requiring discharge on site via infiltration or overland discharge (including irrigation or dust suppression) should meet relevant concentrations in relevant guidelines such as the DER's Freshwater and Marine Water levels and nutrients

must be treated to site baseline levels (calculated using the geometric mean as 4 mg/L for total nitrogen and 0.12 mg/L for total phosphorus) identified during the DSI (Golder 2013b) as a minimum.

Table 13: Summary of Trigger Values for Discharge to the Swan River and the River-fed Lake

Parameter	Trigger Value (SRT 2012)
Total nitrogen	1 mg/L
Total phosphorus	0.1 mg/L
Total iron	>1 mg/L
Dissolved aluminium	>150 µg/L
Total aluminium	>1.0 mg/L
TTA (Acidity)	>40 mg/L
Odours and colours	No objectionable odours or visible colour changes in the receiving water
Floatable matter	No visible floating oil, grease, scum, little or other objectionable material
Settleable matter	No deposits which adversely affect the recreation and ecosystem values of the receiving waters
Turbidity	Not to vary more than 10% from the baseline level (in the receiving environment) or cause a visible reduction in light penetration of receiving waters
Temperature	Not to vary more than 2°C from the baseline level (in the receiving environment)
Salinity	Not to vary more than 10% from the baseline level in the receiving environment
Dissolved Oxygen	<80-90% stable saturation
pH	Not vary more than 1 pH unit from the baseline level of the receiving environment
Toxins and broader water quality analytes such as the following contaminants of concern: Pesticides, PAHs and PCBs	ANZECC 95% protection trigger values. In the absence of estuarine guidelines, the lowest of either the freshwater or marine guidelines levels should be applied.
Winter discharge rates	Provided the water quality criteria have been met, rates up to 30 L/s can be discharged during winter
Summer discharge rates	Rates greater than 3.9 L/s should not be discharged during summer (assuming the water quality criteria have been met)

The DMP indicates that weekly or fortnightly sampling for laboratory analysis of the dewatering discharge is required and must not exceed trigger values. Proposed analytes are listed in Table 14.

Table 14: Required Analytes for Laboratory Suite for Dewatering Effluent

Type	Analyte
Inorganics	total acidity, total alkalinity, pH, EC, TDS, TSS, hydrogen sulfide*
Major Ions	Cl, Na, SO_4
Dissolved Metals	Al, Fe, Mn
Total Metals	arsenic, boron, cadmium, chromium, copper, nickel, lead, zinc, aluminium, selenium, iron, mercury, molybdenum, manganese, tin
Nutrients	Ammoniacal nitrogen, total nitrogen, reactive phosphorous, total phosphorus
Contaminants of Concern	PAHs (including naphthalene) and organochlorine and organophosphate pesticides

* Only needed when discharging to the stormwater system

10.2.5.2 Groundwater

During dewatering and surcharging activities monitoring of groundwater in the surrounding area must be undertaken as outlined in the DMP (Golder, 2013c). This includes groundwater monitoring prior, during and after dewatering and surcharging activities. A monitoring network of groundwater wells will be established throughout the site. Existing groundwater monitoring well locations are illustrated in Figure 6. These wells can be used for future groundwater monitoring where practicable, however a monitoring network of groundwater wells will be established throughout the site by the Lead Contractor which will likely include a series of groundwater wells installed along the eastern side of the River-fed Lake. This is to monitor groundwater for contamination and enable appropriate management and mitigation measures to be implemented to prevent contaminated groundwater from flowing into the western lake (the River-fed Lake) and the Swan River. A minimum requirement will be the monitoring of wells MW02, MW22, MW38, MW70, MW84, MW99, MW125 and MW128 as these wells are located downgradient of the development area. Monitoring of groundwater between the surcharging area and the River-fed Lake will also be required and can consist of BH03-Fill, BH03-SRA and BH03-SCD or other monitoring wells installed by the Lead Contractor if it is not feasible to retain these monitoring locations. It is recommended that the Lead Contractor attempt to maintain as many of the current monitoring wells as possible during the Construction Phase of the Project.

The final monitoring network will be dependent on the nature and extent of dewatering, including any dewatering associated with the abstraction and treatment/disposal of groundwater expelled from the SRA to the Fill material during the surcharging activities. A preliminary suggestion of monitoring locations and frequency is presented in Table 16. It should be noted that these locations are subject to change based on any further modelling or information pertaining to a final design of the abstraction and treatment/disposal during surcharging activities to be prepared by the Lead Contractor for approval by SP and the Auditor. It is also advised that the ASS groundwater suite of analyses are scheduled on a number of these monitoring wells to better understand the existence of potential acid generation as a result of excavation and surcharging activities. Further information is provided in Procedure D (Appendix A) and the DMP (Golder 2013c), mentioned above.

56,400 56,600 56,800 57,000 57,200 57,400

264,000 263,800 263,600 263,400 263,200

N

MW04 MW07 MW10 MW02 MW20 MW22 POND2 POND3 MW28 MW14 GABH24 BH01 BH01 BH01 MW46 River-fed Lake MW75 MW38 MW70 BH02 BH02 BH02 BH06 MW79 BH05 BH05 BH03 BH03 BH03 BH07 MW91 Irrigation Lake MW84 MW109 POND1 MW99 MW99A MW118 BH08 MW116 BH04 BH04 BH04 MW23 MW30 MW125 Lake 11 MW128 Lake 3 Lake 10

LEGEND

- Monitoring well
- Project area

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Aerial imagery © Nearmap (2012).

0 50 100 150

Metres

SCALE (at A3) 1:3,500

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-041-R-Rev1
DATE	23 Jul 2014
COMPILED	JRP/LD/GGW/MS
APPROVED	IYK

New Perth Stadium CSMP

GROUNDWATER MONITORING WELL LOCATIONS

FIGURE 6

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R41\Rev1\117643077-041-R-F006-Rev1.mxd

The required laboratory suite analytes for groundwater monitoring is outlined in Table 15. Field monitoring should commence one week prior to start of surcharging and/or dewatering and continue throughout the surcharging and/or dewatering period until one week after completion.

If the dewatering ceases due to unforeseen events for a period of less than 14 days, measurement of groundwater level should continue during this period. If the dewatering hiatus is greater than 14 days, the groundwater level monitoring could cease during this period.

Groundwater samples should be collected from the monitoring wells prior to commencement of dewatering activities, and then at fortnightly intervals during the dewatering operation depending on the dewatering duration.

Where appropriate, collection of samples should be undertaken as per the SAP (Golder 2012c) for the DSI (Golder 2013b).Table 15: Required Analytes for Laboratory Suite for Groundwater

Category	Parameters
Field parameters	Groundwater level, pH, electrical conductivity, total titratable acidity and total alkalinity
Miscellaneous parameters	total acidity, total alkalinity, pH, total dissolved solids, turbidity
Major ions	Cations: calcium, magnesium, sodium, potassium Anions: chloride, sulfate, bicarbonate, sulfide
Dissolved metals	arsenic, boron, cadmium, chromium, copper, nickel, lead, zinc, aluminium, selenium, iron, mercury, molybdenum, manganese, tin
Total metals	arsenic, boron, cadmium, chromium, copper, nickel, lead, zinc, aluminium, selenium, iron, mercury, molybdenum, manganese, tin
Nutrients	ammonia as N, total nitrogen, total oxidised nitrogen, reactive phosphorous, total phosphorous
Contaminants of Concern	PAHs (including naphthalene) and organochlorine and organophosphate pesticides

The guidance trigger levels employed for groundwater are the:

- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000a)
- *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* (Department of Health, 2011)
- National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Long-term Irrigation Water Protection* (ANZECC/ARMCANZ, 2000b).

Appendix B contained within the Project EMP (Golder, 2013a) outlines the values of the guidance trigger levels as per the guidance material listed above.

As per DER guidelines, where locally or national criteria are not available, Section 1.2 of the DERs document "*Assessment Levels for Soil, Sediment and Water*" provides a mechanism for sourcing alternative guidelines. If contaminants of potential concern are encountered or detected and no local or national guideline exists, then alternative values will be sought in line with DER guidelines.

