February 2013

CROWN PERTH

Crown Towers Environmental Impact Assessment - Section 38 Referral Supporting Document

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REPORT

Report Number. 127643111-010-R-Rev0

Distribution:

3 Copies - Environmental Protection Authority
2 Copies - Crown Perth (+1 Electronic)
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1.0 INTRODUCTION

1.1 Overview

This *Environmental Protection Act 1976* (EP Act) Section 38 Environmental Referral Supporting Document (Referral) has been prepared for the Crown Perth (Crown) Towers project as part of the submission to the Office of the Environmental Protection Authority (OEPA).

The Project is to design, construct, operate and maintain the Crown Towers project (the Project) located within the Burswood Peninsula, Western Australia. Crown is developing a new world class hotel addition at their Integrated Resort in Perth, Western Australia. The Project will consist of a six-star quality, 25-storey hotel constructed on the banks of the Swan River with views of the Perth central business district and the Indian Ocean. The tower will accommodate a total of 500 rooms and will be branded as Crown Towers which is Crown Limited's premium hotel brand. A low-rise podium will contain a large convention and meeting complex, restaurants, retail and public spaces which have been integrated into the existing property.

The design of the property will capitalize on the unique nature of the site and leverage the Mediterranean climate in Perth to create a unique resort setting. The property will cater to affluent business and leisure clientele and support a VIP gaming component which will integrate into the hotel tower through the incorporation of Suite/Villa accommodations and VIP Gaming salons. The Project will also incorporate an expansion of their existing pools and landscaped areas. Phased improvements strategy is defined below and construction is expected to follow the delivery of these packages.

For planning purposes the Project is to be delivered in two phases:

- **Construction Phase:** the construction of the Crown Towers, Podium and associated infrastructure, which will include the use of deep piles to provide building support for the main structures.
- **Operations Phase:** the operation of the Crown Towers. The transition from the Construction Phase to the Operations Phase will occur once the all Construction Phase work has been completed and the Lead Contractor has left site, handing the development infrastructure over to Crown. Ongoing environmental monitoring of the site and management of site facilities will continue during the Operations Phase.

Delivery of the Project has potential for environmental and social impacts (primarily surrounding the works proposed during the Construction Phase) and will, therefore, be referred to the OEPA in accordance with Section 38 of EP Act.

The procurement of the Construction Phase Lead Contractor is underway, with the Request for Proposal (RFP) for the Construction Phase works scheduled to be released Q2 2013 to allow award of the contract in June/July 2013.

Delivery of the Project has potential for environmental and social impacts (primarily surrounding the works proposed for the Construction Phase) and will, therefore, be referred to the OEPA in accordance with Section 38 of the EP Act. This is outlined in the indicative Project Schedule in Table 1.

Table 1: Indicative Project Schedule

Project Phase	Estimated Commencement	Estimated Completion
Construction Phase		
Pre-construction Site Works	April 2013	Q3 2014
Construction Works	Q3 2014	Q3 2016
Operations Phase		
Transition to Opening	Q3 2016	Q3 2016

1.2 Referral Scope

The scope of this Referral focuses on the construction and operation of the Project including:

- Construction of the:
  - Crown Towers' six-star, 25-level, 500-room hotel development.
  - Podium structure, linking the hotel to adjoining buildings and properties (approximately 25 000 m^2 footprint).
  - Associated services buildings (for generators, bins, refuse, hoist and loading bay under croft).
  - Porte cocheré.
  - Pedestrian access ways.
- New and refurbishment of existing external works (including new landscaping and swimming pools, approximately 11 000 m^2).
- Refurbishment of existing function room and associated public spaces.
- Rehabilitation and landscaping (approximately 33 000 m^2 footprint).
- Stormwater catchment lake(s) infill and expansion.

Hotel facilities will include:

- New function/conference facilities will complement the existing function room, which will be refurbished.
- A new resort swimming pool, exclusively for Crown Towers' guests, will be provided. The new resort pool is to be integrated with the existing Crown Metropol Perth pools and VIP enclave pool.
- A mix of standard guest rooms and suites in the hotel towers. The VIP/Crystal Club facilities, including salon gaming VIP lounge and pool areas, will be located on the levels above the standard guest rooms, in effect, separating the standard guest room floors from the floors containing the suites.
- Gaming salons that will form part of the VIP offering, and will be supported by a VIP lounge, Crystal Club, VIP club pool, and bar.
- Back of house facilities located on a number of levels, including the basement, which will also incorporate a loading bay, generators, bins, refuse and a hoist.
- Plant rooms required to operate the hotel facilities.
- Guest and staff uniform laundry operations which will take place on-site in the hotel, whilst hotel and food and beverage linen will be taken off-site.

Figure 1 illustrates the indicative Project layout.

LEGEND

Estimated project

NOTES

Coordinate System: PCG94

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Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 10 20 30 40 50
metres

SCALE (at A3) 1:1,700

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APPROVED	SMB

Crown Towers EIA

INDICATIVE PROJECT LAYOUT

FIGURE 1

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1.3 Objective

This document has been prepared to support the Section 38 Referral application. It provides additional information related to the potential environmental impacts and the proposed management and mitigation measures, monitoring procedures and the relevant legislative processes that will be applied to the Project, if approved. This Referral Supporting Document has been drafted by Golder Associates (Golder) in consultation with Crown and forms part of the Referral package, which also includes a Referral application form and the following Draft Environmental Management Strategy documents (attached) developed for the Project:

- The Construction Environmental Management Framework (CEMF) (Golder, 2013a).
- The Operations Environmental Management Framework (OEMF) (Golder, 2013b).
- The Crown Environmental Management Plan (Project EMP) (Golder, 2013c) (Appendix A).
- The Crown Indicative Operations Environmental Management Plan (OEMP) (Golder, 2013d). (Appendix B).

The objective of this Referral Supporting Document is to articulate the Project:

- **Background:** A background of the Project including details on the planning and development of the Project.
- **Project Scope:** The identification of the works planned for the Construction Phase for the Project.
- **Applicable Legislation and Standards:** An outline of the legislation and standards potentially applicable to the Project and a summary of the current and potential approval requirements for the Project.
- **Stakeholder Engagement:** An outline of the stakeholder engagement undertaken to date and the anticipated community and stakeholder consultation to be undertaken throughout the Project.
- **Existing Environment:** Desktop and baseline environmental investigations undertaken for the Project. Investigations have been undertaken in the areas of legal, geotechnical, hydrogeological, environmental, ecological, contamination and heritage.
- **Environmental Impact Assessment:** An environmental impact risk assessment has been undertaken for the Project which highlighted the key environmental (and social) receptors with associated potential environmental (and social) impacts for the various stages in the Project. In addition to identifying the potential impacts on each of the environmental receptors, the management measures to be implemented for each receptor are also identified.
- **Implementation Strategy:** An outline of the implementation strategy for the Project identifying a number of tenure, planning and environmental processes applicable to the delivery of the Project. The approach to be adopted to manage the planning and potential environmental impacts of the Project includes the preparation and implementation of an Environmental Management Strategy. The Environmental Management Strategy outlines the structure to be implemented to establish and maintain leading practice controls to manage potential environmental and social impacts during the Project. The implementation of the Environmental Management Strategy including discussion of roles and responsibilities is also outlined.

1.4 Project Location and Tenure

Crown Perth complex is located at 201 Great Eastern Highway on the Burswood Peninsula in the City of Perth, Western Australia. The Project will be located within the southern nine holes of the Burswood Park Golf Course located on the Burswood Peninsula, as shown in Figure 2.

The Burswood Peninsula extends over an area of approximately 280 ha and is located approximately 2.9 km east of the Perth CBD. A variety of land uses are located within the Burswood Peninsula including the State Tennis Centre, the Crown Perth complex, the Dome, the Mirvac Burswood Peninsula residential development, the Belmont Racecourse and assorted parklands and car parks. The Burswood Peninsula is accessed by road from the Graham Farmer Freeway, Victoria Park Drive and the Great Eastern Highway, with Belmont and Burswood train stations also servicing the area.

The Project area includes the southern end of the Burswood Park Golf Course, which is currently under the control and management of the Burswood Park Board, and the Crown Perth complex. The Project area is surrounded by land zoned for parks and recreation, residential, and public purposes - special uses (Crown Perth Complex). The Swan River, which is in close proximity but not directly adjacent the Project area is managed by the Swan River Trust (SRT), a state government agency that protects, manages and enhances the Swan Canning Riverpark.

The Project area is shown in Figure 3 (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 Burswood Park Golf Course to the north; the Mirvac residential development to the east; the Crown Perth complex to the south; and the Burswood Water Sports Centre and the Swan River to the west.

The proposed Project Area is comprised of the following four lots (see Table 2) which extend over an area of approximately 7.8 ha.

Table 2: Land Tenure

Lot	Deposited Plan (DP)	CT (vol/folio)	Address	Owner	Total Approx. Area (ha)	Total Area within Project Area (ha)
301	DP42394	LR3139/329	201 Great Eastern Hwy, Burswood	State of Western Australia - proposed to be purchased by Crown.	50.8	5.8
10	DP25931	2694/975	63 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	1.8	1.8
12	DP25931	2694/977	61 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	2.4	0.1
15	DP60786	2696/429	23 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	5	0.1

Note: The portion of the proposed Project area contained in Lot 301 of which Crown is proposing to buy is located within the Burswood Park "C" Class Reserve. This is Lot 301 on Deposited Plan 42394 (CT LR 3139-329).

A plan showing the location of each lot identified in Figure 2.

The Project area has had an extensive history of potentially contaminating land use activities. Therefore, an environmental Detailed Site Investigation (DSI) was conducted in accordance with the Department of Environment and Conservation (DEC) Contaminated Sites Management Series Guidelines and the implications of the DSI findings are discussed throughout this document. It is anticipated that the DSI report, once approved by the Contaminated Sites Auditor engaged for the Project, will be available before the end of February 2013.

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SCALE (at A4) 1:10,000

NOTES
Coordinate System: PCG94

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LEGEND
Estimated project boundary

Crown Towers EIA

REGIONAL LOCATION

FIGURE 2

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CLIENT Crown Perth
DOCUMENT 127643111-010-R-Rev0
DATE 06 Feb 2013
COMPILED GGW
APPROVED SMB

0 50 100 150
metres

SCALE (at A4) 1:4,000

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LEGEND
Estimated project boundary

Crown Towers EIA

PROJECT AREA

FIGURE 3

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CLIENT	Crown Perth
DOCUMENT	127643111-010-R-Rev0
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COMPILED	GGW
APPROVED	SMB

0 30 60 90
metres

SCALE (at A4) 1:2,500

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Cadastres © Western Australian Land Information Authority trading as Landgate (2012).

LEGEND
Estimated project boundary
Cadastral boundary

Crown Towers EIA

LAND TENURE

FIGURE 4

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\010 R\Rev0\127643111-010-R-F004-Rev0-Land_Tenure.mxd

2.0 BACKGROUND

2.1 Overview

In 1984, acting on a suggestion by a Perth businessman, the Western Australian Government proposed that a casino complex be built on Burswood Island.

Burswood Island Casino (as it was originally known) was opened on 30 December 1985. It was at the time, the largest casino in Australia, and third-largest in the world.

In August of 1987, the 'Dome' (formerly known as the Burswood Dome) indoor sports stadium was opened to the public. It was at the time, the largest auditorium in the southern hemisphere.

The Burswood Convention Centre was opened in November of 1987, and in April 1988 the entire Burswood Island complex was officially opened.

In 2004 PBL acquired full control of what was known then as 'Burswood International Resort Casino''. In 2005 it was re-branded as 'Burswood Entertainment Complex'. In August 2005, the Holiday Inn Burswood was added to the facilities at the complex.

In 2009, Crown made the decision to embark upon a holistic upgrade of the complex as part of the company's corporate strategy to maintain their position as Australia's leading Owner/Operator of Integrated Resorts and to position the property to effectively compete with the new resorts being developed in the Asia Pacific region.

In 2012 it was confirmed that the existing hotel would also be re-branded in line with its sister complex, Crown Melbourne, upon completion of a major refurbishment. In June 2012, the 'InterContinental Burswood' became 'Crown Metropol Perth', and the 'Holiday Inn Perth Burswood' was also officially rebranded 'Crown Promenade Perth'. In September of 2012, the entire complex was rebranded as 'Crown Perth' as a part of a comprehensive brand and advertising campaign to support the capital investment (previous and future) approved for the complex.

2.2 Project Planning

On 13 July 2012, the Western Australian Government agreed to sell approximately 5.8 ha of Burswood Park Reserve land to Burswood Nominees Limited as trustee for the Burswood Property Trust trading as Crown Perth. The purpose of the purchase by Crown was for the development of a third hotel and associated facilities.

In accordance with Clause 13 of the Agreement, scheduled to the Casino Act, approval was sought from the Minister for Sport and Recreation; Racing and Gaming for the construction of the third hotel and associated facilities and infrastructure (including road access) in accordance with the Master Plans developed for the Project. A Development Application (DA) was submitted to the Minister's office on 13 November 2012. The Ministers office will review the submission internally as well as solicit review and comments from the Department of Planning and Infrastructure, who in turn has engaged with various Government stakeholders.

2.3 Environmental Management Strategy

An Environmental Management Strategy has been developed for the Project to manage the potential environmental impacts of the Project as outlined in Section 11.0.

3.0 PROJECT SCOPE

3.1 Overview

The delivery of the Construction Phase (including any preconstruction works) of the Project, and the delivery of the Operations Phase of the Project is described in the following sections.

3.2 Construction Phase

3.2.1 Preconstruction Works

Preconstruction works are necessary to prepare the site for construction and in particular, to manage the underlying ground conditions. The main components of the preconstruction works for this Project are site preparation and earthworks. Information in the following sections is based on the *Preliminary Geotechnical Advice and Desk Study* (Golder, 2012a).

3.2.1.1 Site Preparation

The site preparation works have been identified as those that do not require significant ground disturbance:

- 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, if required.

3.2.1.2 Earthworks

Isolated excavation works may be required for the construction/installation of:

- Trenches for provision of services such as sewage and electricity.
- Swimming pools.
- Piles for the main structures.
- Base of the elevator shaft.
- All excavation works will not extend below the clean fill layer where practicable.

Other earthworks include:

- Importation and placement of clean fill materials and undertaking general earthworks including shaping and contouring existing landscape to specific levels.
- Removing the existing car park.
- Clearing existing trees and vegetation.
- The new development needs to be above the 100 year flood level which the Department of Water has estimated at Reduced Level (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 site.
- In relation to the lakes:
  - Partially infill Lake 1.
  - Enlarge and replace clay liner in Lake 2 (estimated total area of 0.25 ha before disturbance) for use in on-site stormwater detention.
  - Infill a portion and reshape and replace clay liner in Lakes 3 (estimated total area of 0.40 ha before disturbance) and 4 (estimated total area of 0.15 ha before disturbance).
  - Completely infill Lake 5 (estimated total area of 0.13 ha before disturbance).

3.2.2 Construction Works

3.2.2.1 Overview

The construction works will commence following completion of the preconstruction works. The development loads associated with the Crown Towers 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.

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:

- Low rise structures (such as Pools and associated deck and landscaped area).
- High rise structures (such as the Crown Towers hotel building).

3.2.2.2 Piling

Potential piling solutions for more heavily loaded areas are:

- Driven precast concrete piles of larger cross-section, such as 450 mm square or 550 mm octagonal sections.
- Driven steel tubular piles of typically about 600 mm to 750 mm diameter.
- Bored piles of typically about 900 mm to 1200 mm diameter.
- Continuous flight auger piles of typically about 750 mm to 900 mm diameter.

Pile lengths of between about 30 m and 35 m would be anticipated at the tower location should 600 mm diameter driven steel tubular piles be constructed. Steel tubular piles are expected to be able to be driven a greater distance into the Kings Park Formation (KPF) than precast concrete piles.

3.3 Operations Phase

The Operations Phase of the Project involves the transition of the Towers, Podium and other infrastructure from construction to operation and being opened to the public. The Operations Phase will include ongoing environmental management and monitoring by Crown. Crown will also be responsible for the maintenance of the facilities and infrastructure and the monitoring of the site which is anticipated to be ongoing for at least a period of two years as detailed in Section 10.0 and within the OEMP (Golder, 2013d).

The potential environmental impacts, proposed management and mitigation measures and monitoring procedures associated with the operations, particularly noise, are detailed in the respective Project Environmental Management Plans (EMPs) (see Section 12.0).

4.0 APPLICABLE LEGISLATION AND STANDARDS

4.1 State Legalisation and Regulations

Key Western Australian legislation and regulations that apply to the Project include, but are not limited to:

- *Casino (Burswood Island) Agreement Act 1985*
- *Contaminated Sites Act 2003*
- *Environmental Protection Act 1986*
- *Health Act 1911*
- *Occupational Safety and Health Act 1984*
- *Planning and Development Act 2005*
- *Rights in Water and Irrigation Act 1914*
- *Swan and Canning Rivers Management Act 2006*
- *Water Supply Sewerage and Drainage Act 1912*

Additional Western Australian legislation and regulations that may apply to the Project include, but are not limited to:

- *Aboriginal Heritage Act 1972*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Electricity Act 1945*
- *Electricity Industry Act 2004*
- *Energy Coordination Act 1994*
- *Environmental Protection (Controlled Waste) Regulations 2004*
- *Environmental Protection (Noise) Regulations 1997*
- *Environmental Protection (Unauthorised Discharges) Regulations 2004*
- *Heritage of Western Australia Act 1990*
- *Heritage of Western Australia Amendment Regulations 2012*
- *Land Administration Act 1997*
- *Litter Act 1979* (currently under review by DEC and will be incorporated into the EP Act)
- *Local Government Act 1995*
- *Main Roads Act 1930*
- *Metropolitan Water Supply, Sewage & Drainage Act 1909*
- *Pollution of Waters by Oil and Noxious Substances Act 1987*
- *Pollution of Waters by Oil and Noxious Substances Regulations 1993*
- *Road Traffic Act 1974*
- *Soil and Land Conservation Act 1945*
- *Waterways Conservation Act 1976*
- *Wildlife Conservation Act 1950*

Native Title considerations are not an impediment to development as Native Title has been extinguished by virtue of previous grants of tenure.

4.1.1 Casino (Burswood Island) Agreement Act 1985

The *Casino (Burswood Island) Agreement Act 1985 (*Casino Act) extends over an area of approximately 126 ha incorporating the Burswood Park Golf Course, the State Tennis Centre, the Crown Perth complex and the Dome. The Casino Act created both a "Site" (Crown Perth complex and Dome) and a "Resort Site" (Burswood Park Golf Course, State Tennis Centre, public parkland and car parks). The Resort Site was placed in the control of the Burswood Park Board which is responsible for the ongoing management and maintenance of the Burswood Park Golf Course and parklands. The "Resort Site" area contained within the Project area will become part of the "Site" area with the purchase of land by Crown.

4.1.2 Metropolitan Region Scheme

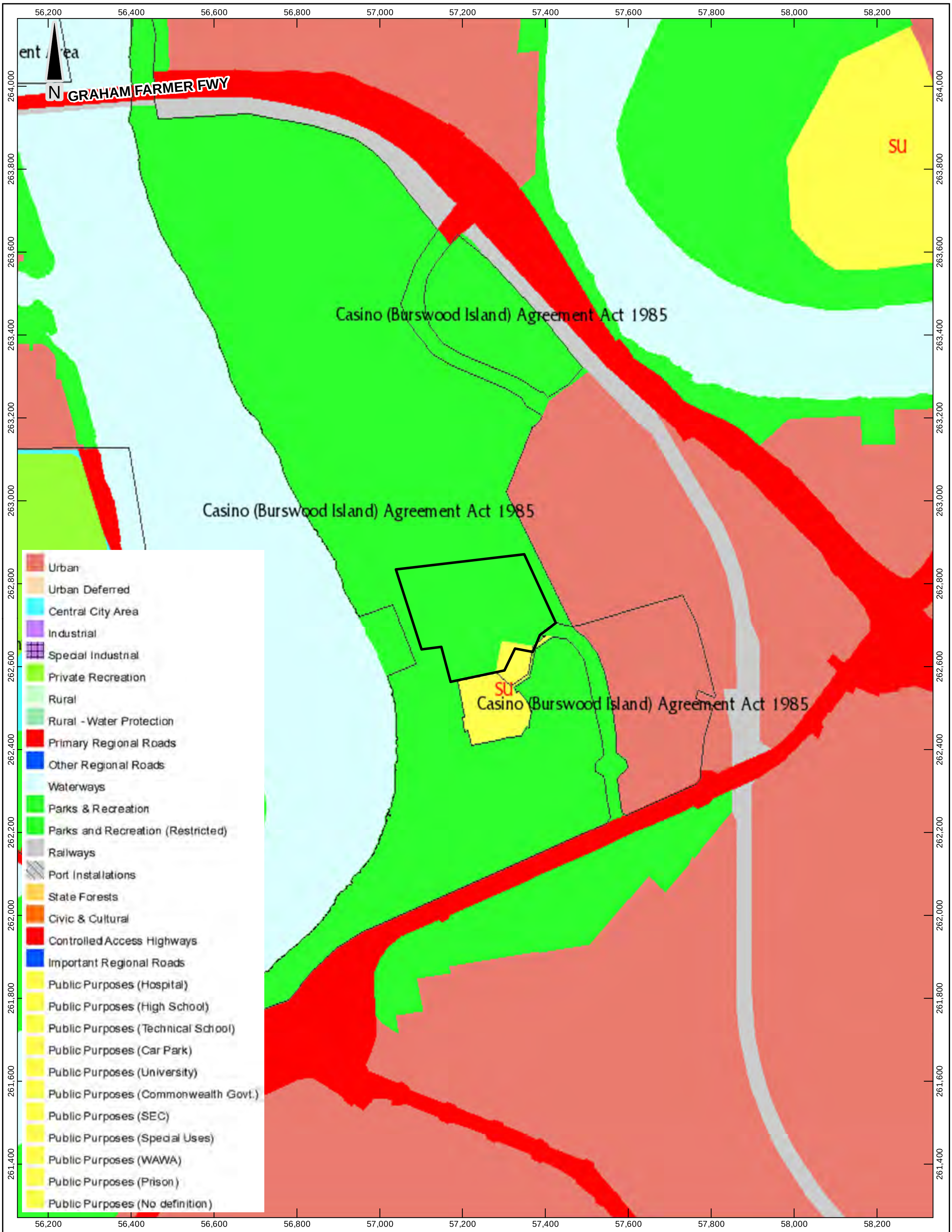
The Metropolitan Region Scheme (MRS) Map does not currently apply any zoning or reservation over the Casino Act area; with the Resort Site identified on the MRS Map as “Act Area” (see Figure 5). This reflects Section 7(1) of the Casino Act which states that, notwithstanding the provisions of the *Planning and Development Act 2005*, the MRS does not apply to the “Resort Lands”: which is determined to be the Resort Site containing the Burswood Park Golf Course. Consequently, development approval under the MRS is not required within the Resort Site. However, a Development Approval submission package has been applied for, as described in Section 5.1.

Under the Casino Act it is possible to revivify the MRS so that the provisions of the MRS are reinstated, which in this instance would be a Parks and Recreation reserve, reflecting the zoning that applied to the land prior to the Casino Act coming into force in 1985.

4.1.3 Town Planning Scheme

The Burswood Peninsula is within the Town of Victoria Park local government area. The Town of Victoria Park Town Planning Scheme No. 1 (TPS 1) generally applies to the land within the local government area; however, Clause 4 of TPS 1 excludes the “Resort Lands" that are subject to Section 7 of the Casino Act from the scope of TPS 1. Therefore, while the Casino Act remains in place over the land, TPS 1 does not apply.

Notwithstanding, TPS 1 identifies the land as MRS Parks and Recreation Reserve in recognition of the site's zoning under the MRS prior to the Casino Act coming into force in 1985. TPS 1 exempts development on MRS Reserved land from requiring approval under TPS 1.



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CLIENT Crown Perth
DOCUMENT 127643111-010-R-Rev0
DATE 06 Feb 2013
COMPILED GGW
APPROVED SMB

0 100 200 300 400 500
metres

SCALE (at A4) 1:12,000

NOTES
Coordinate System: PCG94

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MRS sourced from SLIP Public WMS.

LEGEND
Estimated project boundary

Crown Towers EIA

METROPOLITAN REGION SCHEME

FIGURE 5

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\010 R\Rev0\127643111-010-R-F005-Rev0-MRS.mxd

4.1.4 Environmental Protection Act 1986

Part IV of the EP Act governs the environmental impact assessment process, administered by the OEPA. Part IV of the EP Act has been enacted through the referral process (this document).

Section 38(1) of the EP Act states that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the EPA for a decision on whether or not it requires assessment under the EP Act.

As such, Crown is referring the Project to the EPA with the view that the potential impact of the Project is not significant. Crown has developed environmental management and mitigation measures and monitoring procedures that are to be implemented which Crown believes will adequately address any environmental issues without the need for a formal assessment by the EPA.

This EIA Report has been prepared to support the Section 38 Referral Application and provide additional information related to the potential impacts, proposed management measures and relevant legislative processes that will be applied to the Project, if approved.

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.

4.1.5 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 DEC database indicates that "*landfill material has been identified beneath the site including impacts to soil, groundwater and sediment*". Jason Clay of AECOM Pty Ltd is the Contaminated Site Auditor and, therefore, all environmental matters (including the individual management plans) related to the Project must be reviewed by him from a contaminated sites perspective prior to implementation.

4.1.6 Swan and Canning Rivers Management Act 2006 and Draft River Protection Strategy

The Swan River Trust (SRT) provides advice to the Western Australian Planning Commission (WAPC) on developments that are partially within, or abutting waters in, the Development Control Area. Under Part 5 of the *Swan and Canning Rivers Management Act* 2006, approval by the Minister for Environment is required for works wholly contained within the Development Control Area, with recommendations made by the SRT. The Construction Phase works will not encroach into the Swan and Canning Rivers Development Control Area, under the *Swan and Canning Rivers Management Act* 2006 (refer Figure 6). Despite this, consultation has been undertaken with SRT to inform them of the Project.

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0 100 200 300 400
metres

SCALE (at A4) 1:9,000

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LEGEND
Estimated project boundary
Swan River Trust Development Control Area (October 2004)

Crown Towers EIA

SWAN TRUST DEVELOPMENT CONTROL AREA

FIGURE 6

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\010 R\Rev0\127643111-010-R-F006-Rev0-Swan_River_Trust.mxd

4.1.7 Rights in Water and Irrigation Act 1919

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 *Rights in Water and Irrigation Act 1919* if groundwater abstraction is required.

It is expected that only isolated dewatering will be required during Project works and it is the responsibility of the Lead Contractor for the Construction Phase to obtain a 5C licence to take water from an underground source, if required. Nonetheless, Crown has undertaken consultation with DOW regarding the Project. Nonetheless, Crown Perth has undertaken consultation with DOW regarding the Project.

4.1.8 Occupational Health, Safety and Welfare Act 1984

Construction of the Project as well as any plant designed to remediate contaminated material on-site must be in accordance with the *Occupation Health, Safety and Welfare Act 1984*. This Act is administered by WorkSafe Western Australia and compliance is required to ensure operations meet standards of workplace safety and protection. The registration of a plant design is required under Part 4 of the regulations.

4.2 Approval Requirements

Crown has been liaising with the relevant Decision Making Authorities and regulatory agencies to obtain necessary environmental approvals advice. When there are cases where an approval is only required for a specific area of work in a Project phase, this will be obtained by the Lead Contractor(s) during the Construction Phase and Crown during the Operations Phase of the Project. This process is outlined in the conditions and commitments detailed in this document and the Lead Contractor's Construction Environmental Management Plan (CEMP) and Crown's OEMP (Golder, 2013d).

Crown is responsible for obtaining the approvals expressly stated to be its responsibility in Table 3. 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 3 is an indicative list only and is not exhaustive. The Lead Contractor(s) must identify and obtain all other required approvals, licences and permits relevant to the construction works being undertaken.

Table 3: 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*	Minister for the Environment (on advice from the OEPA)	Section 38 Referral under Part IV of the EP Act. If assessed, API or PER	Crown
Project approval to take action	*Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Commonwealth Minister for the Environment, or Department of Sustainability, Environment, Water, Populations and Communities (SEWPAC) under delegation	EPBC Act Referral of a Proposed Action	Crown
Development Approval	*Planning and Development Act 2005*	Department of Planning and the Western Australian Planning Commission (WAPC)	Development Application	Crown
Contaminated Sites	*Contaminated Sites Act 2003*	DEC	Auditors Report for Reclassification	Crown
Project Works Plan and CEMP	*Public Works Act 1902*	Crown on behalf of Minister for Works.	Design and Construct Contracts	Lead Contractor(s)
Dewatering	*Rights in Water and Irrigation Act 1914*	DOW.	5C Licence to Take Water	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 /DEC	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)
Noise	*Environmental Protection (Noise) Regulations 1997*	DEC	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*	DEC	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)

4.3 Relevant Environmental Guidelines

A range of State and Federal guidelines and codes of practice provide direction for environmental protection and impact assessments.

The key OEPA position statements and guidelines that are of relevance to the Project include:

- No. 2: Environmental Protection of Native Vegetation in Western Australia. December 2000.
- No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection. March 2002.
- No. 4: Environmental Protection of Wetlands. 2004.
- No. 6: Towards Sustainability. August 2004.
- No. 7: Principles of Environmental Protection. August 2004.
- No. 8: Environmental Protection in Natural Resource Management. October 2005.
- No. 9: Environmental Offsets. January 2006.
- Guide to EIA Environmental Principals, Factors and Objectives. June 2009.
- No. 6: Rehabilitation of Terrestrial Ecosystems. June 2006.
- No. 8: Environmental Noise. May 2007.
- No. 12: Minimising Greenhouse Gases. October 2002.
- No. 18: Prevention of Air Quality Impacts from Land Development. 2000.
- No. 33: Environmental Guidance for Planning and Development. May 2008.
- No. 41: Assessment of Aboriginal Heritage. April 2004.
- No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. June 2004.
- No. 55: Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process. December 2003.
- No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. June 2004.
- EPA Interim Industry Consultation Guide to Community Consultation. 2003.

The key DEC, DOW and other regulatory agency guidelines that are of relevance to the Project include:

- *Water Quality Protection Note - Toxic and Hazardous Substances (Storage and Use)* (DOW, 2010a).
- *Water Quality Protection Note - Containment Spills- Emergency Response* (DOW, 2010a).
- *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).
- Environmental Protection Heritage Council National Environmental Protection Measures.
- Kwinana Environment Environmental Protection Policy (EPP) (DEC).

- *Guidelines for the Assessment, Remediation and Management of Asbestos - Contaminated Sites in Western Australia (DEC).*
- *Odour Methodology Guideline* (DEC, 2000).
- *Review of Waste Classification and Waste Definitions 1996 (as amended)* (DEC).
- *Western Australian Guidelines for Direct Land Application of Biosolids and Biosolids Products, February 2002* (DEC).
- DEC Contaminated Sites Management Series Guidelines.

4.4 Commonwealth Legislation, Approvals and Guidelines

Key Commonwealth legislation and regulations and guidelines that may apply to the Project include, but are not limited to:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Aboriginal and Torres Strait Islander Protection Act 1984.*
- *Australia Heritage Council Act 2003.*
- *ANZECC Guidelines for Fresh and Marine Water Quality 2000.*
- *Native Title Act 1993.*

The key federal guidelines that are of relevance to the Project include:

- Australian Dangerous Goods Code (DIT, 2010).
- National Environmental Protection Measures for Air Quality (EPHC, 2003).

4.5 Other Approvals

The potential for the Project, if implemented, to impact on matters of national environmental significance was considered and accordingly, liaison with SEWPAC under the EPBC Act has taken place. The delegate for the Minister for SEWPAC decided that the proposed action is not a controlled action on 18 January 2013. This means that the proposed action does not require further assessment and approval under the EPBC Act before it can proceed.

In accordance with the *Aboriginal Heritage Act 1972*, approval is required to use land or water on which Indigenous sites or objects are located. The Project area is not contained within any registered Indigenous Heritage sites, including the boundary of the Swan River mythological site. Despite this, liaison with the Department of Indigenous Affairs (DIA) regarding the planned Project has been undertaken and liaison with the South West Aboriginal Land and Sea Council (SWALSC) is planned. Advice from the DIA indicates that a Section 18 application under the *Aboriginal Heritage Act 1972* will not be required.

5.0 STAKEHOLDER ENGAGEMENT

Stakeholder engagement undertaken to date has involved both technical stakeholders, e.g. Local and State Government agencies, and community stakeholders.

5.1 Technical Stakeholders

The Western Australian Government has agreed to sell 5.8 ha of Burswood Park reserve land to Crown for the purpose of developing a third hotel and associated facilities. The Development Approval submission package for the Project was submitted to the Minister Sport and Recreation; Racing and Gaming ("the Minister") on 13 November 2012. The Minister's Office will solicit review and comments from the Department of Planning, who in turn have engaged various Government Stakeholders.

Consultation has also been undertaken with OEPA and with DOW, DEC and via two meetings held in Q4 2012. The purpose of the meetings was to inform the regulatory agencies of the Project and the potential environmental impacts associated with the works. Following the initial consultation meeting held with DOW, DEC and, the invite was extended for the respective regulatory agencies to attend the weekly environmental working group meetings held between Crown and Golder personnel; however, they opted to receive a copy of the weekly meeting minutes instead.

In addition, discussion has been held with the following key stakeholders to provide an overview of the Project, and for input on key items:

- DIA (see Section 4.5).
- SEWPAC (see Section 4.5).
- SWALSC (pending, see Section 4.5).
- Town of Victoria Park - Meetings have been held with the CEO of the Town of Victoria Park to review the DA Submission and hold a workshop with the Town of Victoria Park to discuss and review any concerns they may have.
- Department of Planning - In addition to formally assessing the Project's Development Approval submission package, consultation with the Director of Strategic Project Implementation to provide an overview of the Project's detailed plans has been undertaken, focusing on intentions to access the new development from a road network standpoint. This information is to feed into the District Structure Plan currently being developed, which considers other major developments within the Burswood Peninsula.
- Main Roads - Liaison has also been undertaken with the Development Manager at Main Roads in relation to Crown's preferred road access solutions for the proposed Project. Intensions are to create a four-way proper intersection at Craig Road and align it with the existing Camfield Drive (which currently runs along the river) to create an additional vehicular entry point to the Burswood Peninsula on the far west end.

5.2 Community Stakeholders

Community engagement has been undertaken for the Project and will continue through both direct engagement and via electronic and published media. The Burswood Peninsula residents have been informed of the Project through a series of meetings. The Burswood Residents Action Group (BRAG) has been provided with a series of direct briefings outlining the proposed Project layout and design. Following a meeting held with BRAG on 27 November 2012, Crown was required to formally address BRAG's concerns in a letter to the Minister for Sport and Recreation; Racing and Gaming ("the Minister").

6.0 EXISTING PHYSICAL ENVIRONMENT

6.1 Overview

Comprehensive desktop and baseline environmental specialist investigations have been undertaken to establish the existing physical environmental characteristics of the Burswood Peninsula and specifically, the southern portion of the Burswood Park Golf Course which will accommodate the Project.

Assessments have been undertaken in the areas of:

- Geotechnical and other physical environment aspects.
- Groundwater.
- Surface water.
- Native Title and Indigenous heritage.

- European heritage.
- Contamination.

The competed studies, methodology and outcomes of the assessments are summarised in the section below.

6.2 Climate

Climate data for the Burswood Peninsula was obtained from the Bureau of Meteorology, represented by data from the Perth Airport Bureau of Meteorology station located approximately 8.7 kilometres (km) from the Project area.

The climate of the Project area is described as Mediterranean, with cool wet winters and warm dry summers. The station has recorded data from 1944 to present.

The data collected between 1944 and 2011 recorded an average maximum monthly temperature of 31.9°C during February; however, temperature data also show January as having high maximum temperatures at 31.6°C. The majority of minimum average temperatures were recorded at 8.0°C during both July and August.

Mean monthly rainfall over the 67 year period recorded the highest level of rainfall occurring in June with an average of 162.4 mm and the lowest level occurring in January with a minimum of 9.4 mm. An average annual rainfall of 776.4 mm has been recorded at the station.

The recorded data shows higher wind speeds being present at 3 pm than at 9 am. For wind speeds at 3 pm, the highest mean was recorded during December at 22.7 kilometres per hour (km/h) and the lowest at 14.7 km/h in May.

6.3 Surface Features and Topography

6.3.1 Overview

The Project area is located on generally low-lying ground located within an ox-bow bend of the Swan River, approximately three km to the north-east of the Perth Central Business District (CBD). Features of the site comprise of the following:

- The 1997 Perth Groundwater Atlas indicates that the maximum groundwater level across the site is below RL 3 m AHD.
- Depth to groundwater is typically about 1.3 m below the ground surface. Seasonal variation in the groundwater level up to about 1 m could be expected.
- A landscaped golf course is present over the northern part of the site. The surface comprises manicured lawn, except for a limestone gravel access track along the southern boundary of the course. The ground surface varies from an elevated green at about RL 7.8 m AHD to about RL 2.5 m AHD.
- An asphalt sealed car park (estimated total area of 1.55 ha) is present over the southern part of the site. The ground surface is relatively level and ranges from about RL 2.4 m AHD to RL 3.1 m AHD.
- Four lakes within the Burswood Park Golf Course and one lake in parkland adjacent to the Burswood Park Golf Course. The lakes hold groundwater sourced from a bore and the water is used for irrigating the Burswood Park Golf Course. The lakes are typically less than 2 m deep.
- Camfield Drive along the strip of land between the Swan River and the westernmost Lake. Camfield Drive has recently (about 2010) been sealed and widened to include car parking bays. The surface elevation of the pavement is about 3 m AHD.

The Burswood Peninsula is elevated outside of the Swan River foreshore flood way; however, like much of the Swan River foreshore areas in Perth, parts of the Burswood Peninsula are within the 100-year flood plain (see Figure 7).

All materials likely to be disturbed during Construction Phase works at the site are considered Acid Sulfate Soils (ASS). Management procedures are outlined in the Contaminated Site Management Plan (Golder, 2013e) included as Appendix C.

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 golf course portion of the site largely consists of undulating grass fairways, greens, sand bunkers and "rough" areas containing grass and trees as well as four shallow man-made lakes (Lakes 2 through 5). The western portion of the site consists of a portion of Lake 1. The southern portion of the site consists of a large parking lot used by the nearby Crown Perth complex. None of these lakes are connected via permanent water ways to the Swan River.

The ground surface level over this part of the Burswood Peninsula is largely low lying and is subject to inundation during flooding of the Swan River. During elevated periods of rain the groundwater levels on the golf course may also rise above ground surface resulting in boggy conditions. The current ground surface elevation at the Burswood Park Golf Course generally ranges from RL 2.0 m AHD near Lake 1 and gently undulates to the east with an overall increase to about RL 4 m AHD. A topographical high point is located on the south-east corner of the golf course with an RL 7.4 m AHD at a recently reconstructed bunker area. In comparison the parking lot on the southern portion of the site is generally flat with a topographical range of approximately RL 2.4 m AHD to 3.1 m AHD. The topography of the site has changed dramatically over the years due to the importation of various types of fill material which has generally increased the topographically elevation due to the placement of the fill material.

Imported fill will be used so the final design level of the Towers and other infrastructure within the Project area will be at or above RL 3.3 m AHD, which includes an allowance of 0.9 m for sea level rise and 0.5 m freeboard.

Golder Associates

CLIENT Crown Perth
DOCUMENT 127643111-010-R-Rev0
DATE 06 Feb 2013
COMPILED GGW
APPROVED SMB

0 100 200 300 400 500
metres

SCALE (at A4) 1:15,000

NOTES
Coordinate System: PCG94

COPYRIGHT
Aerial imagery © Nearmap 2012 & Landgate 2012.
Flood plain sourced from DoW 2003.

LEGEND
Estimated project boundary
100 year flood plain

Crown Towers EIA

1 IN 100 YEAR FLOOD PLAN

FIGURE 7

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6.4 Geology

6.4.1 Completed Studies

Golder has been involved with the development of the Crown Perth complex (formerly known as the Burswood Entertainment Complex (BEC)) since early planning in 1983. A list of reports containing site investigation data prepared by Golder and relevant to the proposed development is provided below:

- *Report to Cameron, Chisholm & Nicol Architects and Engineers on Geotechnical Investigation For Burswood Island Resort,* May 1985: Golder document reference 85640011.
- *Results of Electric Friction-cone Probe, October 2005:* Golder document reference 05642413 - L02
- *Results of CPT Testing - Proposed VVIP Rooms, Burswood Entertainment Complex, 18 December 2009:* Golder document reference 097642482-001-L-Rev0.
- *Results of Additional CPT Testing - Proposed VVIP Rooms, Burswood Entertainment Complex, May 2010*: Golder document reference 107642196-001-L-Rev0.
- *Results of Additional CPT Testing - Proposed Fire Tanks and Food Court, Burswood Entertainment Complex, September 2010:* Golder document reference 107642196-003-L-Rev0.
- *Preliminary Geotechnical Investigation for Kagoshima Park Area, Burswood Entertainment Complex, December 2010:* Golder document reference 107642196-005-R-Rev0.
- *Results of Additional CPT Testing - Proposed Swimming Pool Area, Burswood Entertainment Complex, April 2011:* Golder document reference 107542196-008-L-Rev0.

Coffey Environments Pty Ltd has undertaken environmental work for a previously proposed ferry terminal which was planned to be located near the development site. Copies of the following reports were provided to Golder by BEC during the study period:

- *Preliminary Site Investigation (PSI) & Detailed Site Investigation (DSI) - Proposed Burswood Ferry Inlet (Lot 301) Burswood, WA:* Coffey Environments Reference ENVIBURW10617AA-R1B, dated 7 April 2008.
- *Acid Sulphate Soil Investigation (Sediments) And Addendum Management Plan - Burswood Ferry Inlet Investigation, Burswood, WA*: Coffey Environments Reference ENVIBURW10617AA-R02, dated 31 March 2008.
- *Environmental Management Plan Proposed Burswood Ferry Inlet Burswood, WA:* Coffey Environments Reference ENVIBURW10617AA-R4A, dated 31 March 2008.

Geotechnical assessments completed for the Project area include:

- Preliminary Geotechnical Advice and Desk Study New Hotel Development, Burswood Entertainment Complex. 127642102-004-R-Rev0 (Golder, 2012a).
- Geotechnical Factual Report Crown Towers Perth, Burswood. Golder document reference 127642138-001-R-Rev0 (Golder, 2013f).
- Preliminary Geotechnical Advice, Crown Towers Perth, Burswood. Golder document reference 127642138-004-L-Rev0 (Golder, 2013g).
- Geotechnical Interpretive Report Crown Towers Perth. Golder document reference 127642138-003-R-Rev0 (Golder, 2013h).

6.4.2 Overview

The geotechnical conditions underlying the Burswood Peninsula have been investigated through:

- A literature review of previous investigations, and collation and review of all available geotechnical and groundwater data contained within 197 background documents.
- Site investigations and a detailed geotechnical investigation within the Project area.
- 2-D and 3-D hydrogeological modelling of groundwater quantities and movement.

The geotechnical investigation fieldwork was conducted between 19 November and 7 December 2012 and comprised the following:

- Drilling of 10 geotechnical boreholes, designated BH01 to BH10, extended to target depths of between 36.08 m and 52.31 m below surface level.
- Installation of two slotted PVC monitoring wells within BH04 and BH09.
- Undertaking groundwater level measurement and collection of groundwater samples from the groundwater monitoring wells for laboratory analysis to allow for assessment of corrosivity potential of the groundwater.
- Performing cone penetration testing (CPT) at 12 locations, designated CPT1 to CPT12 and CPT12A, generally extending to depths between 22.86 m and 40.2 m (CPT12 refused shallowly at a depth of 0.48 m). CPT1 to CPT11 and CPT12A were all terminated at refusal due to high penetration resistance.
- Excavation of test pits at seven locations, TP01 to TP07, extending to refusal depths of between 1.6 m and 2.5 m depth.

Golder has also undertaken a range of shallow boreholes for environmental purposes. Eleven of these boreholes were developed as monitoring wells (SB001, SB004, SB006, SB0015, SB0017, SB0019, SB0020, SB0024, SB0025, SB0031 and SB0033) to enable the shallow groundwater levels to be measured.

A plan showing the location of the geotechnical test locations, environmental monitoring wells and previous geotechnical investigation points is contained within (Golder, 2013f).

The following information has been reported in the SEWPAC Referral of Proposed Action (Golder, 2012i).

The Burswood Peninsula and adjacent Swan River has changed shape and appearance significantly since colonisation. The Burswood Peninsula was originally described as mudflats with a series of island sand bars. The shape and form of the present land surface is a result of river bank works and infilling over the Burswood Peninsula comprising a combination of dredged material sourced from the River, placement of uncontrolled fill whilst the site was used as a landfill facility, and clean sand fill placed as a containment barrier.

A key feature of the site is the ongoing slow movement (some horizontal but mainly vertical) of the SRA and other compressible fill materials which are present. These movements are still ongoing even though in most areas no load has been applied since around 1985.

A generalised subsurface ground profile encountered during the investigation is provided below:

- Unit 1 - FILL: Generally granular, but containing varying amounts of landfill comprising brick and brick fragments, plastics and plastic sheeting, timber, rubber tyres, concrete and steel, generally about 3 m to 5 m thick and encountered to levels of between about RL 0.4 m and RL 2.5 m AHD; overlying

- Unit 2 - SRA: Silty CLAY to Clayey SILT high plasticity normally consolidated which is very soft to soft but becoming firm with depth. The base of the unit varies significantly across the development site and ranges in level between about RL -4.8 m and RL -23.5 m AHD; overlying
- Unit 3A - Guildford Formation: Silty CLAY to Sandy CLAY (CL-CH) medium to high plasticity with fine to coarse grained quartz sand and gravels. Very stiff to stiff becoming soft at the base, not encountered at all locations, extending to a level of between about RL -13.5 m and RL -25.6 m AHD; overlying
- Unit 3B - Guildford Formation: SAND (SP)/Gravelly SAND (SP)/Clayey SAND (SC)/Silty SAND (SM): fine to coarse grained sand with trace gravels and well cemented lenses and nodules, generally medium dense to very dense (except BH10 as discussed below), extending to a level of between about RL -22.3 m and RL -33.0 m AHD; overlying
- Unit 4A - Mullaloo Sandstone: Silty Clayey SAND (SC-SM): fine to coarse sand with about 15-25% medium plasticity fines, predominantly medium dense with lenses of dense and very dense material, loose in parts (BH05), possesses soil properties, extending to a level of between about RL -30.8 m and RL -45.9 m AHD; overlying
- Unit 4B - Mullaloo Sandstone: SAND (SP): very dense, fine to coarse quartz sand, appears to possess soil properties, extending to the maximum depth investigated at RL -49.7 m AHD.

A plan showing the location of the geotechnical test locations, environmental monitoring wells and previous geotechnical investigation points is included in the Dewatering Management Plan (DMP) (Golder, 2013j) included as Appendix D.

Cross sections showing the different subsurface units across the development are also included in the DMP (Golder, 2013j).

6.5 Contamination

6.5.1 Completed Studies

The contamination assessments completed for the Project include:

- *Environmental Investigation Proposed Crown Towers Hotel Sampling and Analysis Plan and Data Quality Objectives.* Golder document reference 127642102-008-R-Rev0 (Golder, 2012b).
- *Environmental Investigation Proposed Crown Towers Hotel Detailed Site Investigation.* Golder document reference 127642102-R-R0XX (Golder, yet to be released).

The following reports have also been competed for the new Perth Stadium Project and are also relevant to the Crown Towers Project:

- *Desktop Study and Review of Previous Environmental Reports, Proposed Burswood Stadium, Rev* 117643077-002-R-RevB-DRAFT, (Golder, 2012c).
- *Preliminary Site Investigation Report, Proposed Perth Major Stadium,* Rev 117643077-005-R-Rev1, (Golder, 2012d).

6.5.2 Sampling and Analysis Plan

A SAP was prepared by Golder (2012b) in November 2012. The SAP (Golder, 2012b) provides a comprehensive guide for the collection of soil, landfill gas, groundwater, sediment, surface water and soil gas data for an evaluation of potential risks and remediation requirements.

A DEC Accredited Contaminated Sites Auditor from AECOM has been engaged (the Auditor), and has reviewed the SAP (Golder, 2012b) prior to its implementation.

6.5.3 Detailed Site Investigation

A DSI has been undertaken in stages in accordance with the respective stages of the SAP (Golder, 2012b). The DSI has included soil, sediment, surface water, groundwater, acid sulfate soils and landfill gas sampling and analysis.

All sampling undertaken as part of the DSI was completed in December 2012 with the exception of some landfill gas sampling undertaken in early January 2013. The final report for the DSI is anticipated to be available before the end of February 2013, subject to approval by the Contaminated Sites Auditor.

Consultation with the appointed Contaminated Site Auditor Jason Clay (AECOM) has occurred through each stage of the contaminated site investigation with submittal of each report to the Auditor for comment and clarification.

The results of the DSI 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.

The Contaminated Site Management Plan (Golder, 2013e) for a summary of the exceedances of DEC Ecological Investigation Levels (EIL) and DEC Health Investigation Levels (HIL D) in soil samples and the DSI (Golder, 2013k) for detailed results.

The OEPA will be kept advised of development of the contaminated sites investigation as it occurs.

6.6 Acid Sulfate Soils

6.6.1 Completed Studies

In addition to the information in Section 6.5 above, the following information was reviewed to assess the potential ASS risk of the soils at the site:

- DEC centralised ASS risk mapping database (WA Atlas) published by Landgate
- Australian Soil Resource Information System (ASRIS) maps by CSIRO Land and Water
- Previous consultant reports at the site.

6.6.2 Overview

Information collected from the above sources and their interpretations relating to the potential presence of ASS and hydrogeology are discussed in the sections below.

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 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 (see Figure 8)

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. Consequently, the information derived from the maps cannot be relied upon to confirm whether ASS management will be required for a specific location, even though these maps provide a broad-scale indication of ASS risk.