The groundwater sampling should be carried out by an experienced groundwater professional or environmental scientist in accordance with Australian sampling standards and using appropriate low flow sampling methods.

10.2.5.3 Other Monitoring

The 3D Groundwater modelling undertaken by Golder has indicated that surcharging activities will temporarily raise the groundwater elevation in the immediate area and increase the hydraulic gradient between the site and the Swan River. The Lead Contractor is required to minimise impacts on the Swan River and the River-fed Lake from this increase in hydraulic gradient. Groundwater modelling results have found that an increase in nutrient loading to the Swan River will occur in the first year of the surcharging activities and an abstraction and treatment/disposal system is recommended as a mitigation measure. Vertical mobilisation of groundwater from the SRA to the Fill will occur with further horizontal mobilisation of nutrients towards the Swan River and it is likely that the River-fed Lake will intercept a portion of this groundwater flow. Therefore the River-fed Lake will also require monitoring during surcharge activities.

A summary of recommended locations which should be considered for monitoring of groundwater and surface water quality as part of the surcharge activities is presented in Table 16. Groundwater monitoring well locations are illustrated in Figure 6. Additional locations will likely be required if dewatering is undertaken. These locations will be dependent on the location and volume of dewatering that is required.

Table 16: Water Monitoring Schedule

Name	Location
SW62	River-fed Lake
SW41	River-fed Lake
SW24	River-fed Lake
BH03-Fill	east of the River-fed Lake
BH03-SRA	east of the River-fed Lake
BH03-SCD	east of the River-fed Lake
MW02	north of the River-fed Lake
MW22	west of the River-fed Lake
MW38	west of the River-fed Lake
MW70	west of the River-fed Lake
MW84	west of the River-fed Lake
MW99	south of the River-fed Lake
MW125	South-west corner of site
MW128	South-west corner of site (Aurora well)

The artificial irrigation lake located in the centre of the site (the Irrigation Lake) will be drained and in-filled in preparation for site works. The Irrigation Lake is currently filled with groundwater extracted beneath the site for irrigation purposes. The DSI investigation (Golder, 2013b) found that groundwater within this lake was not contaminated and was significantly fresher than water in the River-fed Lake. Water from the Irrigation Lake is suitable to be consumed through irrigation prior to the required in-filling work; therefore, no monitoring will be required.

Further information regarding water management is detailed in the DMP (Golder, 2013c) for the site.

10.2.6 Contingencies

Potential contingency actions for managing key performance targets which are not achieved are outlined in Table 17. The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0 of the Project EMP (Golder, 2013a)) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor where required, by Section 15.0 of the Project EMP (Golder, 2013a).

Table 17: Contingency Actions for Water Management Plan

Trigger	Potential Actions
Water from stockpiles impacts on sensitive receptors negatively.	■ Confirm that risk assessment is still valid ■ Contain spill area and alter stockpile bund design accordingly to prevent from reoccurring
Monitoring indicates elevated vapours from dewatering effluent impact on sensitive receptors negatively	■ Ensure that health and safety measures for on-site workers are suitable. ■ Stop activities or move upwind until wind conditions are favourable to minimise risk to sensitive receptors ■ Evaluate vapour risk to nearest downwind sensitive receptor ■ Seek alternative on-site water storage methodology or have water removed off-site
Surcharging activities result in mobilisation of contamination in groundwater	■ Determine extent of contamination mobilisation (contaminants, concentration, potential source) ■ Confirm that a potential risk to a sensitive receptor exists ■ SP to inform DER and other relevant regulatory agencies (if required) and the Contaminated Sites Auditor of impacts as well as mitigation measures applied ■ Implement contingency mitigation measures
Contaminated surface water discharged to the surrounding environment	■ Confirm that risk assessment is still valid ■ Stop pathway of contaminated water to the surrounding environment ■ Stop the source of contamination
Groundwater quality in exceedance of trigger values Table 13	■ A groundwater specialist is to review groundwater monitoring results. ■ Increase monitoring frequency (i.e. weekly laboratory analysis or inclusion of additional analytes to be tested). ■ Additional strategically placed monitoring wells may be required to be installed and monitored in accordance with the revised monitoring schedule to gain a better understanding of the cause. ■ Identify source of water quality change. ■ Implement actions outlined in the DMP. ■ If the change is due to activity that can be modified, remove the cause as appropriate. This may include further optimising the rate of groundwater extraction.
Groundwater quality monitored in the groundwater wells east of the River-fed Lake is identified as being in exceedance of trigger values Table 13	■ Assess validity of risk assessment. ■ If ecological risk is considered unacceptable, consider options such as interception of groundwater via trench and pumping for preventing groundwater from entering the River-fed Lake.

If the above points do not resolve the issues SP is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities such as DER and SRT within a timely manner.

10.3 Air Management Plan

Air quality will be managed during the Construction Phase of the Project according to this CSMP, the Project EMP (Golder, 2013a) and the Lead Contractor's CEMP.

10.3.1 Current Understanding

The DSI (Golder, 2013b) undertaken at the site included the collection of ground gases from monitoring wells across the site and are presented in Figure 7. In total six rounds of ground gas monitoring was undertaken. Ground gas flow rates were not detected at any gas well using a bubble flow meter apparatus during six rounds of monitoring with the exception of a 3 millilitres per minute (mL/min) flow measured in well LGSB117. A Magnehelic® gauge (0 to 60 Pa) detected low pressures in 62 of the 84 ground gas wells. Pressure measured using the Magnehelic® gauge ranged from 1 to a maximum of 20 Pa in Well LGSB117.

The investigation identified 17 monitoring well locations with concentrations of combustible gas above the trigger value of 25% Lower Explosive Limit (%LEL) and 14 with concentrations greater 100 %LEL. Carbon dioxide concentrations ranged from 0 to 50% with concentrations greater than 5% detected at 46 of the 84 wells monitored over the six rounds. Oxygen concentrations ranged from 0.3 to 21% and were generally lowest where elevated concentrations of methane were observed. Carbon monoxide concentrations ranged from 0 to 4 ppm. Several wells contained low hydrogen sulfide concentrations ranging from 1 to 4 ppm and one well (LG59) contained hydrogen sulfide concentrations ranging from 8 to 11 ppm.

No volatile organic compounds were measured in concentrations above relevant guideline values.

Table 18: Summary of Well Locations with Concentrations Greater Than Trigger Value

Trigger	Location
Wells containing combustible gas concentrations >25% LEL	LGSB32, LG37, LG44, LG49, LGSB50, LGSB55, LG58, LG59, LG64, LGSB67, LGSB69, LG74, LG76, LG87, LG89, LGSB97, LGSB110
Wells containing combustible gas concentrations >100% LEL or 5% gas	LGSB32, LG37, LG44, LG49, LGSB50, LGSB55, LG58, LG59, LG64, LGSB67, LGSB69, LG74, LG76, LGSB97

Based on the results of the Gas Screening Values calculations, it can be concluded that the recorded methane and carbon dioxide concentrations present a low risk (in accordance with CIRIA C665) to the site use and surrounds in its current configuration. It is also considered that carbon monoxide and hydrogen sulphide concentrations pose a low risk.

In accordance with CIRIA C665 guidance, the ground gas risk assessment indicates that some risk mitigation measures should be considered for the construction of the Stadium. In addition, Golder considers that due to the potential of enclosed spaces in the Stadium (change rooms, cleaners cupboards or chemical storage rooms etc.) that gas mitigation measures be adopted. Based on CIRIA C665, a *Characteristic Situation 2 or 3* requires two levels of protection. The details of ground gas protection will need to be developed by the Stadium Contractor in line with the principles outlined in CIRIA C665 and in agreement with the Contaminated Sites Auditor.

LEGEND

- LG: Ground gas monitoring well
- LGSB: Soil bore converted into ground gas monitoring well
- Project area

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Aerial imagery © Nearmap (2012).