Investigations including the recently completed DSI (Golder 2012l) have confirmed that ASS is present in areas of the Burswood Peninsula. The high risk natural materials detailed in the DEC 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 Guilford Formation 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 as part of the DSI (Golder 2012l). Acidic 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 greater than 0.5 m below ground level (m bgl) are considered to be ASS and if disturbed during construction activities should be managed according to the procedures present in the Contaminated Site Management Plan (Golder, 2013e). It is advised the top 0.5 m of material excavated at the site can be placed elsewhere on-site without active management, provided it remains within 0.5 m of ground surface and is found to be uncontaminated.

ASS at site will be managed by the Lead Contractor(s) according to the Contaminated Site Management Plan (Golder, 2013e). However, a summary of the relevant matters pertaining to contamination has been summarised below.

Golder Associates

CLIENT Crown Perth
DOCUMENT 127643111-010-R-Rev0
DATE 06 Feb 2013
COMPILED GGW
APPROVED SMB

0 100 200 300 400 500
metres

SCALE (at A4) 1:15,000

NOTES
Coordinate System: PCG94

COPYRIGHT
Aerial imagery © Nearmap 2012 & Landgate 2012.
ASS risk mapping sourced from DEC 2007.

LEGEND
Estimated project boundary
ASS disturbance risk (<3m from surface)
High to moderate
Moderate to low
No known ASS disturbance risk

Crown Towers EIA

ACID SULFATE SOILS

FIGURE 8

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\010 R\Rev0\127643111-010-R-F008-Rev0-ASS.mxd

6.7 Groundwater

6.7.1 Completed Studies

As the Project is predicted to have minimal influence and impact on groundwater, no specific hydrogeology studies were completed. The reports listed in Section 6.5 and the background hydrogeological information obtained from the work completed by Golder for the new Perth Stadium Project provide sufficient information to inform the hydrogeological environment.

6.7.2 Hydrogeology

The three principal geological units underlying the proposed construction are the Fill, the Swan River Alluvium (SRA) and Guildford Formation. The Fill, SRA and Guildford Formation in the Burswood Peninsula 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. Beneath the Project area, the KPF is likely to be represented by an uncemented, very dense sand layer called the Mullaloo Sandstone. These aquifers would not be affected by construction dewatering for Project.

Across the Burswood Peninsula variations in both the thickness and presence of the three superficial units exist. At the site the Guildford Formation and fill are separated by approximately 5 to 25 m of SRA which acts as a semi-confining unit for the Guildford Formation. However, in areas immediately east of the site, the SRA is absent and the fill is in direct contact with the Guildford Formation. 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.

6.7.2.1 Groundwater Levels

Measured groundwater levels within the Fill (Unit 1), as recorded on 12 December 2012, range from about RL 2.8 m AHD to about RL 1.6 m AHD.

Groundwater levels are influenced by rainfall and irrigation resulting in localised changes in level and flow direction. Natural seasonal fluctuation of groundwater levels is likely to be in the order of 0.5 to 1.0 m but this fluctuation range may currently be dampened by irrigation practices.

6.7.2.2 Groundwater Flow

Davidson (1995) and the Perth Groundwater Atlas (2004) indicates that groundwater flow in the vicinity of Burswood is in a north-westerly direction towards the Swan River over the Burswood Peninsula, while at the Project area flow is likely to be west to south-west 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 car park and buildings to the south and eastern extents of the site.

The tidal influence of the Swan River may change the flow direction in close proximity to the Swan River. On a rising tide a localised reversal of flow direction may be observed; however, this is not likely to extend to within the site boundary with the possible exception of areas west of Lake 1.

See the DMP (Golder, 2013i) for information on the hydraulic properties for the shallow fill layer.

6.7.3 Groundwater Quality

Groundwater quality sampling has been completed as part of environmental investigations, with details of the sampling and test results presented in Golder (2013j).

Laboratory test results for groundwater sampling in November and December 2012 from 14 wells are presented in the DMP (Golder, 2013j). Of these wells, 12 are screened in the fill layer, one is screened in the SRA and one is in the Guildford Unit. Results indicate:

- Field measured pH is generally neutral to slightly basic.
- Total Dissolved Solids (TDS) values range from 878 mg/L to 7210 mg/L in the Fill layer. A higher TDS of 8 590 mg/L was reported in the well screened in the SRA.
- Total cyanide was reported above the ANZECC 2000 guideline value at 6 locations.
- Some metal concentrations were marginally above ANZECC 2000 and SRT guidelines with concentrations of nickel, aluminium, copper, and iron exceeding at least one guideline value for at least one sample at the site.
- Ammonia concentrations exceeded the ANZECC 2000 guideline value in all reported results except one, with maximum values significantly higher than the guideline values. Total phosphorus and total nitrogen levels were reported above the SRT guideline at some locations.
- The chloride:sulfate ratio exceeded the DEC Groundwater Acidification guidelines in both wells sampled.
- Total Petroleum Hydrocarbons (TPH C_{10}-C_{36}) were observed in one sample above the ANZECC 2000 guideline, and was reported above the laboratory detection limit at six other locations.

For more information on the existing groundwater environment, see the DMP (Golder, 2013j).

6.7.4 Potential Impacts to Groundwater from Piling

The current Project design includes the use of piling for support of more heavily loaded areas such as the high rise Crown Towers hotel building. Potential piling solutions have been discussed in Section 3.2.2.2. There is a possibility that should it not be managed appropriately, piling activities may increase potential for cross contamination between aquifers. This will depend on the depth of columns and the depth to groundwater at the location of columns.

The potential impacts to groundwater and proposed management and mitigation measures are discussed in Section 9.5.

6.8 Surface Water

6.8.1 Completed Studies

A surface water assessment was undertaken for the new Perth Stadium as part of the *Desktop Study and Review of Previous Environmental Reports, Proposed Burswood Stadium* (Golder, 2012c) which is also relevant to the Crown Towers Project. This report was provided to Crown for use by the Department of Treasury Strategic Projects.

6.8.2 Overview

The Swan River is the dominant surface water feature and bounds the Burswood Peninsula to the north, east and west. Additionally, there are five constructed artificial lakes of various sizes within the Project area, the location of these are shown on Figure 3. The lakes are reportedly clay lined and topped up with bore water to maintain constant levels and provide water for irrigation.

Lakes 2 to 5 are irrigation lakes fed by bores connected to the Leederville Aquifer under a licence held by the Burswood Park Board, issued by the DOW. Lake 1 is a stormwater fed lake, receiving stormwater from the Crown Perth complex buildings, and is not used for irrigation.

During summer, the influence of the Swan River is limited to the river's fringe, whereas in winter, river water levels can rise and extend into the Project area. The extent of the floodway from a 1 in 100 year flood for the Burswood Peninsula is illustrated in Figure 7

Under the current land cover and land-use conditions, the inputs of rainfall will be readily infiltrated into the underlying soil layers. Effective rainfall, net of evaporative losses, will provide recharge to any underlying local groundwater systems. The proportion of rainfall reaching groundwater systems could potentially be reduced by development of the Project area. During extreme storm events, some level of localised surface runoff and ponding may be experienced across the existing site due to high intensity rainfall exceeding the infiltration capacity of the soil.

6.9 Indigenous Heritage

6.9.1 Overview

A search using the Aboriginal Heritage Inquiry System (AHIS) was performed on 18 October 2011 for identification of Indigenous and other heritage sites and only one site was identified within the immediate vicinity of the Project area; the Swan River, a Mythological site with the registered site number 3536.

Sites identified using the AHIS is not exhaustive as sites may not have been recorded in the Register of Aboriginal Sites, or identified in previous heritage surveys/reports but is still protected under the *Aboriginal Heritage Act 1972*. Community consultation with Indigenous communities and native title claimants is underway.

It is understood development of the Burswood Peninsula would need to have an understanding of local Indigenous interests in the area and also of the possibility of encountering subsurface Indigenous skeletal material or Indigenous cultural material. As a matter of course, liaison with the DIA as to the requirement for Section 18 approval to disturb an Indigenous Heritage Site under the *Aboriginal Heritage Act 1972* has been undertaken as described in Section 4.5.

Liaison with SWALSC is also underway and the consultation process with the respective Aboriginal stakeholders has commenced and is being coordinated through DIA and SWALSC.

6.10 European Heritage

6.10.1 Completed Studies

No specific European heritage assessments were required for the Project.

6.10.2 Overview

Based on the database search performed in October 2011 for the new Perth Stadium Project to identify sites of cultural or historical significance on the State's Register of Heritage Places within the Burswood Peninsula; Table 4 outlines the place is in closest proximity to the Project area.

Table 4: Heritage Place Closest Proximity to the Project Area

Place Name	Location	Status	General Use
Old Burswood Canal	Near Goodwood Place, Burswood	Constructed: 1831 to 1834 Demolished: No	Historical: Transport and Communications Present: Transport and Communications

The Project will not impact on the place identified in Table 4.

History of the Burswood Peninsula land uses providing historic context for the Project is summarised in the following sections. Figure 9 illustrates European Historic Land Uses.

6.10.2.1 Early Settlement

The European settlement of Perth saw the Burswood Peninsula being granted to Henry Camfield in 1829 for the use of various agricultural activities including market gardens and a piggery, which continued until the turn of the 20th century under various owners and tenants (Gallop, date unknown). It was during this period that the Burswood Canal was constructed (1831) (Gallop, date unknown) (see Figure 9), connecting the deeper waters found at Maylands to the east and East Perth to the west of the Peninsula, allowing larger vessels travelling along the Swan River between Guildford and Perth to circumvent the shallow waters found to the north of the Peninsula. Burswood Canal is generally acknowledged as one of Perth Colony's first public works programs and is included on the Stage Register of Heritage Places pursuant to the *Heritage of Western Australia Act 1990*.

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0 80 160 240 320 400
metres

SCALE (at A4) 1:12,000

NOTES
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LEGEND
Estimated project boundary

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EUROPEAN HISTORIC LAND USES

FIGURE 9

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\010 R\Rev0\127643111-010-R-F009-Rev0-European_Land_Uses.mxd

6.10.2.2 Recreational Use

The Burswood Peninsula was used for recreation from its earliest days. In August 1895, the former farm of Henry Camfield made way for Western Australia's first public golf course (Gallop, date unknown), which operated on the Burswood Peninsula until 1900. Soon after the closure of the golf course, the Western Australian gold rush saw horse racing surge in popularity, with Albert Cockram taking a lease over Burswood Peninsula, and starting an unregistered race track. The Burswood Turf Club began as a proprietary club of Albert Cockram, with its first event being held on 9 December 1899 (Gallop, date unknown).

Cockram then established a second race course on the adjoining land to the south of Belmont Park, to be known as the Goodwood Racecourse. This site was first built up with sand and railway cinders before being planted with grass, with the track's first meeting held on 17 August 1912 (Gallop, date unknown).

Both Belmont Park and Goodwood were well patronised until in 1943, when the WATC purchased both tracks, putting an end to proprietary racing in Western Australia (Gallop, date unknown). Goodwood Track closed in 1950.

6.10.2.3 Waste Disposal

In 1906, a portion of the land on the western side of the Burswood peninsula was used for the establishment of filtration beds for sewage, which was siphoned under the Swan River form Claisebrook (Gallop, date unknown). The beds were closed in 1934.

In addition to sewage disposal, the Burswood Peninsular has also been used for the disposal of domestic and industrial waste. The area accepted waste from 1946, and while domestic fill ceased in 1972, other waste continued to be dumped until the early 1980s (Gallop, date unknown). Waste included but was not limited to car bodies, building rubble, household garbage, cinders, clay, and bitumen.

6.11 Sensitive Receptors

The Project area is currently used as a section of the southern portion (southern nine holes) of the Burswood Park Golf Course and a car park.

The nearest residences to the Burswood Park Golf Course are the apartment blocks within the Mirvac Burswood Peninsula development and adjacent townhouses off Victoria Park Drive. Residences on Bow River Crescent within the Mirvac development are immediately adjacent to the northern portion of the Project area.

Other surrounding land uses include the:

- Northern portion of the Burswood Park Golf Course (holes 9 to 18), Kagoshima Park and Charles Patterson Park.
- The Burswood Park Golf Course associated buildings including the service area, restaurants and clubhouse.
- Former Swan Portland Cement and James Hardie Industries area (currently Mirvac Fini Development) are located south of the Burswood Tennis Centre.
- Crown Perth complex and the Dome.
- The Swan River to the west of the Project area which is used for recreational purposes, including boating and fishing.

6.12 Air Emissions and Greenhouse Gases

The Burswood Peninsula is not considered to be a dusty environment as it is highly developed and landscaped. Ambient particulate levels in the vicinity of the Burswood Park Golf Course are not routinely monitored. However, airshed data are measured roughly every 5 to 10 years by the DEC for the National Pollutant Inventory (NPI).

According to the latest airshed dataset of 2010/2011, the top five substances emitted to air, their volume and their sources from the Perth airshed, which includes Burswood, are outlined in Table 5.

Due to the proximity of the nearest residences (see Section 6.11) and the potential for dust generating activities due to construction works associated with the Project, potential dust impacts on sensitive receptors from the Project are high. Ambient dust levels, however, are likely to be highly variable and linked to factors such as prevailing climatic conditions and the levels of traffic movements.

The six greenhouses gases that are regulated under the Kyoto protocol are carbon dioxide (CO_2), methane (CH_4), perfluorocarbons (CF_x), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6) and nitrous oxide (N_2O). To compare the warming potential of the different gases, their impact is usually expressed in terms of CO_2 equivalents (CO_2e), by which the potential of each gas to heat the atmosphere is expressed in terms of carbon dioxide equivalents.

Sources of existing greenhouse gasses generated from the Burswood Peninsula include:

- Combustion of fuel to generate electricity for power requirements.
- Combustion of fuel used in light vehicles travelling within and around the Burswood Peninsula.
- Methane from algal ponds and landfill gas.

Table 5: Top Five Air Emissions, Volume and Sources from the Perth Airshed for 2010/2011

Substance	Volume per Annum	Source									
		Motor Vehicles	Solid Domestic Fuel Burning	Lawn Mowing	Aeroplanes	Cigarettes	Architectural Surface Coatings	Domestic/ Commercial Solvents and Aerosols	Service Stations	Biogenics	Gaseous Domestic Fuel Burning
Carbon Monoxide	2 551 131	✓	✓	✓	✓	✓					
Total Volatile Organic Compounds	475 215	✓	✓				✓	✓	✓		
Oxides of Nitrogen	233 335	✓	✓		✓					✓	✓
Particulate Matter 10 µm	43 970	✓	✓	✓	✓						✓
Toluene	29 866	✓		✓			✓	✓			

(National Pollutant Inventory, 2012)

6.13 Noise

Ambient noise levels at the Burswood Park Golf Course are generally low given the current land use, with some audible traffic noise emanating from Victoria Park Drive and potentially some noise generated from Swan River recreational users. The adjacent land use is a mix of generally quiet residential areas and potentially noisy commercial/entertainment areas. The Crown Perth complex is a casino and entertainment venue operating until late seven days per week. The Dome was predominantly a music concert venue; however, has recently been decommissioned. The Crown Perth complex, including associated parking facilities and train stations can be the source of public ambient noise generation, particularly over the weekends.

The potential sensitive receptors in the proximity of the Project are the residential areas located adjacent the Project area, to the east. The Project operations are expected to increase the existing ambient noise levels based on the increase in the volume of people and traffic to access the area. Following the Construction Phase, traffic levels may increase marginally from current levels.

6.14 Traffic

The two main roads allowing access into and out of the Crown Perth complex are Victoria Park Drive and Great Eastern Highway in Burswood. Victoria Park Drive is accessible via two major roads, namely Graham Farmer Freeway (east and west) and Great Eastern Highway (east and west). Graham Farmer Freeway is a 6.4-kilometre inner-city freeway in Perth, Western Australia. It links Rivervale and Burswood with West Perth and Leederville, providing an east-west bypass of Perth's central business district. The Great Eastern Highway is a major road between the Western Australian cities of Perth and Kalgoorlie. It is a key route for vehicles accessing the eastern Wheatbelt and the eastern goldfields. It also forms the westernmost 595 km of the main road transportation link between Perth and the east coast of Australia. Both the Graham Farmer Freeway and the Great Eastern Highway are considered high congestion roads, particularly during peak traffic periods (from 5.45 am to 9:00 am and 3:30 pm to 6:30 pm Monday to Friday (Main Roads, 2012)). Victoria Park Drive can also have busy periods during peak traffic periods and during major events held at the Crown Perth complex.

The two minor roads allowing access to the Crown Perth complex are Bolton Avenue and Glenn Place, accessible via the Great Eastern Highway and/or Victoria Park Drive. Bolton Avenue provides access to the Plaza and Glenn Place provides riverside access. The proposed Project is anticipated to increase the volume of traffic accessing the Crown Perth complex via Victoria Park Drive, and from the Great Eastern Highway feeding into Bolton Avenue and Glenn Place. The Crown Perth complex is also accessible by public transport via train.

The report *Burswood Entertainment Complex Microsimulation Traffic Modelling* (Arup, 2012) was completed for the proposed Project to model future traffic demand and predict key concerns for traffic performance. This report indicates that traffic congestion is already an issue along Glenn Place and Bolton Avenue in peak periods (6 pm to 8 pm), so any additional traffic due to the proposed Project may contribute to this congestion.

It is estimated that traffic volume increases will be minimal during the Construction Phase; regular increases in traffic are likely to be in the form of trucks delivering fill and removing waste material off-site and these are not expected to operate during peak periods. Traffic volumes are likely to increase significantly during the Operations Phase due to the availability of accommodation for more than 500 people as well as the provision of new retail and hospitality options. The Project proposes to create new access to the Crown Perth complex from the west with the modification of Glenn Place; however, if access to Glenn Place is to remain via Bolton Avenue, congestion may potentially be an issue.

6.15 Visual Amenity

There are no current visual amenity issues within the Burswood Peninsula as the area is highly developed, landscaped and could be considered picturesque due to views of the city of Perth and the Swan River.

Future aesthetics and visual amenity issues associated with the Construction Phase works within the Project area, and with the construction of a 25 storey hotel complex, may be unfavourable to some residents in the area. This is predominantly due to the clearing of flora and vegetation associated with the works and the height of the proposed building. Increased traffic volumes within the Project area as well as surrounding roads could also cause concern to local residents and users of the public spaces and surrounding entertainment venues. The local community group BRAG have been consulted with regard to the proposed development design, with a response to comments available on request.

7.0 EXISTING ECOLOGICAL ENVIRONMENT

7.1 Completed Studies

The following reports completed for the new Perth Stadium project, provided to Crown by the Department of Treasury Strategic Projects, also apply to the proposed Crown Project and have been reviewed to provide baseline ecology information:

- *Desktop Study and Review of Previous Environmental Reports: Proposed Burswood Stadium*. (Golder 2012c).
- *Proposed Burswood Stadium - Level 1 Flora Survey.* (Golder, 2012e).
- *Assessment of the importance of Burswood Peninsula and Claisebrook for Migratory and other Significant Birds*. (Bamford, 2012a).
- *Assessment of the importance of Burswood Peninsula and Claisebrook for Non-Avian Fauna*. (Bamford 2012b).

The ecological assessments undertaken for the Crown Project area are:

- Crown Perth Aquatic Fauna Survey (Golder, 2013l)
- Avian Fauna Survey, Proposed Crown Towers, Burswood (ENV Australia, 2012).

Figure 10 illustrates the location of prominent avian fauna, aquatic fauna, flora and vegetation and social impact areas, as discussed in the following sections. The information in the following sections is extracted from the reports listed above.

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0 50 100 150 200 250
metres

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LOCATION OF PROMINENT AVIAN FAUNA, FLORA & VEGETATION, AND SOCIAL IMPACT AREAS

FIGURE 10

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7.2 Desktop and Database Searches

7.2.1 EPBC Act Protected Matters Database

A search of the EPBC Act Protected Matters Register was conducted on 29 November 2012 for the Project area including a one kilometre buffer radius. One item was identified on the Register of National Estate as summarised in Table 6 and Figure 11; however, this site was not located directly within the Project area.

Table 6: Burswood Peninsula: Summary of Environmental Protected Areas within a 1 km Radius of the Project Area

Matters of National Environmental Significance	
World Heritage Properties	None
National Heritage Places	None
Wetlands of International Significance (Ramsar Lakes)	None
Great Barrier Reef Marine Park: Commonwealth Marine Areas	None
Threatened Ecological Communities	None
Threatened Species	16
Migratory Species	12
Other Matters Protected by the EPBC Act	
Commonwealth Lands	None
Commonwealth Heritage Places:	None
Listed Marine Species	9
Whales and Other Cetaceans	None
Critical Habitats	None
Commonwealth Reserves	None
Additional Information	
Place on the Register of the National Estate (RNE)	1
State and Territory Reserves	None
Regional Forest Agreements	None
Invasive Species	16
Nationally Important Wetlands	1

There are no threatened ecological communities listed in the vicinity of the Project or nearby surrounds; however, there are listed threatened species have been indicated as occurring within the vicinity of the Project.

Table 7 outlines the results of the EPBC Act Protected Matters Search Tool for listed threatened fauna identified with the vicinity of the Project area.

Table 7: Results of the EPBC Act Protected Matters Search Tool for Listed Threatened Fauna Identified within the Vicinity of the Project Area

Scientific Name	Common Name	EPBC Act Listing
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo	Endangered
Leipoa ocellata	Malleefowl	Vulnerable
Rostratula australis	Australian Painted Snipe	Vulnerable
Sternula nereis nereis	Fairy Tern (Australian)	Vulnerable
Synemon gratiosa	Graceful Sun Moth	Endangered
Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable
Caretta caretta	Loggerhead Turtle	Endangered
Chelonia mydas	Green Turtle	Vulnerable
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle	Endangered

Table 8 outlines the results of the EPBC Act Protected Matters Search Tool for listed threatened flora identified with the vicinity of the Project area.

Table 8: Results of the EPBC Act Protected Matters Search Tool for Listed Threatened Flora Identified within the Vicinity of the Project Area

Scientific Name	Common Name	EPBC Act Listing
Andersonia gracilis	Slender Andersonia	Endangered
Centrolepis caespitosa	Matted Centrolepis	Endangered
Darwinia foetida	Muchea Bell	Critically endangered
Lepidosperma rostratum	Beked Lepidosperma	Endangered
Thelymitra manginii K.Dixon & Batty ms.	Cinnamon Sun Orchid	Endangered
Villarsia calthifolia	Mountain Villarsia	Endangered

Table 9 outlines the results of the EPBC Act Protected Matters Search Tool for listed migratory species identified within the vicinity of the Project area.

Table 9: Results of the EPBC Act Protected Matters Search Tool for Listed Migratory Species Identified within the Vicinity of the Project Area

Scientific Name	Common Name	EPBC Act Listing
Apus pacificus	Fork-tailed Swift	Threatened
Ardea alba	Great Egret, White Egret	Threatened
Ardea ibis	Cattle Egret	Threatened
Haliaeetus leucogaster	White-bellied Sea-Eagle	Vulnerable
Leipoa ocellata	Malleefowl	Vulnerable
Merops ornatus	Rainbow Bee-eater	Vulnerable
Rostratula benghalensis (sensu lato)	Painted Snipe	Vulnerable
Caretta caretta	Loggerhead Turtle	Endangered
Chelonia mydas	Green Turtle	Vulnerable
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Endangered

An interpretation of these results and an assessment of the potential impact of the proposed Project on the species listed above are being managed under state and Commonwealth referral advice and applications.

7.2.2 ENV Database Review

Golder engaged ENV Australia Pty Ltd (ENV) to undertake a Level 1 Avian Fauna Survey for the Project area. The survey included a database review, undertaken on 3 December 2012, and a field survey, undertaken on 6 and 7 December 2012.

The literature review and database search was undertaken by ENV to determine avian and other fauna species potentially within the vicinity of the Project area based on known patterns of distribution. The following databases were searched on 3 December 2012 based on the boundary of the Project area:

- Birdlife Australia's Birdata database, one degree square buffer (Birdlife Australia, 2012a).
- Birdlife Australia's Shorebird 2020 database, Swan Estuary Marine Park (Birdlife Australia, 2012b).
- DEC combined biological database NatureMap, 5 km buffer (DEC 2012a).
- DEC Threatened and Priority Fauna Database, 5 km buffer (DEC, 2012b).
- SEWPAC Protected Matters Search Tool, 5 km buffer (SEWPAC, 2012).
- Previous biological survey reports by Bamford Consulting Ecologists (2012).
- Ornithological Technical Services (2012).

The results of these database searches are included as Appendix E.

7.2.3 Australian Bilateral Migration Agreements

A search was undertaken to determine which of the migratory and threatened species identified as potentially occurring within the Project area also fell under the following Australian bilateral migration agreements:

- JAMBA: Japan - Australia Migratory Bird Agreement
- CAMBA: China - Australia Migratory Bird Agreement
- ROKAMBA: Republic of Korea - Australia Bird Agreement.

The results of the database searches listed above and the results of the avian fauna surveys completed for the Project, including the database search results and previous survey results are included as Appendix E.

7.2.4 DEC Threatened Flora Species Database for Declared Rare Flora and Priority Listed Taxa

The results from the Threatened Flora Database (DEFL), the WA Herbarium database (WAHerb), and the Declared Rare and Priority Flora Species List for the Project identified no occurrences of, threatened flora, declared rare flora or priority listed taxa within the Project area (Golder, 2012c).

7.2.5 DEC Threatened Ecological Community and Priority Ecological Communities Databases

The results from the DEC Flora and Fauna Divisions search for flora and threatened ecological communities (TEC) database found no known occurrences of TEC recorded within the Project area (Golder, 2012c).

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0 390 780 1,170 1,560 1,950
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Flora locations sourced from DEC & WA Herbarium 2011.
Bird Records sourced from Birds Australia 2012.
ESA sourced from DEC 2011.

NOTES
Coordinate System: PCG94

LEGEND
Estimated project boundary
Envrionmentally Sensitive Area

Flora of Conservation Significance
Priority 3
Priorty 4

Birds of Conservation Significance
Carnaby's Black-Cockatoo
Caspian Tern
Common Sandpiper
Crested Tern
Eastern Great Egret

Crown Towers EIA

LOCATION OF ENVIRONMENTAL DATABASE SEARCH RESULTS

FIGURE 11

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\010 R\Rev0\127643111-010-R-F011-Rev0-Cons_Flora.mxd

7.3 Flora and Vegetation

Golder was commissioned on behalf of the Department of Treasury Strategic Projects, to complete a Level 1 Flora survey for the new Perth Stadium Project proposed for the northern nine holes of the Burswood Park Golf Course, which was conducted in early February 2012 (Golder, 2012e). Despite the survey being scoped for the new Perth Stadium Project, the survey focused on the lake and riparian vegetation of 15 river sites and 10 lake sites over the Burswood Peninsula, which also included the area proposed for the Crown Project. The Department of Treasury Strategic Projects have provided the Level 1 Flora Survey to Crown. The locations of the 15 river sites, 10 lake sites and the Survey area for the Golder (2012e) are shown in Figure 12.

The Survey area consisted of constructed lakes with fringing riparian vegetation, Swan River riparian vegetation, stands and individual trees and palms. Most of the trees appeared to be less than 30 years old and were generally garden specimen trees. Much of the riparian vegetation of the lakes was likely to be sourced from surrounding water bodies by birds and wind transfer of propagules.

Aside from mixed native and mixed exotic hardwood composition, no clear vegetation units were identified due to the extremely modified and variable nature of vegetation along the River margin and amongst the lakes (Golder, 2012e). No units or even individuals of remnant native vegetation were identified. This lack of remnant vegetation was probably due to the historical highly disturbed nature of the Survey area due to previous use as a landfill facility, evidenced by debris along the shoreline and other eroded areas.

A summary of the findings within each area is provided below and additional information is provided in Golder (2012e).

7.3.1 Summary of Findings

The Survey area contained little vegetation that was ecologically significant in itself (Golder, 2012e). Much of the vegetation observed was introduced and not representative of regional flora or vegetation, or consisted of species common to wetlands within the region. All lake and riparian sites surveyed demonstrated significantly degraded conditions. This finding was not surprising given that much of the land comprising these areas was historically used for landfill (Golder 2012e). Although some basic ecological wetland functions were likely to be demonstrated within the artificial lakes, given their vegetation assemblage and expected water qualities, these were not likely to be of high conservation or ecological value.

Nonetheless, much of the Survey area was likely to have significant habitat value for many common waterfowl and amphibian species. Despite primarily hosting common species, these lakes still remain as wetland representation within the greater Perth area, which was significant as wetlands within the Perth region are very depauperate (Golder, 2012e).

In summation:

- The current Swan River riparian ecological values were very depauperate and demonstrated degradation and little remaining original vegetation. Soils were visibly showing landfill wastes along the foreshore and high erosion from boat activity. Conversely, clean landfill waste such as brick and masonry may act as bank armouring and facilitate riparian vegetation establishment.
- Lake vegetation demonstrates little intrinsic conservation significance; however, is of regional value and displayed many vegetation assemblages typical of the region such as *Melaleuca* canopies and *Typha*/*Juncus* understoreys.
- Lake vegetation may further provide valuable habitat to bird fauna in the absence of any other being available within the wider Perth area.
- Due to the lack of any remnant vegetation, it is unlikely that a native vegetation clearing permit will be required from the DEC unless clearing of the riparian flora of the Swan River is proposed. However, Crown will liaise with DEC on this matter.

Additional information is provided in Golder (2012e).

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0 50 100 150 200 250
metres

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LEGEND
- Estimated project boundary
- Fauna survey location / Burswood lake site
- Flora survey location
- Swan River riparian survey site

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STUDY AREA FOR FLORA AND FAUNA SURVEYS

FIGURE 12

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7.4 Avian Fauna

Golder engaged ENV to undertake a Level 1 avian survey for the Project area. The Level 1 avian fauna survey included a database review, undertaken on 3 December 2012, and a field survey, undertaken on 6 and 7 December 2012. The field survey was consistent with EPA guidelines for environmental surveying and reporting for fauna in Western Australia, and consisted of:

- Avian fauna habitat mapping.
- A systematic avian census.
- Targeted roost/nest assessment.
- Opportunistic sightings.

7.4.1 Summary of Findings

The Project area contained three broad habitat types: Moderate Value Habitat; Low Value Habitat; and Lakes. These areas are artificial and widespread throughout the Burswood Park Golf Course and parks surrounding the Project area. A large car park area, classified as Cleared Land, was included in the Project area but provided no avian fauna habitat of any value.

- Moderate Value Habitat was mapped to cover approximately 2.15 ha of the study area, and was confined to the shoreline of the lakes within the study area. These areas contained typical wetland vegetation and grassed areas.
- Low Value Habitat was mapped to cover approximately 4.02 ha of the study area, and consisted of grassed areas, and some areas that included trees and ornamental gardens.
- Lakes were mapped to cover approximately 1.63 ha of the study area, which provide foraging habitat for waterbirds.
- The avian census recorded a total of 46 avian fauna species from 22 families within the study area.

With regard to avian fauna of Conservation Significance, the following observations were of note:

- No species of conservation significance were recorded roosting or nesting within the Project area.
- Four species of conservation significance were recorded during the survey:
  - Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*), listed as Vulnerable under the EPBC Act (five birds opportunistically spotted flying overhead)
  - Great Egret (*Ardea alba*), listed as Migratory under the EPBC Act
  - Black-backed Bittern (*Ixobrychus dubius*), listed as “Priority 4” by the DEC
  - Caspian Tern (*Hydroprogne caspia*), listed as Migratory under the EPBC Act.
- Database searches revealed an additional 52 conservation significant avian fauna species that have been previously recorded within the vicinity of the study area. Of these, two species were considered likely to occur within the Project area:
  - Eastern Osprey (Pandion cristatus)
  - Rainbow Bee-Eater (Merops ornatus).
- Based on ecology, habitat present and known fauna records, a further 41 species were considered “Possible” to occur, eight species were considered “Unlikely” to occur and one species was classified as “Highly Unlikely” to occur.

ENV reported that the clearing of the Project area was unlikely to have an impact on the species occurring or potentially occurring within the Project area. The majority of the species recorded during the survey were common and wide spread with good dispersal abilities, therefore, could easily move to new habitats in the local area. In the local region there are a number of large fresh water lakes which provide suitable habitat. However, further development to the surrounding Burswood Park Golf Course was expected to impact on the local populations of avian fauna in the area.

The results of the avian fauna surveys, including the database search results are outlined in Section 7.0.

7.5 Non-Avian Fauna

Ecologist specialists Bamford Consulting Services (Bamford) completed a non-avian fauna survey for the Burswood Park Golf Course in February 2012. The site inspection was carried out by Dr Mike Bamford and Mrs Mandy Bamford, with the site traversed and any observed fauna counted. Observations and environmental values of the survey area are summarised below, with survey locations shown on Figure 12. More information is provided in Bamford (2012b) and Golder (2012e).

7.5.1 Summary of Findings

- Invertebrates - Based on the flora and vegetation values observed within the Survey area, there is likely no suitable habitat to host any of these significant invertebrates.

- Fish - The lakes in the Survey area contained a number of common fish species including native Wallace's Hardyhead (also common to the Swan River), and native Freshwater Shrimp (*Palaemonetes australis*) and introduced pest Mosquitofish (*Gambusia holbrooki*) both present in high numbers. Native Swan River Goby (*Pseudogobius olorum*) were also common in both lakes and large introduced pest fish Koi Carp (*Cyprinus carpio*) were sighted in Lakes 3 and 4 (Golder, 2013l).

- Reptiles - The Fence Skink (*Cryptoblepharus buchanani)*, was observed during the field survey, while Long-necked Tortoises (*Chelodina oblonga)* are known to inhabit the lakes.

- Mammals - One mammal, the introduced Brown (or Ship) Rat (*Rattus norvegicus*), was observed during the field survey and is reported by golf course staff to be abundant in the area.

The assemblage of non-avian fauna in the Survey area is expected to be very depauperate. This is related to the location of the Survey area (being isolated from areas of native vegetation and surrounded by urban development), its history (long periods of disturbance and degradation) and ecological condition (re-planted with often non-native plant species and broad open lawns with little habitat for fauna). Most of the fauna species will have been lost due to the history of the Survey area, and even where suitable habitat has been recreated there is limited scope for unassisted re-colonisation. The habitat that has been recreated is also often unsuitable for native mammals which often require hollow logs, leaf-litter, dense understorey vegetation or similar.

The Survey area provides little habitat for significant invertebrates, frogs, reptiles and mammals.

7.6 Aquatic Fauna

Golder was commissioned to undertake an aquatic fauna survey of artificial Lakes 1 to 5 located within the Burswood Park Golf Course for the Project (see Figure 3). Lakes 1 to 5 are artificial irrigation lakes north of the Crown Perth complex within the southern portion of the Burswood Park Golf Course. The objective of the aquatic fauna surveys was to assess the values of aquatic fauna and flora inhabiting Lakes 1 to 5, and the requirement for species of conservation significance, if identified, to be relocated prior to Project works being undertaken.

A survey to assess the in-lake aquatic fauna inhabiting Lakes 1 to 5 including fish, frogs, aquatic macroinvertebrates, crustacea and turtles was completed over three days during 30 November and 3 to 4 December 2012. Golder personnel, Dr Clint McCullough and Sarah Brown, undertook the aquatic fauna survey, which involved netting of targeted aquatic fauna types.

7.6.1 Summary of Findings

All lakes showed few aquatic fauna values due to their artificial nature, depauperate littoral (shallows) and riparian (edge vegetation) habitats and only moderate water quality. Lake 1 received storm water run-off (this lake is currently the receival body for Crown’s stormwater) and the habitat in this Lake was very good for native Oblong Turtles (*Chelodina oblonga*).

No Priority Species or species listed under the EPBC Act were observed in Lakes 1 to 5. All lakes had a number of common fish species including native Wallace’s Hardyhead (also common to the Swan River), and native Freshwater Shrimp (*Palaemonetes australis*) and introduced pest Mosquitofish (*Gambusia holbrooki*), both present in high numbers. Native Swan River Goby (*Pseudogobius olorum*) were also common in both lakes and large introduced pest fish Koi Carp (*Cyprinus carpio*) were sighted in Lakes 3 and 4. Native Oblong Turtles were common in most lakes, especially Lake 1. The introduced pest Yabby crayfish (*Cherax destructor*) and native marron (*Cherax tenuimanus*) were also common in almost all lakes.

The Oblong Turtle (*Chelodina oblonga*), classified as Near-Threatened on the IUCN Red List of Threatened Species (ICUN Red List, 2012), was found in Lakes 1, 2 and 3 and this species is likely to be resident there with some potential for breeding as well. Golder (2013l), therefore, recommended capture and relocation of Oblong Turtles (*Chelodina oblonga*) prior to the development or major disturbance of these lakes in a short period prior to any planned disturbance.

Yabby crayfish were found in most lakes. Yabbies are considered an invasive species in Western Australia and are known to predate upon Oblong Turtle hatchlings (Bradsell et al. 2003).

Aquatic macroinvertebrates recorded in the lakes comprised common species to the region, and none were conservation-listed. Some taxa (such as mayfly and caddisfly larvae) indicated moderately good lake water quality. All species found are potential food items for lake fishes and birds; and Chironomid larvae, in particular, are known food items for turtles (Giles *et al.* 2008). Indeed, turtles were found in high abundance in the Lake 1, which had a high abundance of Chironomid larvae.

More details are available in the report *Crown Perth Aquatic Fauna Survey* (Golder, 2013l).

8.0 ENVIRONMENTAL MANAGEMENT OBJECTIVES

The environmental management objectives for the Project are to:

- Minimise and manage the environmental and social impacts arising from Project works.
- Minimise and manage impacts to the Swan River and other ecosystems surrounding the Project area.
- Manage existing and future contamination through appropriate means including monitoring of groundwater, surface water, soil, air and landfill gas during the Construction Phase of the Project and into the Operations Phase.
- 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.
- Minimise and 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 waste reduction and disposal procedures consistent with the EPA waste hierarchy.

9.0 CONSTRUCTION PHASE ENVIRONMENTAL IMPACT ASSESSMENT

9.1 Overview

The site investigations undertaken to date have identified and informed the main characteristics of the Project, with the Project contamination and geotechnical conditions having the greatest influence on the delivery of the Project. A Project environmental risk assessment has been undertaken and highlighted the key environmental receptors with the potential to be impacted at various stages in the Project.
These included:

- Terrestrial flora and fauna.
- Aquatic flora and fauna.
- Surface water (including the lakes and the Swan River).
- Groundwater.
- Air.
- Noise and vibration.
- Visual amenity.
- Indigenous heritage sites.
- Waste management.
- Surrounding social environment (residents).

The following environmental impact assessment sections outline the Project:

- Environmental Management Objectives.
- Potential Environmental Impacts.
- Proposed Limits and Targets.
- Proposed Management and Mitigation Measures.
- Proposed Monitoring Procedures.

The Lead Contractor(s) for the Construction Phase 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 will be used as the basis for the development of the content of the Lead Contractor's CEMP. The CEMF (Golder, 2013a) provides additional information.

Where not otherwise specified, all monitoring procedures are based on Golder's professional experience in consideration of the environmental baseline of the Project area. Mitigation measures listed are minimum requirements and are not exhaustive, Additional environmental issues may be identified or alternative mitigation measures may become available as the project progresses.

9.2 Terrestrial Flora and Fauna

9.2.1 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 (OEPA, 2010).

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.
- Minimise and manage the impact to native fauna habitat.

9.2.2 Proposed 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:

- 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 Position Statement No 3 Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002a).
- 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, 2010).

9.2.3 Potential Environmental Impacts

Potential environmental impacts of the Project to terrestrial flora and fauna during the Construction Phase are:

- 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 loss resulting from vegetation clearance.
- Loss of faunal habitat movement corridors leading to difficulty for animals to access feeding and breeding areas.

- Indirect impacts to terrestrial fauna in the Project area due to loss of habitat and food sources (including aquatic habitat and associated food sources due to the infill of Lake 5 and portions of Lakes 1, 3 and 4.
- 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 Pre-construction and construction related Operations noise (see noise and vibration management in Section 9.6.5.1).
- 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.

9.2.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken to reduce or negate impacts to terrestrial flora and fauna during the Construction Phase are as follows:

- Prevent or mitigate dust emissions impacts to flora and fauna by implementing the air quality management measures listed in Section 9.6.
- Prevent or mitigate noise and vibration impacts to flora and fauna by implementing the noise and vibration management measures listed in Section 9.6.5.1.
- Prevent or mitigate light disturbance to flora and fauna by implementing the visual amenity management measures listed in Section 9.8.
- Retention and protection of Lake 2 (Figure 1) and a portion of Lakes 1, 3 and 4 to maintain habitat for fish and local waterfowl as well as habitat for any migratory birds that utilise the Project area (in addition to the remaining lakes within the Burswood Park Golf Course) and to assist with stormwater management of the Project.
- Manage contamination to land, groundwater and surface water and spills and contamination risks, potentially impacting vegetation, by implementing the waste management and mitigation measures listed in Section 9.9 which include a spill clean-up and remediation procedure and the Contaminated Site Management Plan (Golder, 2013e).
- Construct a fence around the Project area to keep activities and vehicle movements within a designated area and discourage terrestrial fauna from entering. This fence will remain in place for the duration of the Project until the Operations Phase.
- 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.

Proposed mitigation measures to be taken for the management of potential terrestrial flora and fauna impact triggers are outlined in Table 10.

Table 10: Terrestrial Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
A weed outbreak occurs on-site	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issues and if required, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities.
Condition of any vegetation in close proximity to the Project area declines in comparison to baseline conditions.	■ Advise Crown and Crown's Environmental Advisor. ■ Increase vegetation-monitoring frequency to weekly 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. ■ Seek feedback from the relevant regulatory agency on proposed mitigation measures. ■ Undertake rehabilitation activities in affected area (e.g. revegetation with local provenance species, if practicable). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Vegetation in close proximity to the Project area shows a build-up of dust on leaves,	■ Advise Crown and Crown's Environmental Advisor. ■ Relocate the watering truck used for dust suppression to the relevant site and spray vegetation to remove dust particles. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
An incidence of death or injury to fauna occurs within the Project area due to Project Construction Phase works.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Collect or capture dead/injured fauna and treat or preserve specimen based on DEC advice. ■ Investigate mitigation measures (such as fauna crossings) in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger for Action	Mitigation Measure
Individuals or populations of species of conservation significance are at risk from Construction works	■ Advise Crown and Crown's Environmental Advisor. ■ Crown to advise relevant regulatory agencies if required. ■ Investigate relocation of populations and species in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.2.5 Proposed Monitoring Procedures

Fauna monitoring will be conducted as part of daily environmental checks and inspections (see Appendix F 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 dead or 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 Crown 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 Crown's Environmental Advisor 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 and mitigation measures outlined in the Lead Contractor's CEMP and approved by Crown.

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.

9.3 Aquatic Flora and Fauna

9.3.1 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 (OEPA, 2010).

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

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 (OEPA, 2010).

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 Lakes 1 to 5 and in the Swan River.
- Minimise and manage the impacts on aquatic vegetation not requiring clearing for site works.

9.3.2 Proposed 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 2004a)
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002a)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

Due to the heavily disturbed nature of the site (Golder, 2012e), most Project area aquatic values are associated with waterfowl.

9.3.3 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.
- 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 Pre-construction and construction related Operations noise (see air quality Section 9.6 and noise and vibration Section 9.6.5.1).
- Smothering of aquatic foliage from dust mobilised through excavation and other soil disturbances.

- Introduction of aquatic flora and fauna pests.
- 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.

9.3.4 Proposed Management and Mitigation Measures

The Lead Contractor's Environmental Advisor and/or designated qualified subcontractor 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.
- Provide ongoing advice in relation to aquatic fauna management issues.

Proposed management measures to be taken 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 conservation or ecologically significant aquatic vertebrate fauna inhabiting the Project area constructed lakes. The program will focus on trapping Oblong tortoises and other conservation significant species that might inhabit the lakes proposed for infill as outlined in the Aquatic Fauna Survey (Golder, 2013l).
- Undertake groundwater and surface water management and mitigation measures and monitoring procedures as outlined in Sections 9.4 and 9.5 and as per the Contaminated Site Management Plan (Golder, 2013e) and Dewatering Management Plan (Golder, 2013j) to manage impacts to groundwater and surface water which provide habitat to dependent aquatic flora and fauna.
- Retention and protection of portions of Lakes 2, 3 and 4 to provide habitat for aquatic fauna and local waterfowl that utilise the Project area.
- Management of lakes within the Project area to prevent the transference of any feral aquatic fauna to the Swan River. This includes the prevention of:
  - Transport of aquatic flora or sediments, which may contain eggs or larvae, from the lakes to the Swan River.
  - Water flows from the lakes into the Swan River.
- Construction of a fence around the Project area to keep activities and vehicle movements within a designated area and discourage waterfowl from entering. This fence will remain in place for the duration of the Project until the Operations Phase.
- Manage contamination to land, groundwater and surface water and spills and contamination risks, that may potentially impact vegetation, by implementing the waste management and mitigation measures listed in Sections 9.4 and 9.5 and the Contaminated Site Management Plan (Golder, 2013e). The Contaminated Site Management Plan (Golder, 2013e) also includes a spill clean-up and remediation procedure .
- Prevent or mitigate dust emissions impacts to aquatic flora and fauna, by implementing the air quality management measures listed in Section 9.6.

- Prevent or mitigate noise and vibration impacts to aquatic fauna by implementing the noise and vibration management measures listed in Section 9.6.5.1.
- 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.

Proposed mitigation measures to be taken for the management of potential aquatic flora and fauna impact triggers are outlined in Table 11.

Table 11: Aquatic Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
Sediment plume or discharge is visually evident within any retained lakes or the Swan River.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Condition of aquatic vegetation remaining within Project area or in close proximity of the Project area declines in comparison to baseline conditions.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. revegetation with local provenance species, if practicable). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Aquatic vegetation remaining within Project area or in close proximity of the Project area shows a build-up of dust on surface.	■ Advise Crown and Crown's Environmental Advisor. ■ Relocate the watering truck used for dust suppression to the relevant site and spray vegetation to remove dust particles. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger for Action	Mitigation Measure
An incidence of Fishkill occurs within the Swan River or any retained lakes.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Identify any sources of contamination if Fishkill occurs in retained lakes. ■ Investigate mitigation measures in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Individuals or populations of species of conservation significance within any retained lakes are at risk from Construction works.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate relocation of populations and species in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Erosion of the riparian environment of any retained lakes is visually worse than background levels.	■ Advise Crown and Crown's Environmental Advisor. ■ 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 above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.3.5 Monitoring Procedures

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

Aquatic monitoring procedures will include a daily site walk around any retained lakes and the Swan River foreshore, within the Project area, if applicable before works commence each day for dead/injured or trapped fauna and erosion impacts. 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. Erosion is to be managed as per Table 11 above.

Indications of spills, leaks, unexpected/unauthorised discharges and dust should also be made at this time e.g. through observations of discharge or slicks on the water bodies. In addition to water quality monitoring that will be undertaken (see Section 9.4.5) general water quality should be observed and excessive algal blooms and the presence of any odours also recorded. High rates or individual erosion events will also be noted.

Any observations of fauna or riparian vegetation damage or injury should be recorded and submitted weekly to Crown's Environmental Advisor by the Lead Contractor' Environmental Representative. All recorded observations of injured or trapped terrestrial fauna will be provided to Crown for long term monitoring requirements. A biannual aquatic fauna survey to assess the health and populations of aquatic fauna inhabiting the remaining lakes should be implemented by the Lead Contractor to monitor aquatic fauna health.

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 and mitigation measures outlined in the Lead Contractor's CEMP and approved by Crown. 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 migratory avian species. A description of the physical appearance and call of these species should be covered in the environmental inductions.

9.4 Surface Water

9.4.1 Management Objectives

The EPA 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.
- Manage the continued use of water resources.

9.4.2 Proposed 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, 2000).
- *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, 2000).

Appendix G 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 rigger 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.

Table 12 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 12: Trigger Values for Reporting Chemical Stressors in the Swan River South of the Project Area^

Water Quality Indicator	Trigger Value
Chl a*	3
Total Phosphorus (TP)*	30
Free Reactive Phosphorus (FRP)*	5
Total Nitrogen*	750
Nitrogen oxides (NO_x)*	45
Ammonia (NH_4)*	40
Dissolved oxygen (DO) (% saturation) *	90-110
pH* (pH units)	7.5-8.5
Turbidity (NTU) Ω	≤10% increase above reference site, or no visible reduction in colour or light penetration of the receiving environment.
Salinity (as TDS) Ω	≤10% increase above reference site.
Temperature	≤10% increase above reference site.
Other contaminants Ω	≤10% increase above reference site , or exceed levels for which there is evidence of lethal or sub-lethal toxic effects or undesirable physiological responses in humans, plants, birds, animals, fish or other aquatic life.

^ All values are in mg/L unless otherwise stated.

* 90% Aquatic Ecosystem Protection Trigger Values (ANZECC/ARMCANZ, 2000)

Ω Swan River acceptable water quality (SRT, 2000).

Table 13 provides the guideline trigger levels for the constructed lakes within the Project area.

Table 13: Trigger Values for Reporting Chemical Stressors in the Constructed Lakes within the Project Area^

Water Quality Indicator	Trigger Value
Chl a*	30
Total Phosphorus (TP)*	60
Free Reactive Phosphorus (FRP)*	30
Total Nitrogen*	1500
Nitrogen oxides (NO_x)*	100
Ammonia (NH_4)*	40
Dissolved oxygen (DO) (% saturation) *	90-120
pH* (pH units)	7.0-8.5
Turbidity (NTU)	10-100
Salinity (as TDS)	300-1500
Temperature	≤10% increase above seasonal baseline conditions.
Other contaminants	80% ANZECC/ARMCANZ (2000) Aquatic Ecosystem Protection Guidelines

^ All values are in mg/L unless otherwise stated.

* 90% Aquatic Ecosystem Protection Trigger Values (ANZECC/ARMCANZ, 2000)

Ω Swan River acceptable water quality (SRT, 2000).

Trigger levels such as those in Table 12 and Table 13, 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 is provided as Appendix G.