0 50 100 150
Metres

SCALE (at A3) 1:3,500

Golder Associates

CLIENT	Public Transport Authority
DOCUMENT	117643077-041-R-Rev1
DATE	23 Jul 2014
COMPILED	MS
APPROVED	IYK

New Perth Stadium CSMP

GROUND GAS MONITORING LOCATIONS

FIGURE 7

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\117643077\Projects\R41\Rev1\117643077-041-R-F007-Rev1.mxd

10.3.2 Potential Environmental Disturbance and Impacts

The identified potential sources of air quality impacts related to contaminated sites management during the Construction Phase of the Project are as follows:

- An increase in airborne dust generated from potentially contaminated material (may include asbestos) to the environment due to:
  - clearing of flora and vegetation exposing dust which can potentially become airborne with favourable wind conditions
  - project construction and excavation operations which may include stockpiling of material on site
  - the transportation and loading/unloading process of excavated landfill material, fill and other sand
  - on-site vehicle movements on unsealed roads.
- Dust (particulate) emissions may be generated as a result of earthwork activities, particularly during dry, windy conditions. Excessive dust generation may be detrimental to human health, reduce visual amenity as well as smother vegetation and impact fauna.
- Vapours or odours generated from dewatered contaminated groundwater and excavations.
- Ground gas emissions due to the disturbance of landfill material *in situ* at site.

10.3.3 Construction Phase Management Objectives, Targets and Performance Indicators

The contaminated site management objectives, targets and performance indicators relevant to air quality are outlined in Table 19.

Table 19: Air Quality Management Objectives, Environmental Targets and Performance Indicators

Management Objectives	Target	Performance Indicator
Minimise the impact of temporary dust and vapour emissions from the site works	Minimise visible dust crossing the boundary of the site	Visual inspections and reporting
	Minimise observed or monitored impacts or exceedances off-site	Visual inspections and reporting
		Monitoring results as per the Project EMP (Golder, 2013a)
		Environmental Complaint and Incident Register
Minimise the effect of dust on the surrounding land uses	No dust complaints from surrounding land uses	Environmental Complaint and Incident Register
Minimise the potential from generation of dust from landfill material containing asbestos	Minimise airborne asbestos	Monitoring results as per the Project EMP (Golder, 2013a)
Minimise the impact of landfill gases on sensitive receptors	Minimise exposure of sensitive receptor to landfill gas	Monitoring results as per the Project EMP (Golder, 2013a)

10.3.4 Management Measures

Management measures to be taken by the Lead Contractor(s) to minimise impacts to air quality during the Construction Phase are:

- Reduce dust emissions generated by the Construction Phase by operating water carts spraying dust prone surfaces to suppress dust. A minimum of two water carts are required for the site and are to be operating continuously on days likely to generate airborne dust, based on seasonal data, weather monitoring results and types of activities being undertaken. The use of water for dust suppression activities must take into consideration the possibility of generating leachate from contaminated material or ASS and therefore over saturation of the material must not occur.
- Development and implementation of an air quality monitoring programme (including requirements for both public and occupational monitoring) based on the content of this Project EMP (Golder, 2013a). This program should be implemented by a suitably qualified professional.
- Procurement of well maintained, industry standard and fuel-efficient vehicles and plant to reduce the use of machinery causing emissions of greenhouse gases.
- Undertake appropriate and regular vehicle and plant maintenance to avoid excessive greenhouse gases and air emissions.
- Management of asbestos and potential emission of asbestos fibres to air due to construction works adhering to the site's Occupational Health and Safety Procedure as developed by the Lead Contractor taking into consideration the *Occupational Safety and Health Act 1984* , the results of the DSI and the Contaminated Site Management Plan.
- Daily monitoring of weather conditions to ensure unfavourable activities (e.g. excessive dust and/or odours) are undertaken during suitable weather conditions or suitable controls can be put in place, ensuring that odours are kept away from residents and other users of the surrounding area.
- Implementation of an education program as part of the inductions to educate all personnel on the importance of air quality management measures.
- Implementation of any specific conditions applied to the Project by the relevant regulatory agencies.
- Based on the DSI results the site has a *Characteristic Situation 2 or 3* and requires two levels of protection (CIRIA C665). The details of ground gas protection will need to be developed by the Stadium Contractor in line with the principles outlined in CIRIA C665 and in agreement with the Contaminated Sites Auditor.

10.3.5 Monitoring Procedures

This section outlines monitoring to be undertaken by the Lead Contractor(s).

Air quality will be monitored in line with the requirements outlined in the Project EMP (Golder, 2013a) and requires that the following work may be required to be undertaken during the Construction Phase of the Project:

- Air quality monitoring by a qualified specialist via permanent air quality monitors at the boundary of the premises or at nearby sensitive receptors.
- Asbestos monitoring by a suitably qualified specialist.
- Regular ground gas monitoring by a suitably qualified specialist via permanent ground gas monitors to evaluate the presence of ground gas and manage related greenhouse gas, odour and safety issues.

- Localised ground gas monitoring such as a portable continuous sampling device mounted on equipment near open holes or excavations.
- Monitoring of local meteorological conditions such as wind speed, wind direction and atmospheric pressure.

Where appropriate, collection of samples should be undertaken as per the SAP (Golder 2012c) for the DSI (Golder 2013b).

10.3.6 Contingencies

Potential contingency actions for managing key performance targets which are not achieved are outlined in Table 20. The Lead Contractor(s) has responsibility for the implementation of contingency actions, is to notify SP within the allocated timeframe (refer Section 15.0 of the Project EMP (Golder, 2013a)) and shall document the event as a non-conformance. SP will inform the Contaminated Sites Auditor where required, by Section 15.0 of the Project EMP (Golder, 2013a).

Table 20: Contingency Actions for Air Quality Management

Trigger	Potential Actions
Portable ground gas levels in excess of the time weighted average (TWA): ■ 10 ppm hydrogen sulfide ■ 5000 ppm carbon dioxide ■ 25% Lower Explosive Limit (LEL) of methane	■ Stop work activity in the area of excess gas levels. ■ Check that source of emissions is from the open hole or excavation in place of a secondary source such as vehicle exhaust fumes. ■ Evaluate the concentrations against the Short Term Exposure Limits* (STEL) for hydrogen sulphide and carbon dioxide, and against the 25% LEL trigger level for methane. ■ Should concentrations exceed STELs or the methane trigger, evacuate the work area and allow gases to dissipate. ■ Reassess gas concentrations after a minimum duration of 10 minutes. ■ If gas concentrations persist above STELs or the methane trigger implement the appropriate emergency incident response procedures
Permanent ground gas level in excess of 500 ppm	■ Confirm elevated concentrations of ground gas ■ Stop work activity in the area of excess gas levels ■ Implement appropriate emergency evacuation procedures ■ Implement the appropriate emergency incident response procedures
Visible dust generated from potentially contaminated material	■ Increase dust mitigation measures as outlined in the Project EMP (Golder, 2013a) ■ Stop work activity in area impacted by visible dust ■ Wait until wind conditions improve
Airborne concentrations of asbestos above recommend concentration	■ Stop work ■ Identify source of airborne asbestos ■ Increase dust mitigation measures as outlined in the Project EMP (Golder 2013a) and in line with the Lead Contractors CEMP ■ Wait until wind conditions improve ■ Remove source to an off-site locations

*STEL is the acceptable average exposure over a short period of time and values for each chemical can be sourced from WorkSafe's Hazardous Substance Information System (HSIS) website.

If the above points do not resolve the issues SP is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.4 Reporting

Records shall be kept by the Lead Contractor(s) in relation to management measures, monitoring results and contingency actions that are implemented, including the date, specific details (e.g. when exceedance of trigger value occurred and for what period) and justification (e.g. monitoring data shows exceedance of criteria). Records and results should be retained for up to five years by the Lead Contractor(s) and be provided to SP as it requests, including for inspection or reporting on request by stakeholders.