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

The protection level for the artificial lakes within the Project area is set at 80%. This is due to the lakes constructed nature and their low intrinsic aquatic ecosystem values (Golder, 2013l).

9.4.3 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 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.

9.4.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to surface water during the Construction Phase are:

- Control of contamination to land, groundwater and surface water due to spills and contamination risks, by implementing the waste management measures as outlined in Section 9.9 and the Contaminated Site Management Plan (Golder, 2013e).
- Retention and protection of portions of Lakes 2, 3 and 4 and 5 to provide habitat for aquatic fauna 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 9.4 and the Contaminated Site Management Plan (Golder, 2013e).
- Design and implementation of an appropriate stormwater capture and disposal program based on specific site works including measures such as:
  - Diversion of stormwater around infrastructure to specified, bunded collection points.
  - Deviation of stormwater from disturbed areas to avoid undisturbed areas.
  - Direction of stormwater to stormwater collection drains/sewer.
  - Prevention of stormwater pooling.

- Prevention of stormwater flow from disturbed areas into surface water bodies, unless the surface water body is specifically designed for the retention of stormwater.
- Location and design of bulk fuel and chemical storage facilities to avoid stormwater flow paths, and to minimise potential for contamination of stormwater.

- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of protecting the Swan River, any retained lakes and the related management measures. This induction should 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 (Golder, 2013j) and Contaminated Site Management Plan (Golder, 2013e) 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 9.6.

Proposed mitigation measures to be taken for the management of potential surface water impact triggers are outlined in Table 14.

Table 14: Surface Water Mitigation Measures

Trigger	Mitigation Measures
Runoff from stockpiles flows into undisturbed areas or surface water bodies..	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Confirm that risk assessment is still valid. ■ Mitigate spill area and alter stockpile bund design accordingly to prevent from reoccurring. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Contaminated surface water is discharged to the surrounding environment.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Confirm that risk assessment is still valid. ■ Prevent further flow of contaminated water to the surrounding environment. ■ Remove/stop the source of contamination. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Surface water quality is in exceedances of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of water quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Sediment plume or discharge is visually evident downstream of a disturbed area or within the remaining lakes.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify potential cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area as per DEC advice. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Surface water in remaining lakes or in the Swan River is visually impacted by dust or contains large volumes of sediment due to dust emissions.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Stormwater system is blocked and/or overflowing.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify location and source of blockage. ■ Remove blockage. ■ Clean-up spilt or pooling storm water as required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.4.5 Proposed Monitoring Procedures

Surface water monitoring will determine water quality and any potential impacts to the Swan River or other surface water bodies (such as the remaining lakes) due to Construction Phase works. Surface water monitoring will at least include the parameters listed in Table 13 and be conducted with reference to the applicable trigger levels in Table 15 where practicable. Additional analytes may be included pending the outcomes of the DSI.

Monitoring locations will be established in each of the constructed lakes and in the Swan River. Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in Golder (2012b).

Table 15: 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 & SO_4	Weekly	Weekly
Total metals (Fe and Al)	Weekly	Weekly
Total suspended solids (TSS)	Weekly	Weekly
Organochlorine and organophosphate pesticides	Fortnightly	Fortnightly
Polyaromatic hydrocarbons (including naphthalene)	Fortnightly	Fortnightly

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

Surface water monitoring will be reviewed based on DSI and baseline results and each round of monitoring data. Laboratory 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 and mitigation measures outlined in this Project EMP (Golder, 2013c) and the Contaminated Site Management Plan (Golder, 2013e).

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

9.5 Groundwater

9.5.1 Management Objectives

The EPA 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.

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 and useability of the groundwater within the underlying groundwater system.

- 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.

9.5.2 Proposed 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, 2000).
- 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, 2000).
- Drinking Water Aesthetic Values (DEC, 2010).
- Drinking Water Health Values (DEC, 2010).
- Unpublished trigger values provided by the Swan River Trust (2012).

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

Trigger levels such as those in Appendix H, 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.

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 water is proposed to be discharged into the Swan River, the Swan River Trust guidelines for disposal of dewater into the Swan River are outlined in Table 16. Construction Phase works are not anticipated to increase the existing natural groundwater flow into the Swan River.

Table 16: Swan River Trust Guideline Trigger Values for Dewatering Disposal into the Swan River

Item	Trigger Value	Source
Total nitrogen	>1.0 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total phosphorus	>0.1 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total iron (Fe+ and Fe3+)	>1.0 mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Dissolved aluminium	>150 ug/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Total aluminium	>1.0 mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
TTA (Acidity)	>40 mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)

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
Floatable matter	No visible floating oil, grease, scum, litter or other objectionable material	Swan River Trust policy SRT/DE6 Dewatering
Settleable matter	No deposits which adversely affect the recreation and ecosystem values of the receiving waters	Swan River Trust policy SRT/DE6 Dewatering
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
Temperature	Not to vary more than 2 degrees Celsius from the background level (in the receiving environment)	Swan River Trust policy SRT/DE6 Dewatering
Salinity	Not to alter the background level in the receiving environment by more than 10%	Swan River Trust policy SRT/DE6 Dewatering
Dissolved Oxygen	>4 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
pH	Should not fall outside the range of 6-8.5	ANZECC Guidelines for freshwater
All other toxicants	As per ANZECC Guidelines for freshwater or marine water ecosystems. Minimum 95% protection level to be used.	ANZECC Guidelines

9.5.3 Potential Environmental Impacts

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

- The potential for cross contamination between aquifers due to piling activities. This will depend on the depth of piles and the depth to groundwater at the location of piles.
- 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.
- Impacts to water quality due to mobilisation of landfill contaminants and leachate seeping into the groundwater and surface water bodies as a result of ground improvement works.
- 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.
- Should dewatering be required during the Construction Phase, potential impacts will be dependent on the water quality of extracted groundwater and the groundwater disposal location.

9.5.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to groundwater during the Construction Phase are:

- Control of contamination to groundwater, land and surface water due to spills and contamination risks, potentially impacting groundwater, by implementing the management measures as outlined in Section 9.9 and the Contaminated Site Management Plan (Golder, 2013e).

- Development and implementation of a groundwater monitoring program to monitor for any potential adverse impacts on the Swan River as per Section 9.5, the Dewatering Management Plan (Golder, 2013j) and the Contaminated Site Management Plan (Golder, 2013e).
- Design and implementation of appropriate stormwater capture and disposal program based on specific site works including measures such as:
  - Diversion of stormwater around infrastructure to specified, bunded collection points.
  - Deviation of stormwater from disturbed areas to avoid undisturbed areas.
  - Direction of stormwater to stormwater collection drains/sewer.
  - Prevention of stormwater pooling.
  - Prevention of stormwater flow from disturbed areas into surface water bodies, unless the surface water body is specifically designed for the retention of stormwater.
- Should dewatering be required, the management of dewatering treatment and disposal will be detailed in a separate plan entitled Dewatering Management Plan (Golder, 2013j) in consultation with the relevant regulatory agencies.
- 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 should 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.
- Construction Phase activities will be conducted in accordance with the Project's Dewatering Management Plan (Golder, 2013j) and Contaminated Site Management Plan (Golder, 2013e) to manage hydrology and hydrogeology impacts, groundwater contamination impacts and related indirect impacts to surface water bodies.
- Should dewatering be required during the Construction Phase, management measures will be dependent on the water quality of extracted groundwater and the groundwater disposal location, see the Dewatering Management Plan (Golder, 2012j) for more information.

Proposed mitigation measures to be taken for the management of potential groundwater impact triggers are outlined in Table 17.

Table 17: Groundwater Mitigation Measures

Trigger	Mitigation Measures
Measured decline/increase in groundwater levels is at variance to the modelled change.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Groundwater quality is in exceedance of trigger values	■ Advise Crown and Crown's Environmental Advisor. ■ 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 the DMP (Golder, 2013e) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Identified deteriorating groundwater quality	■ Advise Crown and Crown's Environmental Advisor. ■ 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 the DMP (Golder, 2013e) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner. .
Groundwater quality monitored in the groundwater wells east of the Swan River, with potential for discharge to the Swan River, is identified as being in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Assess validity of risk assessment. ■ If ecological risk is considered unacceptable, consider mitigation options such as installing a trench with in-pit sump pump(s), pumping well(s) or dewatering spears for preventing contaminated groundwater from entering the Swan River as per the Dewatering Management Plan (Golder, 2013i). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Extracted groundwater volume increases from modelled predictions.	■ Advise Crown and Crown's Environmental Advisor. ■ Crown and the Lead Contractor to discuss increased groundwater extraction volumes with DOW and other relevant regulatory agencies as required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Survey of adjacent structures shows settlement or abnormalities.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.5.5 Proposed Monitoring Procedures

9.5.5.1 Overview

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 Agriculture and Food *Guidelines for Groundwater Monitoring* (2008).
- 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, 2000).
- 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.
- DEC Contaminated Sites Management Series Guidelines.

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

Monitoring of the groundwater (using monitoring wells) and dewatering discharge (if applicable) is required during the Construction Phase. The monitoring will have to commence prior to Construction Phase activities and continue after the cessation. Details of the proposed monitoring may be dependent on the nature and extent of any dewatering and will need to be outlined in the Phase specific DMP(s) and/or CEMP(s). The requirement for any other new monitoring well locations would need to be assessed during the preparation of the Phase specific DMP(s).

The following sections outline likely monitoring requirements based on the guidelines from DOW (2006) and DEC (2011).

9.5.5.2 Groundwater

A groundwater monitoring well network is currently being established as part of the ongoing geotechnical and environmental investigation and the network will be monitored as part of the Project EMP (Golder 2013c). 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 based during the preparation of the specific DMP (2013).

Field Monitoring

Groundwater level, pH, electrical conductivity, TTA, total alkalinity, oxygen redox potential and dissolved oxygen should 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 should be compared to estimates from the groundwater modelling to provide early indication of the likelihood that groundwater levels could daylight.

Laboratory Analysis

Groundwater samples should 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 water samples taken during the ongoing environmental investigation will be used as background water quality.

The proposed analytes to test for are presented in Table 18. Field pH, electrical conductivity, dissolved oxygen, redox potential, TTA and temperature should be measured in the field when collecting the water samples.

Table 18: Proposed Analytes for Laboratory Suite for Groundwater

Miscellaneous Parameters	Total Titratable Acidity, Total Actual Acidity, Total Alkalinity, pH, TDS, turbidity, ORP, EC.
Major Ions	Cations (Ca, Mg, Na, K), Anions (Cl, SO_4, HCO_3)
Dissolved Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Total Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Nutrients	Ammonia as N, Total Nitrogen, reactive Phosphorous, Total Phosphorus
Additional contaminants of concern	*Polycyclic Aromatic Hydrocarbons (including naphthalene) and Organo Chlorine and Organo Phosphate Pesticides.**

Note: * required analytes may be dependent on the location of dewatering

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.

9.5.5.3 Dewatering Discharge

At this stage it is only anticipated that dewatering be required during the Construction Phase of the Project.

Dewatering may be required for service installation or modification, in particular the stormwater system and the sewer system. Dewatering may also be required for a lift pit.

It is also possible that if excavation is required to remove obstructions in the fill, dewatering may also be required; however, Golder understands that generally the site will be raised (i.e. fill will be bought onto the site) rather than cut to establish site level and the need for excavation will be minimised.

If dewatering is required, then dewatering management and discharge monitoring should be undertaken as detailed within the DMP (Golder, 2013j).

9.5.5.4 Monitoring in Accordance with ASS Guidelines

ASS monitoring should be undertaken as detailed within the Contaminated Sites Management Plan (Golder, 2013e).

9.5.5.5 Other Monitoring

Additional contaminants of concern may be required to be monitored based on results of DSI (Golder, 2013j) 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 1.0 mg/L
- Total phosphorus - trigger level 0.1 mg/L
- Total iron - trigger level 1.0 mg/L
- Odours and colours - No objectionable odours or visible colour
- Floatable matter - No visible floating oil, grease, scum, litter or other objectionable material
- Total aluminium - trigger level >1.0 mg/L.

It is proposed that photos are taken regularly of the dewatering effluent to document the visual quality of the water.

9.5.5.6 Settling Effects

The DMP (Golder, 2013j) must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. Proximity to nearby infrastructure including the Crown Perth complex and residential buildings to the north and east 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 be determined at an interval during the dewatering period. Survey data should be recorded and reviewed and the reasons for any changes or movements identified.

9.6 Air Quality

9.6.1 Management Objectives

The EPA 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).

9.6.2 Proposed Limits and Targets

9.6.2.1 Overview

Current approaches to air quality management at development sites are contained in "*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).

The DEC guideline presents a risk based approach to air quality management at a development site. The guideline notes that for potentially contaminated sites, a health risk assessment (HRA) should be conducted in accordance with the HRA requirements of the Department of Health (DOH).

Noting the above, a preliminary site classification has been undertaken using the site classification chart for uncontaminated sites, as contained in the DEC guideline document (DEC, March 2011). The assessment is preliminary and may need to be revisited pending the outcome of the DSI. This Project EMP (Golder, 2013c) will be updated as required following these studies.

The nuisance potential for dust generation during the Construction Phase is considered to be moderate due to the landscaped nature of the site, and that little screening is located around the site to minimise dust migration off-site. Preliminary assessment using the DEC guidance (DEC, March 2011) indicated a site classification of medium/high, as there is potential for adverse dust impacts during site clearing if site activities are not closely managed. This rating should be used as guidance only, as the site is undergoing a detailed investigation to determine the presence/and or extent of contamination on the site.

9.6.2.2 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 Project, provided that other site features including bare areas and material stockpiles are appropriately managed.

The DEC guidance (DEC, March 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 DEC. These are presented in Table 19, Table 20 and Table 21.

Table 19: 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 20: 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 21: Kwinana EPP, TSP Ambient Air Quality Standards and Limits for Area C (rural/residential area)

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

9.6.2.3 Asbestos

Asbestos is known to be present within the Burswood Peninsula. Asbestos presents a risk to human health rather than a risk to the environment. The main area which may be identified in the DSI as being impacted by asbestos is the former landfill area, which has the potential to contain asbestos containing material (ACM). Due to the nature and age of the landfill, asbestos fibre cannot be discounted.

Mitigation measures will be put in place by the Lead Contractor(s) to remove or contain asbestos and ACM from the site prior to construction works commencing. 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 22.

Table 22: Air Quality Limit for Asbestos (DOH, 2009)

Pollutant	Limit
Asbestos	0.01 fibres/mL

9.6.2.4 Landfill Gas

There is the potential for landfill gases to be emitted from the site during Construction Phase works. Construction workers in the immediate vicinity of works are those most likely to be impacted by the presence of landfill gas. The ambient air environment in surrounding areas may be impacted by the odour impacts of landfill gas. Potential hazards from landfill 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 landfill gas are 500 ppm (permanent gas level limit).

9.6.2.5 Odour

There is the potential for odour to be emitted from the site during construction due to the release of landfill gas and the excavation of odorous material. The 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.

9.6.3 Potential Environmental Impacts

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

- An increase in greenhouse gas emissions to the environment due to the combustion of fuel, and decomposition of soil and organic matter following 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 could potentially become airborne under certain meteorological conditions (i.e. wind direction, number of days since last rainfall).
  - Project pre-construction 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). Given the potential for site contamination, there is also the potential for other contaminants to be associated with windblown particulates. Potential contaminants will be identified following completion of the DSI.
- 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, and has potential to smother vegetation and impact fauna.
- Uncontrolled landfill gas impacts due to the disturbance of *in situ* landfill material may result in:
  - Subsurface migration, the underground movement of landfill gas from landfills to other areas within the landfill property or outside the landfill property.
  - Emissions of landfill 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 Pre-construction activities can cause related health issues (such as respiratory issues) and be unpleasant and irritate residential occupants, the public and stakeholders.

9.6.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to air quality during the Construction Phase are:

- Reduce dust emissions generated by the Construction Phase by operating water carts to spray 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 forecasts, weather monitoring results and types of activities being undertaken.
- 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, 2013c). This program should be implemented by a suitably qualified professional.

- Procurement of fuel-efficient vehicles and plant where practicable to reduce the use of machinery causing emissions of greenhouse gases.
- Management of asbestos and potential emission of asbestos fibres to air due to construction works by administering appropriate personal protective equipment (PPE), adhering to the site's Occupational Health and Safety Procedure as developed by the Lead Contractor in conjunction with the asbestos handling standards in the *Occupational Safety and Health Act 1984.* The results of the DSI and the Contaminated Site Management Plan (Golder, 2013e) are to also be consulted in the development of asbestos handling and management measures.
- Daily monitoring of weather conditions to manage unfavourable activities (e.g. excessive dust and/or odours) 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.
- Implementation of a landfill gas recovery system (combustion by flare/electricity generation equipment or another system use) if landfill gas is identified on-site, to reduce overall air and greenhouse gas emissions from landfills, reduce odour and manage subsurface migration.
- Should odours occur, consultation will be undertaken with DEC and affected parties to determine appropriate management measures.

Proposed mitigation measures to be taken for the management of potential air quality impact triggers are outlined in Table 23.

Table 23: Air Quality Mitigation Measures

Trigger	Potential Mitigation Measures
Portable landfill gas levels are in excess of the time weighted average (TWA): ■ 10 ppm hydrogen sulfide ■ 5000 ppm carbon dioxide ■ 5% Lower Explosive Limit (LEL) of methane	■ Advise Crown and Crown's Environmental Advisor. ■ Check that source of emissions is from the open hole or excavation. ■ Evaluate the concentrations against the Short Term Exposure Limit (STEL). ■ Stop work. ■ Implement appropriate emergency evacuation procedures. ■ Implement the appropriate emergency incident response procedures. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Permanent landfill gas levels are reported to be in excess of 500 ppm.	■ Advise Crown and Crown's Environmental Advisor. ■ Confirm elevated concentrations of landfill gas. ■ Stop work. ■ Implement appropriate emergency evacuation procedures. ■ Implement the appropriate emergency incident response procedures. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Visible dust is generated from potentially contaminated material.	■ Advise Crown and Crown's Environmental Advisor. ■ Increase dust management measures. ■ Stop work. ■ Wait until wind conditions improve. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Airborne concentrations of asbestos are reported above recommended concentrations.	■ Advise Crown and Crown's Environmental Advisor. ■ Stop work. ■ Identify source of airborne asbestos. ■ Increase dust management measures. ■ Wait until wind conditions improve. ■ Remove source to an off-site location. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Air quality is in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of air quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Potential Mitigation Measures
Dust emissions complaint is received.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase dust management measures. ■ Wait until wind conditions improve. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Odour complaint is received.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase odour management measures. ■ Wait until wind conditions improve. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.6.5 Proposed Monitoring Procedures

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

9.6.5.1 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:

- DEC's *Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities* (2011).
- 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).*
- DEC's *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 9.6.2.

9.6.5.2 Asbestos

The requirement for asbestos management and monitoring will depend on the Construction Phase 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 and mitigation measures and monitoring procedures in this Project EMP (Golder, 2013c). If prepared, the asbestos management and monitoring procedure will be submitted to the Department of Health for review prior to implementation.

9.6.5.3 Landfill Gas

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

- DEC's *Siting, Design, Operation and Rehabilitation of Landfills.*
- *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).

Landfill gas monitoring should be undertaken regularly by a qualified specialist via the installation of permanent landfill gas monitors. Landfill gas monitoring assessing the presence of landfill gas will be undertaken according to the specifications and procedures detailed in this document, the Contaminated Site Management Plan (Golder, 2012e) and as per the Lead Contractor's CEMP. Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in Golder (2012b). Landfill gas monitoring procedures will be approved by Crown prior to being implemented and Crown may engage relevant regulatory agencies or the Contaminated Sites Auditor to review the monitoring procedures.

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

See the Contaminated Site Management Plan (Golder, 2013e) for more information.

9.6.5.4 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 Crown 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 landfill gas monitoring results and assist in the implementation of air quality and landfill gas management and mitigation measures.

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

9.7 Noise and Vibration

9.7.1 Management Objectives

The EPA 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.

9.7.2 Proposed 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) (OEPA, 2007).

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

Construction Out of Hours

For construction work done outside the hours 7 am and 7 pm on any day which is not a Sunday or public holiday the:

- Work must be carried out in accordance with Section 2 and 3 of AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.*
- Equipment used for the construction work will be the quietest practically available and economically viable.
- Lead Contractor(s) must advise all nearby occupants of the work to be carried out at least 24 hours before it commences.
- Lead Contractor(s) must show it was reasonable necessary for the work to be performed out of hours.
- Lead Contractor(s) must submit to the chief executive officer (CEO) a noise management plan at least seven 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.

Project Noise Evaluation

In order to manage potential noise impacts of the hotel during operations, the Lead Contractor(s) designing and constructing the Project is required to:

- Study and measure existing noise sources such as vehicular, rail and aircraft traffic and advise on building design, layout and construction method to assess compliance with minimum acoustical performance.
- Analyse construction specifications, details and methodology to assess compliance with minimum acoustical performance.
- Analyse MEP systems design including components location and distribution network, provide recommendations and specifications to assess compliance with minimum acoustical performance and where necessary specify specific construction techniques such as vibration isolators or floating floors.
- Select interior finishes for special function spaces such as meeting rooms, ballrooms, gaming areas, offices, etc., to insure an adequate acoustical environment which supports the activities of that space.

Construction Materials and Methodology

Crown recommends that all construction materials are sourced from manufacturers who are able to provide validated certification of product compliance with the project's acoustical criteria.

Installation methodology and quality achieved must assess compliance with the minimum acoustical performance outlined in Table 24.

Table 24: Minimum Acoustical Performance Matrix

Performance Standard	Sound Absorption 1	Sound Transmission Loss 2	Sound Transmission Loss 2	Sound Transmission Loss	Open Office	Open Office	HVAC Spectrum Noise
Class	**Noise Reduction Class (NRC)**	**Sound Transmission Class (STC)**	**Outdoor-Indoor Transmission Class (OITC)**	**Noise Isolation Class (NIC)**	**Articulation Class (AC)**	**Articulation Index (AI)**	**Room Criteria**
Areas							
Public Areas, Lobby Circulation	.40 ± .10	40 dB ± 2 dB	40 dB	35 dB ± 2 dB	N/A	N/A	35 (N)
Restaurant and Bar	.60 ± .10	40 dB ± 2 dB	40 dB	35 dB ± 2 dB	180 dB ± 10 dB	.10	45 ®
Convention/Meeting Rooms	.60 ± .10	55 dB ± 2 dB	50 dB	50 dB ± 2 dB	N/A	N/A	45 (N)
Offices	.60 ± .10	40 dB ± 2 dB	40 dB	35 dB ± 2 dB	180 dB ± 10 dB	.10	35 (N)
Support Areas	.50 ± .10	40 dB ± 2 dB	40 dB	35 dB ± 2 dB	N/A	N/A	35 (N)

Note:

1) To provide adequate interior acoustics for a space, an evaluation of the required surface area of absorptive material must be performed.

2) Non-typical adjacencies may require a higher STC rating than stated in the table. These adjacencies should be identified, and an adequate STC rating should be determined.

9.7.3 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 will cause an increase in localised noise concerns to neighbouring properties (residential, commercial and recreational), terrestrial and aquatic fauna and heritage buildings/structures.
- Vehicle and machinery operation will cause an increase in vibration concerns to neighbouring properties (residential, commercial and recreational), terrestrial and aquatic fauna and heritage buildings/structures.

9.7.4 Proposed Management and Mitigation Measures

Management measures to be taken 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 2 and 3 of AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.*
- All construction work will be carried out within 7 am and 7 pm on any day which is not a Sunday or public holiday; 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 and economically viable consistent with Operations requirements, and will be routinely maintained to assess effectiveness of noise suppression systems and equipment.
- Implementation of 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 Operations/management procedures by Crown's Environmental Advisor and the Lead Contractor's Environmental Representative as a basis for development and implementation of appropriate modified practices.

Proposed mitigation measures to be taken for the management of potential noise impact triggers are outlined in Table 25.

Table 25: Noise Mitigation Measures

Trigger	Potential Mitigation Measures
Measured noise or vibration levels are reported to be in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of increase in noise or vibration levels. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Noise or vibrations complaint is received.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate reason for complaint. ■ Undertake additional training if applicable. ■ Increase noise management measures if applicable. ■ Wait until wind conditions improve if applicable. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.7.5 Proposed 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 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 and mitigation measures outlined in this Project EMP (Golder, 2013c) and the Lead Contractor's CEMP.

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

9.8 Visual Amenity

9.8.1 Management Objectives

The EPA 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 objectives with regard to the management of visual amenity during the Construction Phase are to:

- Minimise and manage impacts to the visual amenity of the Swan River, Burswood Park recreational area and the Burswood Peninsula.

9.8.2 Potential Environmental and Social 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 may be unfavourable to some residents in the area.

9.8.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken 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 Complaints Management Procedure detailed in the Project EMP (Golder, 2012c).
- 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.
- 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 dependent on DSI results and soil classification.
- 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 and mitigation measures.

9.8.4 Proposed Monitoring Procedures

Proposed monitoring procedures to be taken for visual amenity impacts during the Construction Phase are:

- Review complaints as they are 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.

9.9 Indigenous Heritage

9.9.1 Overview

No Indigenous heritage sites have been identified within the Project area.

In the event that a previously unknown/unregistered Indigenous heritage site is disturbed during the Construction Phase works, the mitigation measures that will 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 26.

Table 26: Indigenous Heritage Mitigation Measures

Trigger	Potential Mitigation Measures
Indirect contamination to Indigenous heritage sites.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of contamination and cease source if able. ■ Crown to work with the DIA in consultation with a representative of the Noongar people to remediate the area. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Ground disturbance resulting in disturbance of unknown Indigenous sites of significance.	■ Advise Crown and Crown's Environmental Advisor. ■ Cease disturbance activity and fence off area around site including a 20 m buffer. ■ Crown to work with the DIA in consultation with a representative of the Noongar people to assess and remediate the area. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.10 Waste Management

9.10.1 Management Objectives

The environmental objective adopted for the Project relating to solid and liquid waste requires 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 DEC policy - Review of Waste Classification and Waste Definitions 1996 (as amended).

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 DEC and other regulatory requirements.

9.10.2 Proposed Limits and Targets

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

- *Environmental Protection (Controlled Waste) Regulations 2004.*
- EP Act.
- Review of Waste Classification and Waste Definitions 1996 (as amended).

- *Litter Act 1979* (currently under review by DEC 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.

9.10.3 Potential Environmental and Social 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/bricks.
- 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 a spill isn't immediately remediated.
- Putrescible/domestic 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 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 of waste.
- Excessive waste generation may result in inefficient use of resources.

9.10.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise waste during the Construction Phase are:

- All fuel and other hazardous material stored on-site will be stored in appropriately sealed containers on a designated and appropriately sized bunded pallet/platform within an appropriate fenced and signed storage area.
- All fuel and other hazardous material will be stored and transported in accordance with the Dangerous *Goods Safety Act 2004* and regulations.

- A DEC licensed controlled waste management contractor will regularly remove and transport contaminated and classified wastes off-site for licensed disposal or recycling. Volumes will be recorded in a controlled waste transport 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.
- General domestic waste will be collected and stored in appropriately sealed and labelled 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 recycling waste.
  - A separate labelled bin for aluminium can recycling.
- The waste management hierarchy of elimination, reduction, reuse, recycling, treatment and disposal will be adhered to where possible. Disposal should only be considered as a last resort.
- Sewage will be treated via an appropriate sewage or anaerobic treatment system.
- Waste generated will be managed in a manner which minimises any potential impacts to the environment.
- Waste management will comply with applicable 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, including the preferred remediation process for all contaminated material on-site, including diesel, used preconstruction water, stormwater.
- Spill clean-up procedures will be implemented, including the preferred remediation process for all contaminated material on-site, including diesel, used preconstruction water and stormwater.
- Testing and treatment of any cut and fill material will be undertaken in accordance with regulator guidelines and the requirements in the Contaminated Site Management Plan (Golder, 2013e).

- Soils proposed for re-use on-site will be classified as suitable for re-use, with sampling results assessed against the criteria outlined in the *Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*. This document also outlines the number of samples required for adequate waste soil classification. Further details are available in the Contaminated Site Management Plan (Golder, 2013e).
- Disposal of waste, including any cut and fill material deemed unsuitable for reuse on-site, will be undertaken in accordance with relevant guidelines, in particular, *Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*.
- Waste soils requiring disposal off-site will be classified as required by the *Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*, prior to disposal, with the appropriate disposal facility identified based on the soil classification results.
- Disposal of contaminated soil and other material is managed under the conditions in the Contaminated Site Management Plan (Golder, 2013e).
- Disposal of contaminated soil and other material will be managed under the conditions included in the Contaminated Site Management Plan (Golder, 2013e).

Proposed mitigation measures to be taken to manage potential waste impact triggers are outlined in Table 27.

Table 27: Waste Mitigation Measures

Trigger	Potential Mitigation Measures
Complaints from relevant regulatory bodies are received regarding the disposal of waste in an environmentally unacceptable manner.	■ Advise Crown and Crown's Environmental Advisor. ■ 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.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Implement Emergency Incident Response Procedure (refer Section 19.0). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Leak or spill of sewage waste occurs within the Project area.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Implement Emergency Incident Response Procedure (refer Section 19.0). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
The volume of non-recyclable wastes disposed (following the first year of the Construction Phase) has exceeded that of the previous year.	■ Advise Crown and Crown's Environmental Advisor. ■ 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.
Excessive litter is observed within the Project area	■ Advise Crown and Crown's Environmental Advisor. ■ Deploy on-site personnel to clean-up litter. ■ Re-educate on-site personnel of waste management procedures.

9.10.5 Proposed Monitoring Procedures

Monitoring for contamination will be required based on the outcomes of the DSI and on the monitoring procedures contained within this document and within the Contaminated Site Management Plan (Golder, 2013e). This may include:

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

The frequency and techniques for monitoring are provided in this document and in the Contaminated Site Management Plan (Golder, 2013e).

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

9.11 Dewatering Management

If a situation arises in which dewatering is required, management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures can be located in the Dewatering Management Plan (Golder, 2013j).

9.12 Contaminated Site Management

If localised contaminated sites are discovered, management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures can be located in the Contaminated Site Management Plan (Golder, 2013e).

10.0 OPERATIONS PHASE ENVIRONMENTAL IMPACT ASSESSMENT

10.1 Overview

A risk assessment was undertaken for the Project against the Operations Phase of the Project and it was considered that the key environmental factors that have the potential to be impacted by the proposed operations include:

- Terrestrial flora and fauna.
- Aquatic flora and fauna.
- Surface water (including any retained lakes and the Swan River).
- Groundwater.
- Landfill Gas.

This phase assumes that all clearing and loss of vegetation will have occurred during the Construction Phase of the Project. Heritage has also been determined not to be a key risk as there will be no ongoing impacts to heritage sites once the Project is constructed.

The following environmental impact assessment sections outline the Project:

- Environmental Management Objectives
- Potential Environmental Impacts

- Proposed Limits and Targets (where applicable)
- Proposed Management and Mitigation Measures
- Proposed Monitoring Procedures.

Crown 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 Crown's OEMP (Golder, 2013b). The OEMF (Golder, 2013b) provides more information.

Where not otherwise specified, all monitoring procedures are based on Golder's professional experience in consideration of the environmental baseline of the Project area.

10.2 Terrestrial Flora and Fauna

10.2.1 Management Objectives

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

- Minimise and manage impacts to 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 impacts to indigenous or otherwise protected fauna that are located on-site, including the protection of remaining terrestrial fauna habitats.

10.2.2 Potential Environmental Impacts

Potential impacts to terrestrial flora and fauna during the Operations Phase are particularly dependent on the conservation and preservation of remaining undisturbed avian fauna habitat (such as the remaining lakes, the adjacent Swan River environment and any remaining vegetation habitats) and newly vegetated environment.

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

- Indirect terrestrial flora and fauna habitat conservation risks, including habitat disturbance, associated with a large commercial entertainment venue operating adjacent to a river habitat.
- Indirect terrestrial flora and fauna habitat contamination risks associated with a large commercial entertainment venue operating adjacent terrestrial fauna habitat. Contamination risks could include increased risk of pollution due to incidents such as poor waste management, stormwater discharge, increased respiratory impacts due to high traffic volumes and increased greenhouse gas emissions contributed by the operation of new buildings and associated vehicle emissions.
- Aural and other impacts to aquatic fauna due to noise and vibration impacts as a result of increased vehicle operation and Operations noise associated with a large commercial entertainment venue.
- Indirect effects from light pollution affecting circadian rhythms and migratory activity patterns.
- Introduction of terrestrial flora and fauna pests.

10.2.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to terrestrial flora and fauna during the Operations Phase are:

- Maintenance and upkeep of rehabilitated terrestrial fauna habitat within the Project area.
- Maintain vegetation around the remaining lakes established during the rehabilitation phase to offset habitat loss and predator protection.
- Manage contamination to land, groundwater and surface water, spills and contamination risks potentially impacting remaining habitat areas (both terrestrial and aquatic), by implementing waste management measures and the Contaminated Site Management Plan (Golder, 2013e). These include a spill clean-up and remediation procedure.
- Maintenance and upkeep of rehabilitated terrestrial flora and vegetation within the Project area.
- Implementation of any specific conditions applied to the Project by regulatory authorities.

Proposed mitigation measures to be taken to manage potential terrestrial flora and fauna impact triggers include, but are not limited to those outlined in Table 28.

Table 28: Terrestrial Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
A weed outbreak occurs on-site	■ Advise Crown's Environmental Advisor. ■ 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 an appropriate weed management procedure. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Condition of any vegetation remaining within the Project area or in close proximity to the Project area declines in comparison to baseline conditions.	■ Advise Crown's Environmental Advisor. ■ Increase vegetation-monitoring frequency to weekly 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 or as required. ■ 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, disease infestation. ■ Undertake rehabilitation activities in affected area (e.g. revegetation with local provenance species). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger for Action	Mitigation Measure
An incidence of death or injury to fauna occurs within the Project area due to Project operations.	■ Advise Crown's Environmental Advisor and DEC. ■ Collect or capture dead/injured fauna and treat or preserve specimen based on DEC advice. ■ Crown to advise relevant regulatory agencies if required. ■ Investigate mitigation measures in consultation with the DEC, if required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Individuals or populations of species of conservation significance are at risk from operations	■ Advise Crown's Environmental Advisor and DEC. ■ Investigate relocation of populations and species in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.2.4 Proposed Monitoring Procedures

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 their deterioration. Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two year period, a review will determine if monitoring is to continue occur and at what frequency.

10.3 Aquatic Flora and Fauna

10.3.1 Management Objectives

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

- Minimise and manage the impacts to aquatic fauna and flora located within the lakes remaining within the Project area.
- 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.

10.3.2 Potential Environmental Impacts

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

- Indirect aquatic flora and fauna habitat conservation risks, including habitat disturbance, associated with a large commercial entertainment venue operating adjacent a river habitat.
- Indirect aquatic flora and fauna habitat contamination risks associated with a large commercial entertainment venue operating adjacent a river habitat. Contamination risks could include increased risk of pollution due to incidents such as poor waste management, stormwater discharge, increased respiratory impacts due to high traffic volumes and increased greenhouse gas emissions contributed by the operation of new buildings and associated vehicle emissions.

- Indirect aquatic flora and fauna habitat contamination risks due to the alteration in hydrology and hydrogeology of underlying aquifer(s), 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 Operations noise associated with a large commercial entertainment venue.
- Indirect effects from light pollution affecting circadian rhythms and migratory activity patterns.
- Introduction of aquatic flora and fauna pests.

10.3.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to terrestrial and aquatic flora and fauna during operations are to:

- Maintenance and upkeep of rehabilitated aquatic fauna habitat within the Project area.
- Maintain vegetation around the remaining lakes established during the rehabilitation phase to offset habitat loss and predator protection.
- Manage contamination to land, groundwater and surface water, spills and contamination risks potentially impacting remaining habitat areas (both terrestrial and aquatic), by implementing waste management measures and the Contaminated Site Management Plan (Golder, 2013e). These include a spill clean-up and remediation procedure.
- Maintenance and upkeep of rehabilitated terrestrial flora and vegetation within the Project area.
- Implementation of any specific conditions applied to the Project by regulatory authorities.

Proposed mitigation measures to be taken for the management of aquatic flora and fauna triggers include, but are not limited to those outlined in Table 29.

Table 29: Aquatic Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
Sediment plume or discharge is visually evident within retained lakes or the Swan River.	■ Advise Crown's Environmental Advisor and DEC. ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify potential cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Condition of aquatic vegetation remaining within the Project area or in close proximity of the Project area declines in comparison to baseline conditions.	■ Advise Crown's Environmental Advisor. ■ 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 the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
An incidence of Fishkill occurs within the Swan River or retained lakes.	■ Advise Crown's Environmental Advisor and DEC. ■ Identify the source of contamination if Fishkill occurs in retained lakes. ■ Investigate mitigation measures in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Erosion of the riparian environment of the retained lakes or the Swan River is visually worse than background levels.	■ Advise Crown's Environmental Advisor. ■ 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 above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.3.4 Proposed Monitoring Procedures

To determine if any long term impacts have occurred to the immediate Swan River foreshore and the retained lakes, follow-up vegetation and bank condition monitoring along the Swan River adjacent to the Project area and around the remaining lakes will be undertaken. Focus will also be directed to aquatic fauna habitat, specifically avian fauna habitat.

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 their deterioration. Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two year period, a review will determine if monitoring is to continue occur and to at what frequency.

10.4 Surface Water

10.4.1 Management Objectives

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

- Emissions are not to 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 Operations Phase.
- Maximise the efficient use of water for the Project and allow the continued use of water resources.

10.4.2 Potential Environmental and Social Impacts

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

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

10.4.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to surface water during operations are:

- Continue to monitor ground and surface water for two years into the Operations Phase of the Project to determine any adverse impacts to water quality and implement contingency measures where required.
- Manage waste by providing sufficient waste disposal bins, recycling bins and other waste collection points within and surrounding the Crower Towers Development.
- Maintain and manage the extensive stormwater and urban water collection and management system for the Project, using the remaining lakes as catchment and treatment points. Associated infrastructure will be designed to minimise the risk of contamination to land, groundwater and surface water due to spills and unmanaged surface water flows.
- Implementation of any specific conditions applied to the Project by regulatory agencies.

Proposed mitigation measures to be taken for the management of potential surface water impact triggers include, but are not limited to those outlined in Table 30.

Table 30: Surface Water Mitigation Measures

Trigger	Mitigation Measures
Contaminated surface water is discharged to the surrounding environment	■ Advise Crown's Environmental Advisor and DEC. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Surface water quality is in exceedance of trigger values	■ Advise Crown's Environmental Advisor. ■ Identify source of water quality change. ■ If the change is due to activity that can be modified, remove the potential cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Sediment plume or discharge is visually evident downstream of a disturbed area or within the remaining lakes.	■ Advise Crown's Environmental Advisor, DEC and . ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify potential cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area, if practicable as per DEC/ advice. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Storm water system is blocked and/or overflowing	■ Advise Crown's Environmental Advisor. ■ Identify location and source of blockage. ■ Remove blockage. ■ Clean-up spilt or pooling stormwater as required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.4.4 Proposed Monitoring Procedures

Surface water monitoring will be undertaken during the first two years of the Operations Phase of the Project to assess the ongoing quality of surface water in the remaining lakes and the surrounding ecosystem. Monitoring to be undertaken by Crown will include at a minimum:

- Monthly water quality sampling of the parameters and units outlined in Table 13 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 13 for any retained lakes 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 Crown's OEMP (Golder, 2013d) and the Contaminated Site Management Plan (Golder, 2013e).
- Monthly inspections of the stormwater capture system to clear debris and 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 retained lakes within the Project area to identify and remove any waste from the lakes.
- Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two year period, a review (undertaken by Crown, in liaison with relevant regulatory authorities if required) will determine if monitoring is to continue to occur and at what frequency.

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

10.5 Groundwater

10.5.1 Management Objectives

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

- Require 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 Operations Phase.
- Maximise the efficient use of water for the Project.

10.5.2 Potential Environmental Impacts

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

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

10.5.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken 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 waste management measures and the Contaminated Site Management Plan (Golder, 2013e).
- Maintain and manage the extensive stormwater and urban water collection and management system for the Project, using the remaining lakes as catchment and treatment points. Associated infrastructure will be designed to prevent contamination to land, groundwater and surface water due to spills and unmanaged surface water flows.
- Implementation of any specific conditions applied to the Project by regulatory agencies.

Proposed mitigation measures to be taken for the management of potential groundwater impact triggers include, but are not limited to those outlined in Table 31.

Table 31: Groundwater Mitigation Measures

Trigger	Mitigation Measures
Measured decline in groundwater levels is at variance to the modelled change.	■ Advise Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Contaminated groundwater is discharged to the surrounding environment	■ Advise Crown's Environmental Advisor and DEC. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Groundwater quality is in exceedances of trigger values	■ Advise Crown's Environmental Advisor. ■ 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 the Dewatering Management Plan (Golder, 2013j) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Survey of adjacent structures shows settlement or abnormalities.	■ Advise Crown's Environmental Advisor. ■ A geotechnical specialist should be employed to review the data and propose appropriate measures. ■ Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities if required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Identified deteriorating groundwater quality	■ Advise Crown's Environmental Advisor. ■ 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 the Dewatering Management Plan (2013j) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.5.4 Proposed Monitoring Procedures

Groundwater monitoring (using monitoring wells) will be conducted within the first two years of operation of the Project 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.

A groundwater monitoring well network will need to be established post Construction Phase works as many monitoring wells may have been destroyed. Groundwater monitoring will be reviewed based on DSI (Golder, 2013k) results and 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 and mitigation measures outlined in the OEMP (Golder, 2013d) and within the DMP (Golder, 2013j).

All data collected will be stored by Crown for long term monitoring requirements.

Groundwater samples should be collected from the monitoring wells for laboratory analysis prior to commencement. The groundwater quality results from the laboratory should be compared with the background water quality results.

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

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.

Proposed monitoring procedures to be undertaken for the management of groundwater during operations are:

- Quarterly monitoring of groundwater bores for first two years of the Operations Phase to allow continued monitoring of water quality trends (at a minimum the parameters outlined in Section 9.4) and groundwater pressures. This will assess any adverse effects of the Operations Phase on groundwater quality trends.
- Monthly inspections of stormwater capture infrastructure to manage and clear blockages to prevent overflows. Inspections should be carried out more regularly should inclement weather be forecast.
- Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two year period, a review (undertaken by Crown, in liaison with relevant regulatory authorities if required) will determine if monitoring is to continue to occur and at what frequency.

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

10.6 Landfill Gas

10.6.1 Management Objectives

The Project's environmental objectives with regard to the management of landfill gas impacts during the Operations Phase are to:

- Minimise and manage the release of landfill gas throughout the Operations Phase.

10.6.2 Proposed Limits and Targets

The DSI investigation (Golder, 2013b) undertaken at the site included the collection of ground gases from monitoring wells across the site (see the Contaminated Site Management Plan (Golder, 2013d)). The investigation identified 16 out of 20 locations with concentrations of combustible gas above the trigger value of 25% Lower Explosive Limit (%LEL). Ten wells also contained combustible gas concentrations exceeding 100% LEL or the equivalent of 5% gas as methane. A summary of the exceedances of the trigger values is included in Table 32. No other chemical were measured in concentrations above relevant guideline values.

Table 32: Summary of Well Locations with Concentrations Greater Than Trigger Value

Trigger	Location
Wells containing combustible gas concentrations >25% LEL	ASS002, ASS004, ASS005, ASS007, ASS008, SB003, SB008, SB009, SB011, SB012, SB013, SB018, SB026, SB028, SB029, SB030
Wells containing combustible gas concentrations >100% LEL or 5% gas	ASS004, ASS005, ASS007, ASS008, SB008, SB009, SB011, SB013, SB026, SB028, SB029, SB030

10.6.3 Potential Environmental Impacts

With respect to outdoor air quality, once groundcover is established on-site ongoing air monitoring is not required during the Operational Phase of the Project.

With respect to the design and operation of the building and considering indoor air quality, the findings from the DSI (Golder 2013c) indicated that some risk mitigation measures should be considered for the operation of the Project. Due to the explosion and asphyxiation risk caused by landfill gas accumulation, Golder considers that due to the potential for enclosed spaces in the building structures that gas management and mitigation measures be adopted.

10.6.4 Proposed Management and Mitigation Measures

Based on CIRIA C665, a *Characteristic Situation 2 or 3* requires two levels of protection. CIRIA specifies management and mitigation measures which may be included in the design and construction of the Project such as:

- Reinforced concrete case *in situ* floor slab (suspended, non-suspended or raft) with at least 1200 g DPM2.
- Beam and block or pre-cast concrete slab and minimum 2000 g DPM/reinforced gas membrane.
- Possibly underfloor venting or pressurisation in combination with the above two points depending on use.
- All joints and penetrations sealed.

10.6.5 Proposed Monitoring Procedures

An indoor air monitoring program should be developed and implemented during the Operational Phase to ensure that the mitigation measures are effective.

10.7 Dewatering Management

If a situation arises in which dewatering is required, such as extraction of groundwater for irrigation, management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures can be located in the Dewatering Management Plan (Golder, 2013j).

10.8 Contaminated Site Management

If localised contaminated sites are discovered, management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures can be located in the Contaminated Site Management Plan (Golder, 2013e).

11.0 REHABILITATION MANAGEMENT PLAN

11.1 Overview

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

Rehabilitation will be required within the landscaped areas and the retained lakes, and other undeveloped areas within the Project area. A Rehabilitation Management Plan will be prepared by the Crown Towers Construction Phase Lead Contractor. The role of the Lead Contractor(s) in preparing the site for rehabilitation is outlined in the Project EMP (Golder, 2013c) and will be included in the contract documents for the Construction Phase works.

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 Construction Phase 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).

11.2 Construction Phase

The Lead Contractor for the Construction Phase of the Project 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 relevant regulatory agencies and will be approved by Crown prior to being implemented.

Prior to clearing for earthworks to be undertaken, a suitably qualified environmental professional should undertake a walkover of the Project area to 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 determine they are not located in stormwater flow ways, are not being disturbed by works and are free of weeds.

Protection of designated preservation areas (if any) will be undertaken as part of the rehabilitation procedures throughout the Construction Phase.

The Lead Contactor(s) along with Crown's Environmental Advisor 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.

The Lead Contactor(s) along with Crown's Environmental Advisor 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.

11.3 Operations Phase

Crown will be required to implement the rehabilitation monitoring and maintenance components of the Rehabilitation Management Plan developed by the Lead Contractor. This will involve monitoring the status of the landscaping and rehabilitation as well as undertaking measures should rehabilitation be unsuccessful.

12.0 ENVIRONMENTAL MANAGEMENT STRATEGY

12.1 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). The EMPs recognise the current environmental conditions of the site and specify management and mitigation measures and monitoring procedures for the potential environmental impacts (which also considers social impacts).

The series of EMPs are generally:

- Prepared by Crown in liaison with the regulatory authorities and the appointed Contaminated Sites Auditor.
- Implemented by the Lead Contractor(s) at each phase of the Project.
- Monitored and enforced by Crown through the award of contract.

The EMPs prepared by Crown are an integral part of the procurement process for the Project, with the EMPs included with each Request for Proposal (RFP) for the Project, namely Construction Works and operations. The importance of the EMPs is reflected in the evaluation criteria included in the RFPs, where a weighting is attributed to compliance with the Project's environmental objectives and EMPs. This approach reduces the risk that preparation and implementation of the required EMPs will not be adequately undertaken.

The Environmental Management Strategy objectives are to:

- Minimise and manage the environmental and social impacts arising from Project works.
- Manage contamination through monitoring of groundwater, surface water, soil, air and landfill gas during the Construction Phase of the Project and into the Operations Phase.
- 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.
- Compliance with conditions set on the Project, if any, and applicable legislation and guidelines produced by the relevant regulatory agencies.

The Environmental Management Strategy illustrated in Figure 13 identifies the Project's environmental objectives and details the environmental commitments, management and mitigation measures; and monitoring procedures necessary to manage the Project's environmental impacts and meet the stated objectives.

Crown is responsible for preparing the majority of the listed Environmental Management Strategy documents in consultation with the regulatory agencies. The Lead Contractor(s) are responsible for implementation (including monitoring) of the EMPs, which will be overseen and enforced by Crown through the Contract of Award applicable to each phase of work. This approach reduces the risk that preparation and implementation of the required EMPs will not be adequately undertaken.

The Environmental Management Strategy for the Project, outlined in Figure 13 is made up of the following documents:

- Construction Environmental Management Framework (CEMF) (Golder, 2013a).
- Operations Environmental Management Framework (OEMF) (Golder, 2013b).
- Project Environmental Management Plan (Project EMP) (Golder, 2013c) including environmental management and mitigation measures and monitoring procedures.
- Environmental Sub-management Plans for the Project's key environmental issues.
- Lead Contractor(s)' Construction Environmental Management Plan (CEMP).
- Crown's Operations Environmental Management Plan (OEMP) (Golder, 2013d).

These documents will be implemented to facilitate the management of potential environmental impacts resulting from Project works.

12.2 Environmental Management Frameworks

The purpose of the EMFs is to outline the Project's Environmental Management Strategy, environmental objectives and environmental commitments for each phase.

The EMFs have been developed by Golder in consultation with Crown. The content of the EMFs is used to develop the environmental management and mitigation measures, and monitoring procedures for the Project within the Project EMP (Golder, 2013c). The CEMF (Golder, 2013a) and OEMF (Golder, 2013b) are attached as Appendices A and B.

12.3 Project Environmental Management Plan

The Project EMP (Golder, 2012c) is the overarching document in the Environmental Management Strategy for the Project and its purpose is to describe the:

- Potential Environmental Impacts.
- Environmental management and mitigation measures.
- Environmental monitoring procedures.
- Applicable standards, guidelines and legislation.
- Limits and targets for all work occurring during the Project.
- Reporting and audit schedule.
- Other relevant environmental management mechanisms.

The Project EMP (Golder, 2013c) defines the Environmental Sub-management Plans required to be prepared by Crown to meet specific environmental management of and appropriate compliance with any conditions, licences, permits, consents and approvals.