Accurate records of any stockpile volumes and their duration on site shall be maintained by the Lead Contractor(s) in the MTS to ensure stockpiles are not on site for greater than three days after receipt of analytical results. Photographs of stockpiles of potentially contaminated material will be taken by the Lead Contractor(s) to show their condition throughout the construction period. Records will also be kept by the Lead Contractor(s) of all soil management strategies or contingency actions that are implemented, including the date, locations and justification for any management implemented.

All non-conformances with the CSMP should be managed as per Section 15.0 of the Project EMP (Golder 2013a).

After completion of site works, the Lead Contractor(s) must include the following information outlined in Table 21 in an Environment Completion Compliance Report to SP.

Table 21: Construction Phase Reporting Requirements

Factor	Information to be Included in Closure Report
Soil	■ results of any monitoring data ■ details of management measures undertaken at the site ■ summary of the amount of contaminated soil removed off-site as per the MTS ■ effectiveness of the management strategies and controls implemented at the site ■ any potential risks to sensitive receptors, the environment or human health which may have occurred ■ evidence of any non-conformances during site works
Water	■ results of any monitoring data ■ details of management measures undertaken at the site ■ summary of the amount of contaminated water removed off-site as per the MTS ■ effectiveness of the management strategies and controls implemented at the site ■ any potential risks to sensitive receptors, the environment or human health which may have occurred ■ evidence of any non-conformances during site works
Air	■ results of any monitoring data ■ details of management measures undertaken at the site ■ effectiveness of the management strategies and controls implemented at the site ■ any potential risks to sensitive receptors, the environment or human health which may have occurred ■ evidence of any non-conformances during site works

11.0 IMPLEMENTATION OF THE CSMP FOR THE OPERATIONAL PHASE

This section contains separate management plans for soil, water and air to be implemented during the Operating Phase of the Project to manage contamination. It is possible that these items could be managed under the umbrella of an Environmental Management System Manual. Each respective management plan section recommends management measures and some monitoring procedures if deemed necessary.

11.1 Soil Management Plan

Intrusive work should not occur on site without the approval from the Operating Phase Lead Contractor. If intrusive work is to take place, this work will need to be evaluated and appropriate measures be in place including the preparation of a Soil Management Plan and Job Hazard Assessment (JHA) to be revised by a suitably qualified environmental practitioner if deemed necessary.

11.2 Water Management Plan

11.2.1 Groundwater

Abstraction of groundwater from the fill material should not be undertaken at any time. Groundwater from deeper formations is permitted for irrigation purposes only (with the appropriate valid licence from Department of Water). Irrigation water should be tested by the Operating Phase Lead Contractor for known contaminants of interest on a biannual basis. Where appropriate, collection of samples should be undertaken as per the SAP (Golder 2012c) for the DSI (Golder 2013b).

Dependent on results of monitoring during the Construction Phase, groundwater monitoring may be required to continue into the Operating Phase to continue monitoring the potential impacts or long term improvements of the Project.

11.2.2 Surface Water

The design of the proposed Project includes the retainment of the River-fed Lake and the Project EMP (Golder, 2013a) has highlighted that the River-fed Lake will be rehabilitated as part of the Lead Contractor's Rehabilitation Management Plan. In the first two years following the completion of the Project the River-fed Lake will undergo biannual monitoring (summer and winter) to ensure no ongoing contamination issues exist. After three years and based on the results from the monitoring and feedback from the Contaminated Site Auditor, ongoing monitoring may no longer be required. Where appropriate, collection of samples should be undertaken as per the SAP (Golder 2012c) for the DSI (Golder 2013b).

11.3 Air Management Plan

With respect to outdoor air quality in relation to ground gases, once groundcover is established on-site ongoing air monitoring is not required during the Operating Phase of the Project.

Design and installation of ground gas mitigation measures will be included as part of the construction phase of the project. However, once construction has been completed an indoor air monitoring programme should be developed and implemented to ensure that the mitigation measures are effective. A Sampling and Analysis Plan for the monitoring of indoor air will be required and implemented during the Operating Phase until it is deemed no longer necessary.

11.4 Reporting

Until the site is reclassified a brief letter/report should be submitted on a yearly basis to the Contaminated Sites Auditor and DER by the Lead Contractor. The letter should detail:

- results of any monitoring undertaken during the year
- results of any investigations or remediation undertaken to address the classification of the site
- effectiveness of the management strategies and controls implemented at the site

- any potential risks to sensitive receptors, the environment or human health which could occur or may have already occurred.

12.0 AUDITS AND INSPECTIONS

Throughout the Construction Phase the site will be subject to internal and external audits and inspections as outlined in the Project EMP (Golder, 2013a). The purpose of the audits and inspections in relation to contamination are to:

- assess the environmental site conditions
- assess compliance of the CSMP as well as related management plans
- assess compliance to relevant licence conditions
- assess compliance of contaminant issues included on the Construction Environmental Inspection Checklist (included in the Project EMP (Golder, 2013a))
- review of the monitoring of key performance indicators outlined in the individual management plans
- review of relevant documentation which includes the Environmental Complaints and Incident Register
- review of the previous inspection Construction Environmental Inspection Checklists.

13.0 MANAGEMENT OF NON-CONFORMANCES, ENVIRONMENTAL INCIDENTS AND PUBLIC COMPLAINTS

A non-conformance and environmental incidents management procedure has been developed as part of the Project EMP (Golder 2012a) and should be followed if one of the following occurs:

- A breach or non-conformance of statutory requirements or procedures which have been prescribed in the Project EMP, CEMP(s), CSMP or DMP.
- An exceedance of trigger values or a failure to meet performance metrics which have been detailed in the individual management plans.
- A breach or non-conformance of relevant licence conditions.
- A breach or non-conformance of environmental management procedures applied to the Project by SP.

All non-conformances with the CSMP should be managed as per Section 15.0 of the Project EMP (Golder 2013a).

13.1 Public Complaint Management

If deemed to constitute an environmental incident complaints received by the public, in relation to impacted sensitive receptors or the environment are to be recorded and actioned as per the Public Complaint Management Section 15 of the Project EMP (Golder 2013a),

14.0 TRAINING

Contaminated site inductions shall be provided by the Lead Contractor's Environmental Representative, or delegate, to all site personnel involved in the Project prior to commencing work. The required content of the environmental induction is outlined in the Project EMP (Golder, 2013a), but shall also include the:

- Purpose and objectives of the CSMP and the associated environmental management plans.
- Health and safety requirements associated with dealing with potentially contaminated materials.

- Roles and responsibilities of personnel on site, under the environmental management procedures contained within the preliminary CSMP.

During the Operating Phase site personnel should be made aware that the site is a contaminated site under the *Contaminated Sites Act 2003*. Personnel are to be made aware that groundwater abstraction and intrusive work is not to be undertaken without approval from the Operating Phase Lead Contractor.

15.0 ENVIRONMENTAL DOCUMENTATION

The Lead Contractor's Environmental Representative will be responsible for issuing documentation (including the CSMP) to site personnel and maintaining an inventory of documentation distribution. They will also be responsible for ensuring all document holders receive any updates to the documents.

The Operating Phase Operations Manager will be responsible for issuing documentation to site personnel and maintaining an inventory of documentation distribution. The Operating Phase Operations Manager will also be responsible for ensuring all document holders receive any updates to the documents.

16.0 REFERENCES

ANZECC/ARMCANZ. (2000a). National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

ANZECC/ARMCANZ. (2000b). National Water Management Australian and New Zealand Environment Conservation Council Strategy *Australian and New Zealand Guidelines for Long-term Irrigation Water Protection* (ANZECC/ARMCANZ, 2000).

Department of Environment and Conservation. *Assessment Levels for Soil, Sediment and Water (Version 4, Revision 1),* February 2010

Department of Health (DOH). (2011). *Guidelines for the Non-potable Uses of Recycled Water in Western Australia.* Department of Health, Perth, W.A.

GHD Pty Ltd (2007). Burswood Peninsula Redevelopment, Preliminary Environmental Impact Assessment

Golder Associates (2012a). Conceptual Design of Ground Improvement, Preconstruction Site Works, Proposed New Perth Stadium and Sports Precinct, Burswood (127642088-001-R-Rev0), September 2012.

Golder Associates (2012b). Preliminary Site Investigation Report, Proposed Perth Major Stadium (117643077-005-R-Rev1), May 2012.

Golder Associates (2012c). Sampling and Analysis Plan and Data Quality Objective, Environmental Investigation Proposed Perth Major Stadium (117643077-005-R-Rev3) July 2012.

Golder Associates (2013a). New Perth Stadium Project Environmental Management Plan (117643077-036-Rev0), July 2013.

Golder Associates (2013b). New Perth Stadium Stage 1 Detailed Site Investigation Interpretive Report (127643056-010-R-Rev0) July 2013.

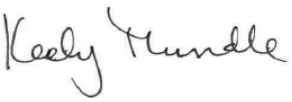
Golder Associates (2013c). Dewatering Management Plan, New Perth Stadium (117643077-040-R-Rev0) July 2013.

Golder Associates (2013d). New Perth Stadium Groundwater Modelling Report (127643056-029-R-Rev1) July 2013.

Swan River Trust (SRT) (2012). Disposal of Dewatering Effluent in the Swan Canning Catchment, Draft Discussion Paper, May 2012.

Report Signature Page

GOLDER ASSOCIATES PTY LTD



Keely Mundle
Senior Environmental Engineer

Ivan Kwan
Associate, Principal Environmental Engineer

KM-RW/IYK/eh

Endorsed

Public Transport Authority Environmental Manager

Endorsed

Manager Planning, Department of Treasury Strategic Projects

Approved

Principal Project Director, Strategic Projects,

A.B.N. 64 006 107 857

\\pth1-s-file01\jobs\env\2011\117643077 - pta desktop review burswood\correspondence out\041 - csmp\rev1\117643077-041-r-rev1-csmp.docx

APPENDIX A

Management Procedures

1.0 GENERAL

The procedures outlined below are provided for the identification of ASS materials which may be disturbed during excavations at the site.

2.0 OBJECTIVES

- Correct identification of ASS materials.
- Correct identification of suspected ASS.
- Comply with conditions of licences, permits or other approvals issued for the project.

3.0 STATUTORY REQUIREMENTS AND GUIDELINES

- Environmental Protection Act, 1986
- Treatment and management of soils and water in acid sulfate soil landscapes. Perth, Western Australia: Department of Environment and Conservation, 2011
- Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes. Perth, Western Australia: Department of Environment and Conservation, 2009.

4.0 IDENTIFICATION OF ASS

ASS materials identified on-site are described as:

- Fill: SAND
- Fill: WASTE
- CLAY/Silty CLAY/Sandy CLAY/SAND

Any material meeting the descriptions above should be considered as suspected ASS and should be stockpiled separately until assessed.

Where the suspected ASS materials are within 0.5 m of the ground surface and are above the water table, they may be moved without further assessment as long as they remain in the same environment.

Thus, all materials disturbed during construction works should be considered ASS, however, non-putrescible building rubble and steel structures identified within the waste fill material should not be regarded as ASS, but should be regarded as contaminated material. A detailed decision tree for the process for management and treatment of the excavated material and the final selection of the required Class landfill for disposal is included in Procedure B (Appendix A) and should be referred to.

4.1 Training

Equipment operators and supervisors shall be trained in the basic recognition of ASS as part of induction training. An experienced ASS practitioner shall be appointed to conduct site inspections and assist in the identification of ASS on an as required basis.

4.2 Soil Handling

Accurate records of materials movement shall be kept with respect to volumes excavated, material description, origin and destination, and date excavated. Information relating to information records is detailed in the Materials Transport System (MTS) in Section 6.0 of this CSMP.

4.3 Screening

Field screening was not a useful tool for identifying ASS at the site as there was little correlation between ASS risk and the results. The presence of ASS should be done based on material description and proximity to groundwater (refer to Section 4.0).

All materials disturbed above the groundwater fluctuation zone during construction works should be considered non-ASS, and may be placed in a similar environment (e.g. above the groundwater zone) without active management.

4.4 Auditing

An experienced Contaminated Land and ASS practitioner shall make weekly site inspections during at least the first 6 weeks of commencing works. The frequency of inspections required following this initial inspection period would be reviewed based on specific requirements of the excavation works.

In addition to regular site inspections, an experienced practitioner shall be available "on call" to provide technical assistance, as required.

5.0 PERFORMANCE INDICATORS

Item	Performance Indicator
Identification of ASS units	■ Inspections conducted by suitably qualified person ■ ASS units identified correctly ■ All contractors responsible for identification of ASS have received appropriate training
Soil handling	■ ASS (or suspected ASS) has been stockpiled separately from non-ASS material ■ Contaminated material stockpiled separately from non-contaminated material ■ Accurate material movement records kept according to MTS
Non-conformance	■ All non-conformances are reported and rectified

6.0 MONITORING AND REPORTING

The Lead Contractor's Construction Manager shall keep a record of all equipment operators and supervisors who are trained in the basic recognition of ASS as part of induction training.

The Lead Contractor's Construction Manager and experienced ASS practitioner shall maintain a record of inspections. A summary report of all inspections shall be compiled by the Contractors Site Manager each month and be submitted to the Superintendent.

The Lead Contractor's Construction Manager shall maintain a register of all test results.

The Lead Contractor's Construction Manager shall maintain a register of all material movement.

1.0 GENERAL

The procedures outlined below are provided for the management of contaminated material and ASS excavated on site and removal of the material to an approved licensed treatment and disposal facility.

2.0 OBJECTIVES

- Appropriate management of stockpiles on-site.
- Stockpile relevant contaminated material and ASS on site on appropriately constructed bunds.
- Remove relevant contaminated material and ASS to an approved licensed treatment and disposal facility.
- Comply with conditions of licences, permits or other approvals issued for the project.

3.0 STATUTORY REQUIREMENTS AND GUIDELINES

- *Environmental Protection Act 1986*
- Identification and Investigation of Acid Sulfate Soils, 2009
- Treatment and management of soils and water in acid sulfate soils landscapes, 2011
- Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines, 2002
- Landfill Waste Classification and Waste Definitions 1996 (as amended) DEC, 2005
- A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities (DEC, 2011).
- Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia (DOH, 2009).

4.0 MANAGEMENT MEASURES

Either of the following measures shall be adopted for management of potential contaminated material and identified ASS materials disturbed during site excavations:

- If soil classification for waste disposal was undertaken *in situ* and results available than material can be removed immediately off-site to a DER approved treatment and disposal facility as per Section 4.1.
- Otherwise stockpiling of materials on-site on a suitably constructed bunded area with limestone pad must be undertaken until waste classification results are available. Specifications for the preparation of the bunded area are provided in Section 4.2 and the procedure for classification is summarised in Figure 1. Following excavation, materials should not be stockpiled longer than 3 days after receipt of analytical results.

4.1 Removal to DER approved treatment and disposal facility

Provided that the materials excavated at the site are not contaminated and are not within the groundwater fluctuation zone they can be placed elsewhere on site without active management, provided they remain within a similar environment (e.g. above the groundwater fluctuation zone).

If they are not contaminated, are suspected ASS (they meet the description in Procedure A, Section 4.0), and cannot be re-used on site as stated above, they should be disposed of at a DER approved treatment facility.