The Project EMP (Golder, 2013c) was drafted by Golder in consultation with Crown based on the content of the EMFs and will be finalised based on the findings of the DSI to the satisfaction of the relevant regulatory agencies.

The Project EMP (Golder, 2013c) is to be implemented by each Lead Contractor working on-site during the Construction Phase.

12.4 Environmental Sub-management Plans

The purpose of the Environmental Sub-management Plans is to act as standalone documents specifying the management of particular issues including:

- Acid Sulfate Soil.
- Dewatering of groundwater.
- Contaminated media (soil, air, water).

Like the Project EMP (Golder, 2013c), the Lead Contractor(s) (and Crown, where applicable) will be required to implement each of the Environmental Sub-management Plans, which will be prepared to the satisfaction of the relevant regulatory agencies and may be submitted with any required licence or permit applications required.

12.5 Lead Contractor's Construction Environmental Management Plan

The purpose of the Lead Contractor's CEMP is to detail how the Lead Contractor(s) will comply with the content of the EMFs, the Project EMP (Golder, 2013c) and the Environmental Sub-management Plans. The Lead Contractor's CEMP will be prepared based on the content of the EMFs, Project EMP (Golder, 2013c) and the Environmental Sub-management Plans.

Lead Contractor(s) will be contractually required to prepare a CEMP through which they will commit to managing the environmental factors relevant to their specific construction activities.

The CEMP will specify:

- The implementation process for each of the environmental management and mitigation measures, and monitoring procedures detailed in the Project EMP (Golder, 2013c) and the Environmental Sub-management Plans.
- Methodologies.
- Trigger levels.
- Contingency measures.
- Roles and responsibilities.
- Auditing of management and mitigation measures.
- Training (see Section 22.0).
- Data collection.
- Reporting and other procedures.

As part of the CEMP, the Lead Contractor(s) are to comply with conditions, licences, permits, consents and approvals relating to the Project. The CEMP will also detail the Lead Contractor(s)' Environmental Management Strategy.

The Lead Contractor(s) CEMP will be required to be approved by Crown before any form of work begins on-site and will be contractually binding under the *Public Works Act 1902.*

12.6 Crown's Operations Environmental Management Plan

The purpose of the OEMP (Golder, 2013d), to be prepared by Crown, is to detail how Crown will comply with the content of the EMFs, the Project EMP (Golder, 2013c) and the relevant Environmental Sub-management Plans and will be prepared based on the content of these documents.

The OEMP (Golder, 2013d) will specify:

- The implementation process for each of the environmental management and mitigation measures; and monitoring procedures detailed in the Project EMP (Golder, 2013c) and the Environmental Sub-management Plans.
- Methodologies.
- Trigger levels.
- Contingency measures.
- Roles and responsibilities.
- Data collection.
- Reporting and other procedures.

As part of the OEMP (Golder, 2013d), Crown is to comply with conditions, licences, permits, consents and approvals relating to the Project. The OEMP (Golder, 2013d) will also detail Crown's environmental management strategy.

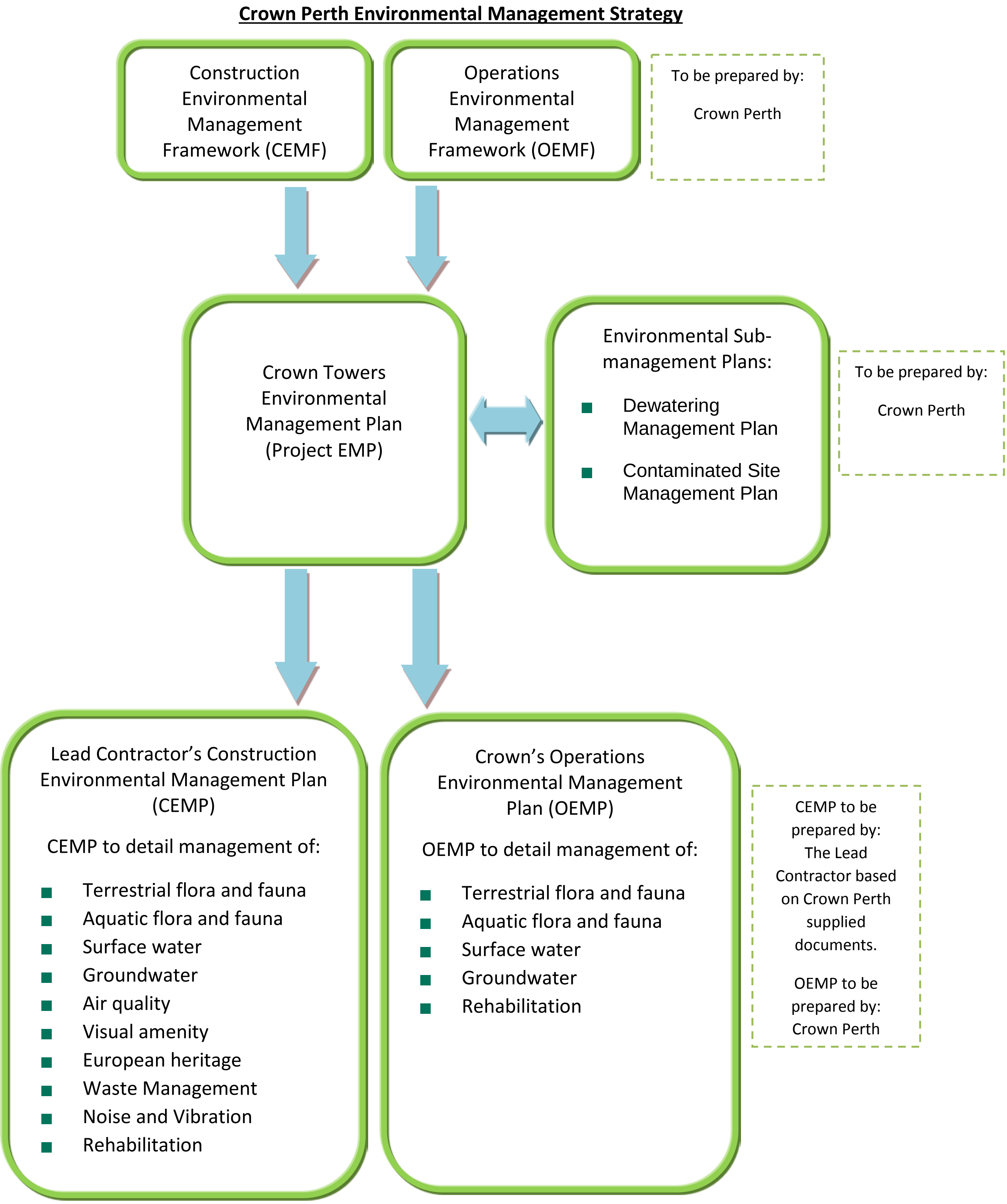

Figure 13: Environmental Management Strategy Structure

13.0 ROLES AND RESPONSIBLITIES

13.1 Overview

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

13.2 Crown

13.2.1 General

The key general responsibilities for Crown include:

- Develop, maintain and continuously improve the Environmental Management Strategy documents to the satisfaction of the regulatory agencies (see Section 23.0).
- Coordinate the delivery of the Project to meet the environmental objectives.
- Prior to commencement of construction work, confirm that the successful Lead Contractor(s) has developed a detailed CEMP in accordance with the CEMF (Golder, 2013a), Project EMP (Golder, 2013c) and Environmental Sub-management Plans.
- Liaise with regulatory agencies where required. Liaison will include, but not be limited to:
  - Reporting of site conditions when requested by the regulatory agencies.
  - Reporting of unexpected conditions where advice on the appropriate mitigation measures may be sought.
  - Reporting of incidents where there is potential for contamination issues, and corrective action is required.
- Coordinate the completion and Contaminated Sites Auditor review of the contamination investigation reports to the satisfaction of DEC.
- Coordinate and manage the contractors engaged to undertake environmental and contamination investigations.
- Being the first point of contact for the Lead Contractor(s) to report environmental incidents and provide assistance in resolving incidents occurring on-site.
- Conduct internal environmental audits to assess conformance with the Lead Contractor's CEMP, the Environmental Sub-management Plans and the OEMP (see Section 15.0).

13.2.2 Operations

The key operations responsibilities for Crown include:

- Establish, implement, maintain and continuously improve an OEMP (Golder, 2013d) and any other necessary environmental documentation in accordance with the OEMF (Golder, 2013b) and relevant Environmental Sub-management Plans.
- Conduct internal environmental audits to assess conformance with the Environmental Sub-management Plans and OEMP (Golder, 2013d).
- Obtain relevant work specific environmental approvals, licences and permits prior to commencing certain works.

- Prior to commencement of work; confirm that subcontractors have complied with the relevant requirements of the Project EMP (Golder, 2013c), Environmental Sub-management Plans and OEMP (Golder, 2013d).
- Regularly review subcontractors' performance against the requirements of the OEMP (Golder, 2013d) and take corrective action as necessary.

13.2.3 Crown's Environmental Advisor

The key responsibilities for Crown's Environmental Advisor include:

- Provide environmental advice and support to Crown during the Construction and Operations Phases of the Project.
- Assist in the coordination and management of contractors engaged to undertake environmental and contamination investigations on behalf of Crown, where required.
- Being the first point of contact for environmental incidents to be reported and provide assistance to Crown in resolving incidents occurring on-site.
- 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 CEMP/Project EMP (Golder, 2013c), Environmental Sub-management Plans and their CEMP.

13.3 Lead Contractor(s) (Construction Phase)

13.3.1 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 (Golder, 2013c) and Environmental Sub-management Plans.
- Conduct internal environmental audits to assess conformance with the Project EMP (Golder, 2013c), Environmental Sub-management Plans and CEMP.
- Obtain relevant work specific environmental approvals, licences and permits prior to commencing certain works.
- Prior to commencement of work, confirm subcontractors have complied with the relevant requirements of the Project EMP (Golder, 2013c), 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 Crown as required.
- Manage the input of suitably qualified environmental specialists into the development of the CEMP and any other environmental documentation.
- Undertake monitoring for the various environmental aspects as outlined in the Project EMP (Golder, 2013c), Environmental Sub-management Plans and the Lead Contractor's CEMP.

13.3.2 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 appropriate level of training has been provided to all site staff to minimise environmental impacts from Project works and contamination.
- Informing Crown's Environmental Advisor 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.

13.3.3 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 Crown's Environmental Advisor where required.
- The power to stop work on-site where necessary due to foreseen environmental risks.

13.4 Contaminated Sites Auditor

Jason Clay from AECOM Pty Ltd has been appointed as the Contaminated Sites Auditor 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*. Information (e.g. site records, registers and soil and water quality data monitoring results etc.) must be made available to the Contaminated Sites Auditor at his request.

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 classify/re-classify the site. On classification/re-classification of the site, regulation of the Project will be by the relevant regulatory agencies.

14.0 ENVIRONMENTAL REPORTING REQUIREMENTS

14.1 Project Compliance

Monthly compliance reports will be provided to Crown by the Lead Contractor(s) covering as a minimum:

- Environmental activities.
- Environmental monitoring results.
- Compliance auditing and tracking.
- Rehabilitation progress.

- Public complaints.
- Any exceedances and corrective actions.
- Environmental incidents.
- Non-conformances.

In addition to the monthly compliance reports, annual environmental compliance reports will be completed by the Lead Contractor(s) and submitted to Crown.

Annual compliance reports will be completed by Crown's Environmental Advisor for the first two years during the Operations Phase covering as a minimum:

- Environmental activities.
- Environmental monitoring results.
- Compliance auditing and tracking.
- Rehabilitation progress.
- Public complaints.
- Any exceedances and corrective actions.
- Environmental incidents.
- Non-conformances.

These reports will be provided to the Environmental Auditor for assessment.

14.2 Compliance Tracking

A corrective actions and compliance tracking program will be developed by the Lead Contractor(s)/Crown to manage and track Project compliance with the commitments in the Project EMP (Golder, 2013c), Environmental Sub-management Plans and CEMP/OEMP (Golder, 2013d). The tracking document will be a standalone document and will be provided to Crown/Crown's Environmental Advisor as part of the monthly compliance reports.

14.3 Management of Non-compliance

Non-compliance will be managed by the Lead Contractor(s) responsible for each phase and Crown under the implementation of the Project EMP (Golder, 2013c), Environmental Sub-management Plans and CEMP/OEMP (Golder, 2013d). Procedures for managing non-compliance including the recording, reporting and implementation of mitigation measures or corrective action and responsible persons will be detailed in the CEMP/OEMP (Golder, 2013d). A non-conformance register will be maintained by the Lead Contractor(s) which should include, at a minimum:

- A description of the non-conformance.
- Any mitigation actions implemented.
- Reporting details, including date and who the non-conformance was reported to.

14.4 Records of Environmental Activities

Environmental records for the Construction Phase and Operations Phase will be maintained to demonstrate compliance with the Project EMP (Golder, 2013c); Environmental Sub-management Plans and the CEMP/OEMP (Golder, 2013d), 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 for the Construction Phase will be provided in the monthly compliance reports and provided to Crown.

This information for the Operations Phase will be kept on-site by Crown.

15.0 AUDITING

15.1 Contaminated Sites Auditor

Jason Clay from AECOM Pty Ltd has been appointed as the Contaminated Sites Auditor for the Project. The 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*. Information (e.g. site records, registers, etc) must be made available to the Contaminated Sites Auditor at his request.

15.2 Audits and Inspections

The Lead Contractor's Environmental Representative, is to conduct daily inspections as outlined within the Project EMP (Golder, 2013c).

A qualified (e.g. RABQSA) Environmental Auditor (Lead or Principal Auditor level) will be engaged by the Lead Contractor to conduct environmental audits during the Construction Phase of the Project as outlined within the Project EMP (Golder, 2013c).

From the commencement of the Construction Phase, environmental audits will be undertaken weekly for the duration of the first quarter of Construction Phase. Environmental audits will then be held monthly thereafter. The objective of the monthly environmental audits is to assess the Lead Contractors' compliance with the Project EMP (Golder, 2013c), Environmental Sub-management Plans and CEMP. The results of the monthly environmental audits will be recorded and any non-conformances identified against the Project EMP (Golder, 2013c), Environmental Sub-management Plans and CEMP, along with proposed corrective actions, will be reported to Crown in the monthly environmental compliance report. Crown and Crown's Environmental Advisor will manage the Construction Phase Lead Contractor to implement suitable corrective actions.

A qualified (e.g. RABQSA) Environmental Auditor (Lead or Principal Auditor level) will be engaged by Crown to conduct quarterly environmental audits during the first two years of the Operations Phase of the Project. The objective of the monthly environmental audits is to assess Crown's compliance with the Project EMP (Golder, 2013c), Environmental Sub-management Plans and OEMP (Golder, 2013d). The results of the quarterly environmental audits will be recorded and any non-conformances identified against the Project EMP (Golder, 2013c), Environmental Sub-management Plans and OEMP (Golder, 2013d), along with proposed corrective actions, will be reported to Crown's Environmental Advisor. Crown's Environmental Advisor will then take corrective action. Depending on the results of the quarterly audits, audits may be able to be reduced to bi-annually.

16.0 COMMUNICATION OF ENVIRONMENTAL MATTERS

16.1 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 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.
- Reiteration of specific environmental management procedures which have already been communicated to site personnel.

Regular meetings between the Lead Contractor's Construction Manager and Crown's Environmental Advisor 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.

16.2 Construction Environmental Inspection Checklist

During the Construction Phase the site will be subject to daily site inspections prior to the commencement of work for the 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 of the Project EMP (Golder, 2013c), CEMP and Environmental Sub-management Plans.
- Assess compliance with all relevant licence conditions.
- Review of the monitoring of key performance indicators outlined in the individual EMPs.
- Review of relevant records which include the Environmental Complaints and Incident Register.
- Review of the previous week's Construction Environmental Inspection Checklists.

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 included as Appendix F and the checklist format is to be based on the format included as Appendix F.

The Construction Environmental Inspection Checklist is to be kept on record by the Lead Contractor and provided to Crown on request.

16.3 Phase Handover

An important element in the successful implementation of the Project is the handover between the Lead Contractor(s) and Crown. The Lead Contractor(s) will contractually be required to prepare a Handover Management Plan (separate to the CEMP). At least two months prior to the completion of the Construction Phase the appropriate Lead Contractor(s) will liaise with Crown and coordinate at least two meetings to discuss handover. As a minimum, the handover should cover:

- Monitoring data storage and system use.

- Other data storage and system use.
- Stakeholder consultation undertaken.
- Environmental issues observed and management measures undertaken.
- Risk management.
- Rollover of environmental management and monitoring measures.

17.0 MANAGEMENT OBJECTIVES AND KEY PERFORMANCE INDICATORS

The CEMP and OEMP (Golder, 2013d) outline the specific environmental management objectives, targets and key performance indicators for the respective environmental aspects. Environmental management objectives are to be based on those developed by Crown as listed in Section 8.0. 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.

18.0 MATERIAL TRACKING SYSTEM

A Material Tracking System (MTS) shall be prepared and implemented by the Lead Contractor(s) during the Construction Phase as per information contained within the Contaminated Site Management Plan (Golder, 2013e) to document:

- All materials brought onto the site and all stockpiling.
- Placement of all materials (whether clean or unacceptable) on the site.
- Placement and movement of all materials (whether clean or unacceptable) going off-site, including quantities.

For specific MTS requirements, refer to the Contaminated Site Management Plan (Golder, 2013e).

19.0 EMERGENCY RESPONSE PROCEDURE

The Lead Contractor(s) will be responsible for preparing an Emergency Response Standard Operation Procedure (ERSOP) (independent of the CEMP).

Crown has in place an ERSOP (Crown Perth, 2012) for their existing operations. The content of the ERSOP (Crown Perth, 2012) will be the basis for the development of a similar ERSOP for the Crown Towers Project. The ERSOP (Crown Perth, 2012) outlines emergency, incident response and evacuation procedures and situations where works should be promptly ceased. The ERSOP to be developed for the Crown Towers project will also require an emergency contact number to be established which can be telephoned 24 hours a day, seven days per week.

The ERSOP for both the Construction and Operations Phases should detail the following 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 should result in stopping of works/operations.

20.0 ENVIRONMENTAL INCIDENTS MANAGEMENT PROCEDURE

An environmental incident is any of the following:

- A breach or non-conformance of statutory requirements or procedures which have been prescribed in the Project EMP (Golder, 2013c) and CEMP/OEMP (Golder, 2013d).
- A failure to meet targets or key performance indicators which have been outlined in the individual management plans.
- A breach or non-conformance of relevant licence conditions.

The relevant regulatory agencies will be notified of any major incidents with actual or potential environmental impacts as soon as practicable after the occurrence of the incident.

Environmental incidents are to be managed in accordance with the contingency procedures outlined in the individual Emergency Response Procedure. However, the following general procedure (illustrated in Figure 14 is to be followed in the event of an environmental incident during the Construction Phase:

1) The Lead Contractor(s)' Construction Manager and Environmental Representative shall be notified immediately upon the occurrence of an environmental incident and they shall immediately notify Crown's Environmental Advisor and Crown's Environmental Advisor.
2) Subject to the nature and extent of the environmental incident, the Lead Contractor(s)' Construction Manager or Environmental Representative in conjunction with Crown's Environmental Advisor shall issue a work order to halt and/or rectify the environmental impact/harm caused as a result of the environmental incident.
3) Within 24 hours of the environmental incident having been reported to the Lead Contractor(s)' Construction Manager and/or Environmental Representative, written notification of the time, date and nature of the environmental incident, plus the corrective action if required, shall be forwarded to Crown's Environmental Advisor, who will inform regulatory agencies where required.
4) The Lead Contractor(s)' Construction Manager in conjunction with Crown's Environmental Advisor shall assess the environmental incident report and shall assess the nature of further corrective action to be taken and shall state 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 by Crown's Environmental Advisor and Crown's Environmental Advisor.

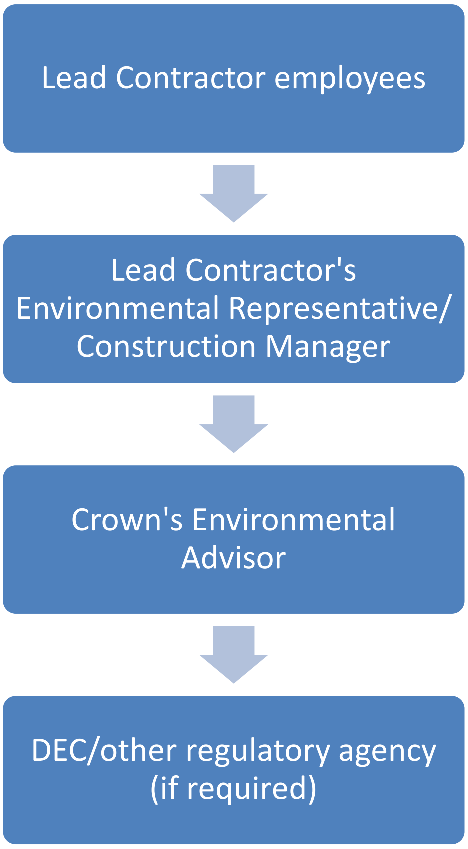

Figure 14: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Construction Phase

Environmental incidents are to be managed in accordance with the contingency procedures outlined in the individual Emergency Response Procedure. However, the following general procedure (illustrated in Figure 15) is to be followed in the event of an environmental incident during the Operations Phase:

1) A Crown representative and Environmental Advisor shall be notified immediately upon the occurrence of an environmental incident.

2) Subject to the nature and extent of the non-conformance, Crown's Environmental Advisor shall issue a work order to halt and/or rectify the environmental impact/harm caused as a result of the environmental incident.

3) Within 24 hours of the non-conformance having been reported to Crown's Environmental Advisor, written notification of the time, date and nature of the environmental incident, plus the corrective action if required, shall be forwarded to Crown Senior Management, and relevant regulatory agencies where required.

4) Crown's Senior Management in conjunction with Crown's Environmental Advisor shall assess the environmental incident report and the nature of further corrective action to be taken, and shall state the timeframe within which the corrective action is to be implemented.

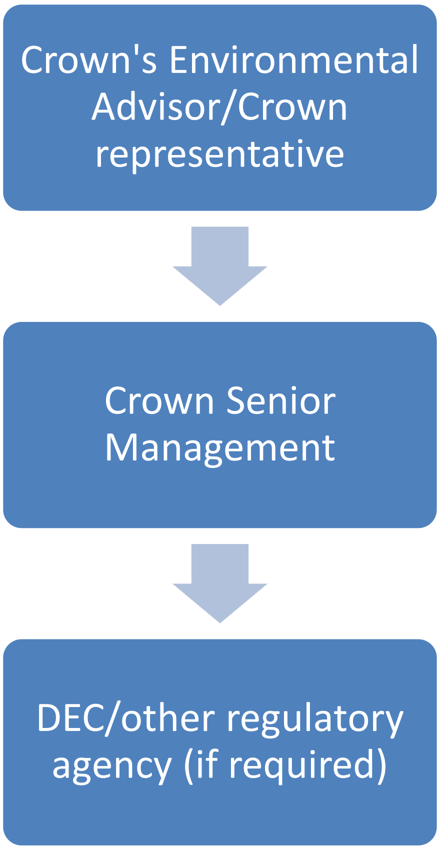

Figure 15: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Operations Phase

It should be stressed that at any point during the development of the site any site personnel have the right to halt work if human health is at risk.

Environmental incidents and complaints are to be recorded in an Environmental Complaint and Incident Register to be kept by the Lead Contractor(s) and Crown's Environmental Advisor and are to be made available to Crown upon request. The register must also be made available to the DEC officers and any other authorised parties to view upon request.

Crown and/or the Lead Contractor(s) if directed by Crown, will notify the relevant regulatory agencies if required by law of any major incidents with actual or potential 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 and mitigation measures in the CEMP/OEMP (Golder, 2013d) and/or the Emergency Response Procedure.

21.0 PUBLIC COMPLAINT MANAGEMENT

All complaints received by Crown from the public, in relation to impacted sensitive receptors or the environment will be recorded in the Environmental Complaint and Incident Register which will record the following information:

- **Contact details**: Name, address and phone number of party raising concern.
- **Nature of concern**: Details of issue/incident.
- **Action taken or required**: Details of action proposed or undertaken to address the concern, including time and date.

- **Response to action**: Was the party raising the concern satisfied with the outcome. If not, what else needs to be done, or is it outside the scope of the operation of the Crown Towers.
- **Prevention of reoccurrence**: If the concern relates directly to an Operations problem, what action has been taken to prevent the problem from reoccurring.

All complaints shall be referred to Crown for the purpose of investigation.

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.

22.0 ENVIRONMENTAL TRAINING

The Lead Contractor/Crown will see that each person employed to work at the Crown Towers during the Construction Phase/Operations Phase undertakes appropriate training and inductions. The induction should 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.

23.0 REVIEW

The Project EMP (Golder, 2013c), the Environmental Sub-management Plans, CEMP and OEMP (Golder, 2013d) 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 the Project to assess that the documents 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 or mitigation measures, or monitoring procedures.
- Where unpredicted adverse environmental impact necessitates a change in environmental management or mitigation 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.