4.2 Preparation of a Stockpiling Facility

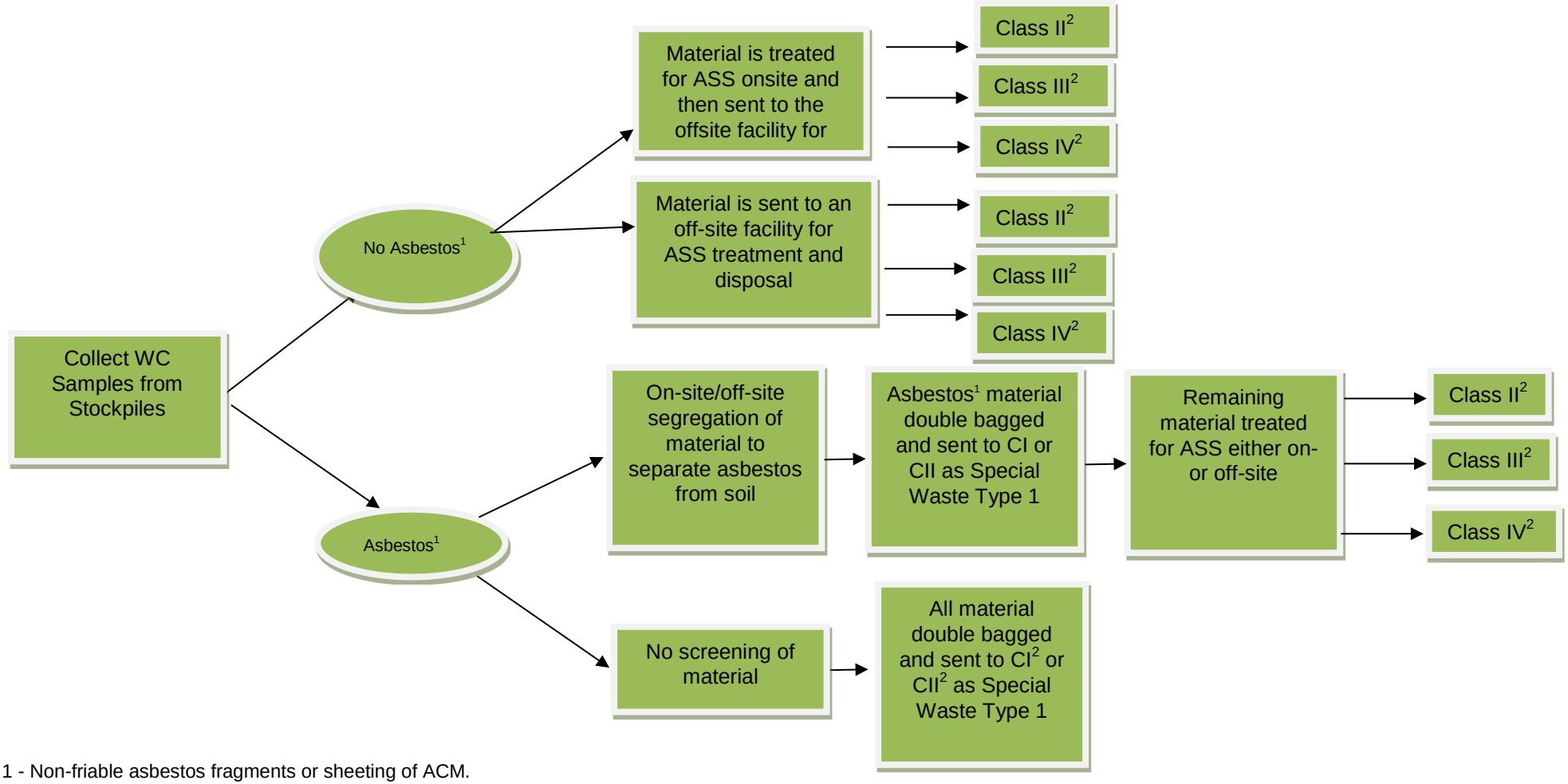
A bunded area with limestone pad (a dedicated facility for stockpiling of soils) shall be prepared as follows:

- The bunded area shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. If sandy materials are exposed in the stripped surface, a layer of low permeability material shall be placed over the stripped surface. An area of at least 2 m width shall be left between the bunds to allow collection of runoff and direction to sumps.
- The area shall be bunded using compacted clay materials. The bund wall shall be of sufficent height to contain and collect runoff from stockpiled materials. The pad should be constructed from crushed limestone (minimum of 300 mm in thickness).
- Bunds will be constructed to allow collection of runoff directed to sumps (shallow drains may be employed to assist in directing flow to sumps). Sumps shall be sized to allow containment of stormwater runoff from pads with due consideration of possible discharge limitations.
- A guard layer with a minimum of 5 kg/m^2 fine ground agricultural lime per vertical metre shall be applied to the areas prior to placement of soils.
- The areas shall be divided into a series of identifiable lots. Each lot shall be large enough to hold up to 250 m^3 of material. Stockpile height is not to exceed 2.5 m in height.

Classification of Excavated Material

Excavated ASS material must be treated first and then once treated should be sent to a Class II disposal facility as a minimum. The waste classification based on other contaminant concentrations if lower does not lower this classification. The ASS classification of class II always overrides unless the waste classification is higher. The required procedure for dealing with excavated material will be dependent on if asbestos is detected. A decision tree has been developed to aid in the selection of the appropriate management, treatment and selection of the Landfill Class and is provided as Figure 1.

PROCEDURE B
Management Options



1 - Non-friable asbestos fragments or sheeting of ACM.

2 – Disposal requirements at the landfill facility are to be determined by the receiving landfill facility based on the waste classification results.

rated Material

Monitoring of Stockpile Areas

When water is present in stockpile area sumps, the water shall be monitored for the same parameters and at the same frequency as dewatered effluent, as outlined in the site Dewatering Management Plan[1] (Golder 2012e).

All monitoring of water quality shall be carried out by a suitably qualified person, using calibrated equipment on samples that are representative of the discharge or background.

5.0 PERFORMANCE INDICATORS

Item	Performance Indicator
Suitably prepared stockpile areas	■ Stockpile areas to be constructed as per 4.2 (i.e. pad, bunding, sump, stockpile height) ■ Guard layer used between pad and stockpile ■ Areas collecting runoff efficiently with no seepage to surrounding environment (i.e. bunding, drains, sumps) ■ Materials should not be stockpiled longer than 3 days after receipt of analytical results.
Remove all material to DER approved treatment and disposal facility	■ All contaminated material and ASS removed to a DER approved treatment and disposal facility and within the specified time frame ■ Records and receipts are kept for the volume of material disposed of at the approved facility through the MTS as per the CSMP ■ Material is transported correctly
Non-conformance	■ All non-conformances are reported and rectified.

6.0 MONITORING AND REPORTING

The Lead Contractor's Construction Manager shall be responsible for ensuring that records of disposal and stockpiling times are recorded.

The Lead Contractor's Construction Manager shall be responsible for ensuring the trench and current stockpiles are managed as described above.

The Lead Contractor's Construction shall maintain a register of the construction details for the backfilling of the current trench.

[1] A Dewatering Management Plan must be prepared for sites that dewater in ASS environments. Monitoring should be consistent with "Treatment and management of soils and water in acid sulfate soils landscapes" (DEC 2011).

1.0 GENERAL

The procedures outlined below are provided for the preparation of a stockpile area on-site for the contaminated and ASS materials encountered during site excavations.

2.0 OBJECTIVES

- Appropriately prepare an area for on-site stockpiling of identified contaminated and ASS materials.
- Appropriately manage stockpiles of contaminated and ASS materials so as to minimise adverse effects on the natural and built environment (including infrastructure).
- Comply with conditions of licences, permits or other approvals issued for the project.

3.0 STATUTORY REQUIREMENTS AND GUIDELINES

- Environmental Protection Act, 1986
- Treatment and management of soils and water in acid sulfate soil landscapes. Perth, Western Australia: Department of Environment and Conservation, 2011.
- Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes. Perth, Western Australia: Department of Environment and Conservation, 2009.
- Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines, 2002.
- Landfill Waste Classification and Waste Definitions 1996 (as amended), DEC 2005.

4.0 TREATMENT AND DISPOSAL FACILITY REQUIREMENTS

4.1 Liming Rates

Liming rates for identified ASS materials are outlined in Table 1 below. These rates should be provided to the selected treatment and disposal facility upon receipt of materials. Treatment of ASS material should not occur on site, unless it has been confirmed that asbestos is not present in the material.

Table 1: Liming Rates

Identified ASS Material	Liming Rate (kg/m^3)
FILL: Sand/Clay	195
FILL: Waste	185
CLAY/Silty CLAY/Sandy CLAY/SAND	213

Liming rates have been calculated from CRS results according to the following equation:

Liming Rate (kg/m^3) = maximum net acidity (%S) x Conversion Rate × SF × SBD × NV

Table 2: Liming Rate Equation Parameters

Parameter	Value	Definition
%S	Unknown	Net acidity
Conversion rate	31.21	%S → kg $CaCO_3$/tonne
SF	2	Safety factor
SBD	1.60 t/m^3	Soil bulk density
NV	95%	Lime neutralising value

Verification should be conducted only on ensuring all material tracking has been recorded in the MTS for the site.

5.0 PERFORMANCE INDICATORS

Item	Performance Indicator
Earthworks strategy	■ An appropriate earthworks strategy has been prepared for the efficient movement of contaminated soil and ASS – see MTS in Section 6.0 of this management plan
Suitably prepared future stockpile areas	■ Stockpile areas to be constructed as per Section 4.2 of Procedure B (i.e. bunding, sump, stockpile height) ■ Guard layer used between pad and stockpile ■ Stockpiles areas collecting runoff efficiently with no seepage to surrounding environment (i.e. bunding, drains, sumps)
Liming rates	■ Correct liming rates are provided to treatment and disposal facility according to Table 1
Non-conformance	■ All non-conformances are reported and rectified.

6.0 MONITORING AND REPORTING

The Lead Contractor's Construction Manager shall be responsible for ensuring the treatment areas are constructed as described above.

The Lead Contractor's Construction Manager shall maintain a register of the construction details of each treatment area prepared at the Site including photographs and confirmatory supporting information including but not limited to survey data to confirm the appropriate thickness of guard layer etc.

The Lead Contractor's Construction Manager shall be responsible for ensuring laboratory analysis is carried out to verify treatment for each 250 m^3 of identified ASS. In the event that soils require further treatment, the Contractors Site Manager shall be responsible for calculating additional liming rates and submitting subsequent verification analysis to a laboratory.

The Lead Contractor's Construction Manager shall be responsible for ensuring laboratory analysis for the landfill disposal suite (as per Section 9.1.7 of the report) is carried out to confirm the waste classification of the material prior to disposal to an off-site facility.

The Lead Contractor's Construction shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Lead Contractor's Construction Manager each week and submitted to the Contaminated Sites Auditor.

1.0 GENERAL

The procedures outlined below are provided to monitor and manage runoff collection in stockpile areas.

For all dewatering management measures, a dewatering management plan (DMP) has been prepared for the site and will act as the overriding document for the monitoring of water quality, and is in accordance with *"Treatment and management of soils and water in acid sulfate soil landscapes"* (DEC 2011).

2.0 OBJECTIVES

- Appropriately manage waters discharged from open excavations and (if required) runoff collected in stockpile areas.
- Comply with conditions of licences, permits or other approvals issued for the project.

3.0 STATUTORY REQUIREMENTS AND GUIDELINES

- Environmental Protection Act, 1986
- Treatment and management of soils and water in acid sulfate soil landscapes. Perth, Western Australia: Department of Environment and Conservation, 2011.
- Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes. Perth, Western Australia: Department of Environment and Conservation, 2009.
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.

4.0 STOCKPILE RUNOFF MONITORING

Monitoring of the runoff from stockpiled areas is required.

Where possible, stockpiles should remain covered to reduce potential leachate generated from infiltration, however, if this is not possible and leachate is generated, management should be conducted according to this procedure.

Water collected within the stockpile areas should not be directly or indirectly discharged to surface water bodies. When runoff is being contained in stockpiled areas, the following procedures shall apply:

- The pH and Electrical Conductivity (EC) of water collected in the stockpile area shall be monitored twice daily. Field measurement of ferrous iron and aluminium levels shall be conducted daily. If ferrous iron is detected, then a water sample shall be collected and laboratory analysed for titratable acidity to confirm total acidity risk and treatment requirements. Where pH of less than 5 is detected, the water shall be treated in a holding pond or tank to meet the performance indicators listed in Section 6.0.
- Treatment shall not be permitted as part of direct discharge to an external surface water body or via infiltration. Treatment shall occur in a holding pond or tank.

All monitoring of water quality shall be carried out by a suitably qualified person, using calibrated equipment on samples that are representative of the runoff. The monitoring results should be recorded on a water discharge monitoring log.

Table 4 and Table 5 present proposed trigger levels and actions for the dewatering discharge and these should also be used for runoff in stockpile areas which are to be discharged to the environment. If water quality has not improved after treatment, additional treatment is required.

The table below details the ASS laboratory suite and contaminants of concern required for testing in order to assess the nature of runoff within the stockpile areas. The groundwater quality results from the laboratory should be compared with the background water quality results obtained prior to start of the excavation activities. Dependent upon results, treatment of the runoff may then be required (according to Table 2) prior to discharge to the surrounding environment.

Table 1: ASS Suite and Contaminants of Concern

Miscellaneous Parameters	Total Acidity, Total Alkalinity, pH, EC, TDS
Major Ions	Cl, SO_4, Na
Dissolved Metals	Al, As, B, Cd, Cr, Fe, Pb, Mn, Mo, Ni, Se, Zn,
Nutrients	Ammonical Nitrogen, Total Nitrogen, Total Oxidised Nitrogen, Reactive Phosphorous, Total Phosphorous
Contaminants of Concern	Polycyclic Aromatic Hydrocarbons (including naphthalene) and Organochlorine and Organophosphate Pesticides

Groundwater sampling should be carried out by an experienced groundwater professional or environmental scientist in accordance with Australian sampling standards using appropriate low flow sampling methods.

Table 2 details the requirements for monitoring of runoff in the stockpile areas. The Lead Contractor's management plan should detail how runoff collected from the stockpiles will be managed and outline the relevant criteria for that discharge location. Additionally, if runoff is proposed to be discharged on-site then water must meet criteria outlined in Table 4 and Table 5.

Table 2: Water Monitoring of Stockpiles

Monitoring Point	Parameter	Performance Indicator		Monitoring Frequency
		Minimum	Maximum	
Sumps and Collected Water in Stockpile Areas	pH	5.0	-	Twice Daily
	EC	-	500µS/cm	
	Ferrous Iron and Al (Field)	-	Detection	
	Total acidity, total alkalinity, Cl, SO_4, Al, Fe, Na	-	ANZECC 2000 95% Protection Level	Fortnightly
	As, Cr, Cd, Mn, Ni, Zn, Se, H_2S, TSS, TDS	-	ANZECC 2000 95% Protection Level	Fortnightly
	Nutrients – Total Nitrogen, Total Phosphorus, Ammoniacal Nitrogen	-	ANZECC 2000 95% Protection Level	Fortnightly
	Contaminants of Concern: Pesticides, PAHs and PCBs	-	Relevant Guideline in relation to discharge location	Weekly

5.0 CONTINGENCY PLANS

Contingency plans will be developed on a site-specific basis to address actions to be undertaken where performance criteria are not met or unforeseen events occur. Contingency plans will consider, but not be limited to monitoring of Surface Runoff (Stockpile runoff areas). Runoff collected from stockpiles shall be monitored and treated if required as per Table 4. Where necessary, bund dimensions may require re-assessment where runoff is likely to exceed holding capacity. Alternatively, the capacity for overflow of the bund should be considered and addressed by transferring to another lined bund prior to disposal (if required).

6.0 PERFORMANCE INDICATORS

Table 3: Performance Indicators

Item	Performance Indicator
Water quality	■ No uncontrolled releases of water from the stockpile areas. Discharge water quality within performance indicators in Table 3. ■ Water quality monitored/measured correctly by a qualified person including correct sampling procedures. ■ Correct actions taken if trigger levels are exceeded.
Runoff monitoring	■ No uncontrolled releases of water from the stockpile areas. Runoff collected within performance indicators in Procedure B.
Monitoring records	■ Accurate records of all treatment, tests and results are stored in the MTS and presented upon request.
Non-conformance	■ All non-conformances are reported and rectified.

7.0 AUDITING AND REPORTING

Additional procedures shall be developed for site specific excavations as required.

The Lead Contractor's Construction Manager shall be responsible for ensuring monitoring listed in Table 4 and Section 4.0 is conducted at the required frequency.

The Lead Contractor's Construction Manager shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Lead Contractor's Construction Manager each week and submitted to the Contaminated Sites Auditor.

The Lead Contractor's Construction Manager shall inform the Superintendent of non-compliance with Table 4 and Table 5 upon detection. The Superintendent shall inform DER of such non-compliances as soon as practicable and instigate an assessment of the impact.

Table 4: Summary of Trigger Value for Discharge

Parameter	Trigger Value
Total nitrogen	>1 mg/L
Total phosphorus	>0.1 mg/L
Total iron	>1 mg/L
Dissolved aluminium	>150 µg/L
Total aluminium	>150 µg/L
TTA (Acidity)	>40 mg/L
Odours and colours	No objectionable odours or visible colour changes in the receiving water
Floatable matter	No visible floating oil, grease, scum, little or other objectionable material
Settleable matter	No deposits which adversely affect the recreation and ecosystem values of the receiving waters
Turbidity	Not to vary more than 10% from the background level (in the receiving environment) or cause a visible reduction in light penetration of receiving waters
Temperature	Not to vary more than 2°C from the background level (in the receiving environment)

Parameter	Trigger Value
Salinity	Not to vary more than 10% from the background level in the receiving environment
Dissolved oxygen	<80-90% stable saturation
pH	Not vary more than 1 pH unit from the background level of the receiving environment
Toxins and broader water quality analytes such as the following contaminants of concern: Pesticides, PAHs and PCBs	ANZECC 95% protection trigger values. In the absence of estuarine guidelines, the lowest of either the freshwater or marine guidelines levels should be applied.
Winter discharge rates	Provided the water quality criteria have been met, rates up to 30 L/s can be discharged during winter
Summer discharge rates	Rates greater than 3.9 L/s should not be discharged during summer (assuming the water quality criteria have been met)

Table 5: Dewatering Effluent Monitoring ASS Matrix (radius of influence of dewatering < 50 m and/or duration of groundwater pumping < 7 days). (*DEC 2011. Treatment and management of soils and water in acid sulfate soil landscapes. Table 7*)

	Trigger	Action	Monitoring
1	**Total titratable acidity <40 mg/L** pH > 6	Continue daily field measurements of pH and total titratable acidity.	**Daily** - field measurement: pH, electrical conductivity (EC), Total Titratable Acidity (TTA), total alkalinity **Fortnightly** - laboratory analysis: total acidity, total alkalinity, pH
2	**Total titratable acidity <40 mg/L** pH in range 4 to 6	Undertake neutralisation treatment (liming),	**Daily** - field measurement: pH, EC, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH
3	**Total titratable acidity in range 40 mg/L to 100 mg/L** pH > 6	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	**Daily** - field measurement: pH, EC, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - field measurement: dissolved oxygen (DO), redox potential (Eh)

	Trigger	Action	Monitoring
4	**Total titratable acidity in range 40 mg/L to 100 mg/L** pH in range 4 to 6	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	**Daily** - field measurement: pH, EC, TTA, total alkalinity **Weekly** -laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide*, EC, Total Suspended Solids (TSS), Total Dissolved Salts (TDS), Total Nitrogen (TN), Total Phosphorus (TP) **Fortnightly** - field measurement: DO, Eh
5	**Total titratable acidity >100 mg/L** or pH < 4 or **total alkalinity < 30 mg/L**	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Increase neutralisation treatment (liming) rate. Advise Contaminated Sites Branch (CSB) DER immediately. CSB may advise appropriate action which may include ceasing dewatering.	**Twice daily -** field measurement: pH, EC, TTA, total alkalinity **Weekly -** laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide*, EC, TSS, TDS, TN, TP **Fortnightly -** field measurement: DO, Eh May be needed to undertake investigations to determine the size of the 'acidic footprint' created and manage this impact appropriately.
6	**Total titratable acidity >100 mg/L and 25% higher than baseline values**	Upgrade to 'Dewatering Management Level 2' including implementation of groundwater quality monitoring program	**Monitoring requirements:** Dependent upon value of total titratable acidity and pH as per guidance above.
7	pH decrease > 1 pH unit from baseline values	Upgrade to 'Dewatering Management Level 2' including implementation of groundwater quality monitoring program	**Monitoring requirements:** Dependent upon value of total titratable acidity and pH as per guidance above.

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Pty Ltd
Level 3, 1 Havelock Street
West Perth, Western Australia 6005
Australia
T: +61 8 9213 7600

Golder Associates

APPENDIX F

Glossary and Definitions

Project Glossary and Definitions

Term	Definition
µg/m^3	Micrograms per cubic metre
ACM	Asbestos Containing Material
AHD	Australian Height Datum
AHIS	Aboriginal Heritage Inquiry System
API	Assessment on Proponent Information
ASS	Acid Sulfate Soils
CBD	Central Business District
CEMF	Construction Environmental Management Framework
CEMP	Construction Environmental Management Plan
Construction Phase	The phase of the Project during which construction works, including preconstruction works will be undertaken.
dB	Decibels
DEC	Department of Environment and Conservation (now DER)
DER	Department of Environment Regulation
DMAs	Decision Making Authorities
DoE	Department of the Environment
DOH	Department of Health
DOW	Department of Water
DSI	Detailed Site Investigation
EMFs	Environmental Management Frameworks
EMPs	Environmental Management Plans
EOI	Expression of Interest
EP Act	Environmental Protection Act 1986
EPA	Office of the Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPP	Environmental Protection Policy
Golder	Golder Associates
IF	Influencing Factor
Irrigation Lake	The artificial irrigation lake in the centre of the Project area
KPF	Kings Park Formation
Lead Contractor	Contractor engaged to undertake Construction Phase works and/or Operating Phase works.
MP	Management Plan
MRWA	Main Roads Western Australia
NEPM	National Environmental Protection Measure
NPI	National Pollutant Inventory
OEMF	Operational Environmental Management Framework
OEMP	Operational Environmental Management Plan
OHS	Occupational Health and Safety

Term	Definition
Operating Phase	The phase of the Project during which operations will be undertaken
Part 1	The construction of the Stadium including the Sports Precinct
Part 2	The construction of the transport infrastructure including the rail station upgrade and the bridge over the Swan River
PCS Works	Preconstruction Works
PDP	Project Definition Plan
PER	Public Environmental Review
PM_{10}	Particulate Matter 10 µm
$PM_{2.5}$	Particulate Matter 2.5 µm
ppm	Parts per million
Project	The new Perth Stadium Project
Project EMP	New Perth Stadium Environmental Management Plan
PSI	Preliminary Site Investigation
River-fed Lake	The lake connected to the Swan River to the west of the Project area
RFP	Request for Proposal
RL	Reduced Levels
SCD	Sandy Channel Deposit
Stadium Works	Stadium Construction Works
SP	Department of Treasury Strategic Projects
Sports Precinct	Includes the Stadium, rail station, bus hub, Swan River bridge, pedestrian access ways and other associated infrastructure
SRA	Swan River Alluvium
SRT	Swan River Trust
Stadium	The new Perth Stadium Structure
Stadium Governance body	Body engaged as the proponent to manage Stadium operations
Stadium Operator	Contractor engaged to undertake Stadium operations
TSP	Total Suspended Particulates

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Pty Ltd
Level 3, 1 Havelock Street
West Perth, Western Australia 6005
Australia
T: +61 8 9213 7600

Golder Associates