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Report Signature Page

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SB/EWC/slj

A.B.N. 64 006 107 857

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APPENDIX A

Crown Environmental Management Plan (Project EMP)

February 2013

CROWN PERTH

Crown Towers Environmental Management Plan

Submitted to:
James Noel
Crown Perth
PO Box 5000
VICTORIA PARK WA 6979

REPORT

Report Number. 127643111-011-R-RevC

Distribution:

3 Copies - Environmental Protection Authority
2 Copies - Crown Perth (+1 Electronic)
1 Electronic Copy - Golder Associates Pty Ltd

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1.0 INTRODUCTION

1.1 Overview

This Crown Towers Perth Environmental Management Plan (Project EMP) has been prepared for the new Crown Towers project (the Project) as part of an Environmental Management Strategy. The Project EMP has been prepared to guide Crown Perth (Crown) 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) (Golder, 2013a), the Operations Environmental Management Framework (OEMF) (Golder, 2013b) and the Crown Operations Environmental Management Plan (Golder, 2013c). These documents provide the following:

- A description of the Construction and Operations Phase works.
- A description of each Environmental Management Plan (EMP) document that comprises the Environmental Management Strategy of the Project.
- Crown's Environmental Objectives and Environmental Commitments for the Project.
- The Environmental Commitments for the Project for the Lead Contractor(s) and Crown.

This Project EMP is a draft working document and may be revised as needed once the Construction Phase Lead Contractor has been engaged and the DSI finalised.

1.2 Background

The Project is to design, construct, operate and maintain the Crown Towers project (the Project) located within the Burswood Peninsula, Western Australia. Crown is developing a new world class hotel addition at their Integrated Resort in Perth, Western Australia. The Project will consist of a six-star quality 25 story hotel constructed on the banks of the Swan River with views of the central business district in Perth and the Indian Ocean in the distance. The tower will accommodate a total of 500 rooms and will be branded as Crown Towers, which is Crown Limited's premium hotel brand. A low-rise podium will contain a large convention and meeting complex, restaurants, retail and public spaces which have been integrated into the existing property.

The design of the property will capitalize on the unique nature of the site and leverage the Mediterranean climate in Perth to create a true unique resort setting. The property will cater to affluent business and leisure clientele and support a VIP gaming component which will integrate into the hotel tower through the incorporation of Suite/Villa accommodations and VIP Gaming salons. The Project will also incorporate an expansion of their existing pools and landscaped areas. Phased improvements strategy is defined below and construction is expected to follow the delivery of these packages.

For planning purposes the Project is to be delivered in two phases:

- **Construction Phase:** the construction of the Crown Towers, Podium and associated infrastructure, which will include the use of deep piles inserted into the ground to provide building support for the main structures.
- **Operations Phase:** the operation of the Crown Towers. The transition from the Construction Phase to the Operations Phase will occur once the all Construction Phase work has been completed and the Lead Contractor has left site, handing the development infrastructure over to Crown. Ongoing environmental monitoring of the site and management of site facilities will continue during the Operations Phase.

Delivery of the Project has potential for environmental and social impacts (primarily surrounding the works proposed for the Construction Phase) and will therefore be referred to the Office of the Environmental Protection Authority (EPA) in accordance with Section 38 of the *Environmental Protection Act 1986*.

1.3 Project EMP Scope

The scope of this Project EMP focuses on the construction of the Project including:

- Construction of the:
  - Crown Tower's six-star, 25 level, 500 room hotel development.
  - Podium structure, linking the hotel to adjoining buildings and properties (approximately 25 000 m^2 footprint).
  - Associated services buildings (for generators, bins, refuse, hoist and loading bay under croft).
  - Porte cocheré.
  - Pedestrian access ways.
- New and refurbishment of existing external works (including new landscaping and swimming pools, approximately 11 000 m^2).
- Refurbishment of existing function room and associated public spaces.
- Rehabilitation and landscaping (approximately 33 000 m^2 footprint).
- Stormwater catchment lake(s) infill and expansion.

Hotel facilities will include:

- New function/conference facilities will complement the existing function room, which will be refurbished.
- A new resort swimming pool, exclusively for Crown Towers Perth guests, will be provided. The new resort pool is to be integrated, design-wise and access-wise, with the existing Crown Metropol Perth pools and VIP enclave pool.
- A mix of standard guest rooms and suites in the hotel towers. The VIP/Crystal Club facilities, including salon gaming VIP lounge and pool areas, will be located on the levels above the standard guest rooms, in effect, separating the standard guest room floors from the floors containing the suites.
- Gaming salons that will form part of the VIP offering, and will be supported by a VIP lounge, Crystal Club, wading pool, and bar.
- Back of house facilities located on a number of levels, including the basement, which will also incorporate a loading bay, generators, bins, refuse and a hoist.
- Plant rooms required to operate the hotel facilities.
- Guest and staff uniform laundry operations which will take place on-site in the hotel, whilst hotel and food and beverage linen will be taken off-site.

Figure 1 illustrates the indicative Project layout.

LEGEND

Estimated project boundary

NOTES

Coordinate System: PCG94

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Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 10 20 30 40 50
metres

SCALE (at A3) 1:1,700

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CLIENT Crown Perth
DOCUMENT 127643111-011-R-RevC
DATE 07 Feb 2013
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APPROVED DRAFT

Crown Project EMP

INDICATIVE PROJECT LAYOUT

FIGURE 1

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1.4 Objective

This Project EMP has been drafted by Golder Associates Pty Ltd (Golder), in consultation with Crown, based on the findings of a Detailed Site Investigation (DSI) and the content of the Environmental Management Frameworks (EMFs) for the Project. This Project EMP is one document in the Environmental Management Strategy for the Project and its objective is to describe the following, with respect to the Construction Phase of the Project:

- 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 and mitigation 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 as well as Crown. 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 to the satisfaction of the relevant regulatory agencies and final approval of the Project EMP by Crown will be required before any form of work begins on-site.

1.5 Project Location and Tenure

Crown Perth is located at 201 Great Eastern Highway on the Burswood Peninsula in City of Perth, Western Australia. The Project will be located within the southern nine holes of the Burswood Park Golf Course located on the Burswood Peninsula, as shown in Figure 2.

The Burswood Peninsula extends over an area of approximately 280 ha and is located approximately 2.9 km east of the Perth CBD. A variety of land uses are located within the Burswood Peninsula including the Burswood Park Golf Course, the State Tennis Centre, the Crown Perth complex, the Dome, the Burswood Peninsula residential development, the Belmont Racecourse and assorted parklands and car parks.
The Burswood Peninsula is accessed by road from the Graham Farmer Freeway, Victoria Park Drive and the Great Eastern Highway, with Belmont and Burswood train stations also servicing the area.

The Project area includes the southern end of the Burswood Park Golf Course, which is currently under the control and management of the Burswood Park Board, and the Crown Perth complex. The Project area is surrounded by land zoned for parks and recreation, residential, and public purposes - special uses (Crown Perth complex). The Swan River, which is in close proximity but not directly adjacent the Project area is managed by the Swan River Trust (SRT), a state government agency that protects, manages and enhances the Swan Canning Riverpark.

The Project area is shown in Figure 3 and is 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 Burswood Water Sports Centre and the Swan River to the west; the Burswood Park Golf Course to the north; the Mirvac Burswood Peninsula residential development to the east; and the existing Crown Perth complex to the south.

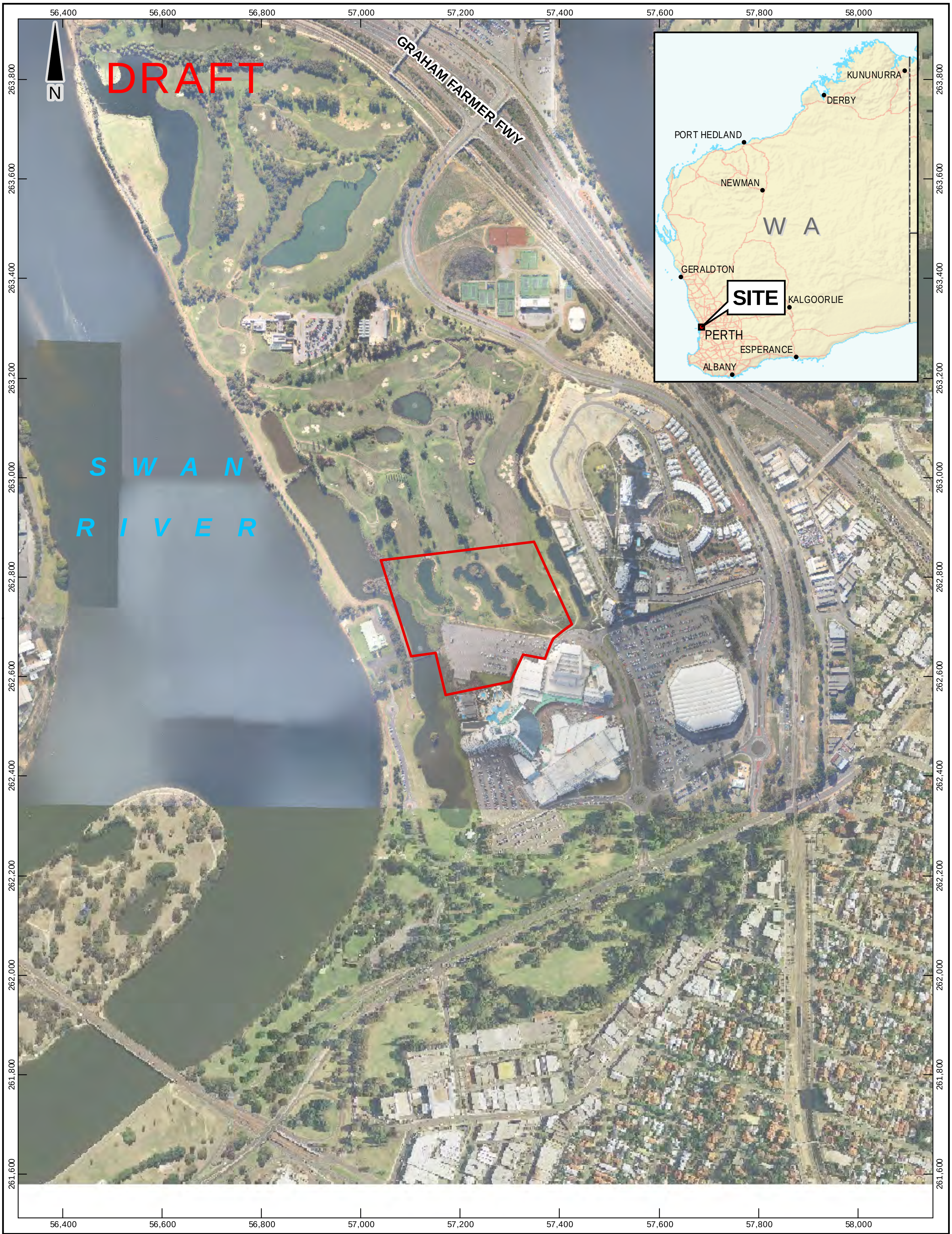
The proposed Project Area is comprised of the following four lots (see Table 1) which extend over an area of approximately 7.8 ha.

Table 1: Land Tenure

Lot	Deposited Plan (DP)	CT (vol/folio)	Address	Owner	Total Approx. Area (ha)	Total Area within Project Area (ha)
301	DP42394	LR3139/329	201 Great Eastern Hwy, Burswood	State of Western Australia - proposed to be purchased by Crown	50.8	5.8
10	DP25931	2694/975	63 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	1.8	1.8
12	DP25931	2694/977	61 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	2.4	0.1
15	DP60786	2696/429	23 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	5	0.1

Note: The portion of the proposed Project area contained in Lot 301 of which Crown is proposing to buy is located within the Burswood Park "C" Class Reserve. This is Lot 301 on Deposited Plan 42394 (CT LR 3139-329).

It has been identified that the Project area has had an extensive history of potentially contaminating land use activities. Therefore, an environmental DSI was conducted in accordance with the Department of Environment and Conservation (DEC) Contaminated Sites Management Series Guidelines and the implications of the DSI findings are discussed throughout this document.



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CLIENT	Crown Perth
DOCUMENT	127643111-011-R-RevC
DATE	07 Feb 2013
COMPILED	GGW
APPROVED	DRAFT

0 100 200 300 400
metres

SCALE (at A4) 1:10,000

NOTES
Coordinate System: PCG94

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LEGEND
Estimated project boundary

Crown Project EMP

REGIONAL LOCATION

FIGURE 2

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CLIENT Crown Perth
DOCUMENT 127643111-011-R-RevC
DATE 07 Feb 2013
COMPILED GGW
APPROVED DRAFT

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metres

SCALE (at A4) 1:4,000

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LEGEND
Estimated project boundary

Crown Project EMP

PROJECT AREA

FIGURE 3

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\011 R\RevC\127643111-011-R-F003-RevC-Project_Area.mxd

2.0 PROJECT SCOPE

2.1 Overview

The delivery of the Construction Phase (including any pre-construction works) of the Project, and the delivery of the Operations Phase of the Project is described in the following sections.

2.2 Construction Phase

2.2.1 Pre-construction Works

Pre-construction works are necessary to prepare the site for construction and in particular, to manage the underlying ground conditions. The main components of the pre-construction works for this Project are site preparation and earthworks. Information in the following sections is based on the *Preliminary Geotechnical Advice and Desk Study* (Golder, 2012a).

2.2.1.1 Site Preparation

The site preparation works have been identified as those that do not require significant ground disturbance:

- 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, if required.

2.2.1.2 Earthworks

Isolated excavation works may be required for the construction/installation of:

- Trenches for provision of services such as sewage and electricity
- Swimming pools
- Piles for the main structures
- Base of the elevator shaft
- All excavation works will not extend below the clean fill layer where practicable.

Other earthworks include:

- Importation and placement of clean fill materials and undertaking general earthworks including shaping and contouring existing landscape to specific levels.
- Removing the existing car park (estimated total area of 1.55 ha before disturbance).
- Clearing existing trees and vegetation.
- The new development needs 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 site.
- In relation to the lakes:
  - Partially infill Lake 1
  - Enlarge and replace clay liner in Lake 2 (estimated total area of 0.25 ha before disturbance) for use in on-site stormwater retention.

- Infill a portion and reshape and replace clay liner in Lakes 3 (estimated total area of 0.40 ha before disturbance) and 4 (estimated total area of 0.15 ha before disturbance).
- Completely infill Lake 5 (estimated total area of 0.13 ha before disturbance).

2.2.2 Construction Works

2.2.2.1 Overview

The construction works will commence following completion of the preconstruction works. The development loads associated with the Crown Towers 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.

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:

- Low rise structures (such as Pools and associated deck and landscaped area).
- High rise structures (such as the Crown Towers hotel building).

2.2.2.2 Piling

Potential piling solutions for more heavily loaded areas are:

- Driven precast concrete piles of larger cross-section, such as 450 mm square or 550 mm octagonal sections.
- Driven steel tubular piles of typically about 600 mm to 750 mm diameter.
- Bored piles of typically about 900 mm to 1200 mm diameter.
- Continuous flight auger (CFA) piles of typically about 750 mm to 900 mm diameter.

Pile lengths of between about 30 m and 35 m would be anticipated at the tower location should 600 mm diameter driven steel tubular piles be constructed. Steel tubular piles are expected to be able to be driven a greater distance into the KPF than precast concrete piles.

2.3 Operations Phase

The Operations Phase of the Project involves the transition of the Towers, Podium and other infrastructure from construction to operation and being opened to the public. The Operations Phase will include ongoing environmental management and monitoring by Crown. Crown will also be responsible for the maintenance of the facilities and infrastructure and the monitoring of the site which is anticipated to be ongoing for at least a period of three years as detailed in Section 11.0 and within the OEMP.

The potential environmental impacts, proposed management and mitigation measures and monitoring procedures associated with the operations, particularly noise, are detailed in the respective Project Environmental Management Plans (EMPs) (see Section 9.0)

3.0 APPLICABLE LEGISLATION

3.1 State Legalisation and Regulations

Key Western Australian legislation and regulations that apply to the Project include, but are not limited to:

- *Casino (Burswood Island) Agreement Act 1985*
- *Contaminated Sites Act 2003*
- *Environmental Protection Act 1986 (EP Act)*
- *Health Act 1911*
- *Occupational Safety and Health Act 1984*
- *Planning and Development Act 2005*
- *Rights in Water and Irrigation Act 1914*
- *Swan and Canning Rivers Management Act 2006*
- *Water Supply Sewerage and Drainage Act 1912*

Additional Western Australian legislation and regulations that may apply to the Project include, but are not limited to:

- *Aboriginal Heritage Act 1972*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Electricity Act 1945*
- *Electricity Industry Act 2004*
- *Energy Coordination Act 1994*
- *Environmental Protection (Controlled Waste) Regulations 2004*
- *Environmental Protection (Noise) Regulations 1997*
- *Environmental Protection (Unauthorised Discharges) Regulations 2004*
- *Heritage of Western Australia Act 1990*
- *Heritage of Western Australia Amendment Regulations 2012*
- *Land Administration Act 1997*
- *Litter Act 1979* (currently under review by DEC and will be incorporated into the EP Act)
- *Local Government Act 1995*
- *Main Roads Act 1930*
- *Metropolitan Water Supply, Sewage & Drainage Act 1909*
- *Pollution of Waters by Oil and Noxious Substances Act 1987*
- *Pollution of Waters by Oil and Noxious Substances Regulations 1993*
- *Road Traffic Act 1974*
- *Soil and Land Conservation Act 1945*
- *Waterways Conservation Act 1976*
- *Wildlife Conservation Act 1950*

Native Title considerations are not an impediment to development as Native Title has been extinguished by virtue of previous grants of tenure.

3.1.1 *Casino (Burswood Island) Agreement Act 1985*

The *Casino (Burswood Island) Agreement Act 1985 (*Casino Act) extends over an area of approximately 126 ha incorporating the Burswood Park Golf Course, the State Tennis Centre, the Crown Perth complex and the Dome. The Casino Act created both a “Site” (Crown Perth complex and Dome) and a “Resort Site” (Burswood Park Golf Course, State Tennis Centre, public parkland and car parks). The Resort Site was placed in the control of the Burswood Park Board which is responsible for the ongoing management and maintenance of the Burswood Park Golf Course and parklands. The Resort Site area contained within the Project area will become part of the “Site” area with the purchase of land by Crown.

3.1.2 Metropolitan Region Scheme

The Metropolitan Region Scheme (MRS) Map does not currently apply any zoning or reservation over the Casino Act area; with the Resort Site identified on the MRS Map as “Act Area” (see Figure 4). This reflects Section 7(1) of the Casino Act which states that, notwithstanding the provisions of the *Planning and Development Act 2005*, the MRS does not apply to the “Resort Lands”: which is determined to be the Resort Site containing the Burswood Park Golf Course. Consequently, development approval under the MRS is not required within the Resort Site. Despite this, a Development Approval submission package for the Project was submitted to the Minister Sport and Recreation; Racing and Gaming (“the Minister”) on 13 November 2012. The Minister’s Office will solicit review and comments from the Department of Planning, who in turn have engaged the following:

- Office of Government Architect
- Department of Transport
- Town of Victoria Park.

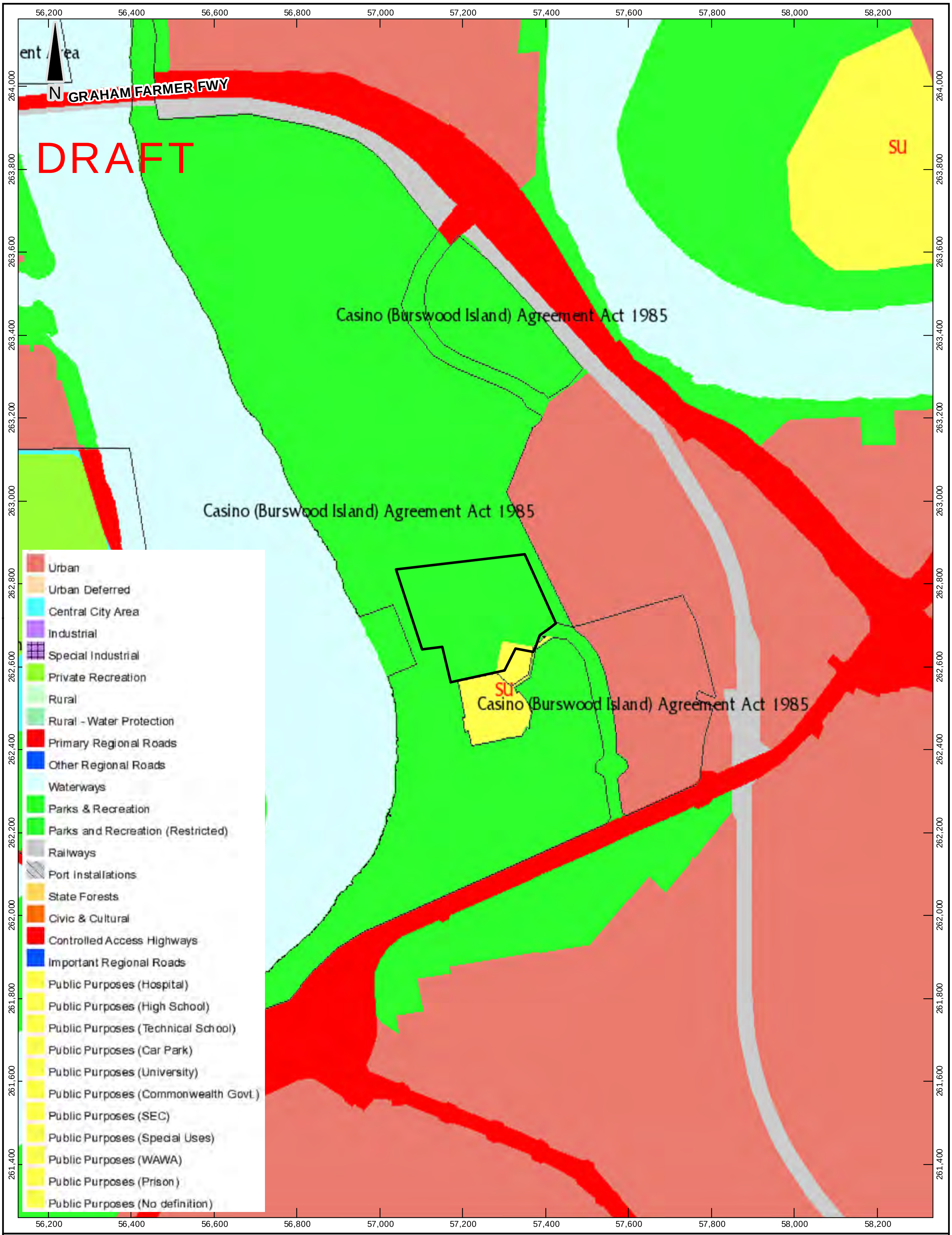
The Minister’s Office will also seek approval from Cabinet.

Under the Casino Act it is possible to revivify the MRS so that the provisions of the MRS are reinstated, which in this instance would be a Parks and Recreation reserve, reflecting the zoning that applied to the land prior to the Casino Act coming into force in 1985.

3.1.3 Town Planning Scheme

The Burswood Peninsula is within the Town of Victoria Park local government area. The Town of Victoria Park Town Planning Scheme No. 1 (TPS 1) generally applies to the land within the local government area; however, Clause 4 of TPS 1 excludes the “Resort Lands” that are subject to Section 7 of the Casino Act from the scope of TPS 1. Therefore, while the Casino Act remains in place over the land, TPS 1 does not apply.

Notwithstanding, TPS 1 identifies the land as MRS Parks and Recreation Reserve in recognition of the site's zoning under the MRS prior to the Casino Act coming into force in 1985. TPS 1 exempts development on MRS Reserved land from requiring approval under TPS 1.



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CLIENT Crown Perth
DOCUMENT 127643111-011-R-RevC
DATE 07 Feb 2013
COMPILED GGW
APPROVED DRAFT

0 100 200 300 400 500
metres

SCALE (at A4) 1:12,000

NOTES
Coordinate System: PCG94

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MRS sourced from SLIP Public WMS.

LEGEND
Estimated project boundary

Crown Towers EMP

METROPOLITAN REGION SCHEME

FIGURE 4

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\011 R\127643111-011-R-F004-RevA-Metropolitan-region-scheme.mxd

3.1.4 Environmental Protection Act 1986

Part IV of the EP Act governs the environmental impact assessment process, administered by the Western Australian Environmental Protection Agency (EPA). Part IV of the EP Act has been enacted through the referral process.

Section 38(1) of the EP Act states that where a development proposal is likely to have a significant effect on the environment, a proponent may refer the proposal to the EPA for a decision on whether or not it requires assessment under the EP Act.

As such, Crown has referred the Project to the EPA with the view that the potential impact of the Project is not significant. Crown has developed environmental management and mitigation measures and monitoring procedures that are to be implemented, which Crown believes will adequately address any environmental issues without the need for a formal assessment by the EPA.

This EIA Report has been prepared to support the Section 38 referral application and provide additional information related to the potential impacts, proposed management measures and relevant legislative processes that will be applied to the Project, if approved.

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.

3.1.5 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 DEC database indicates that "*landfill material has been identified beneath the site including impacts to soil, groundwater and sediment*". Jason Clay of AECOM Pty Ltd is the Contaminated Site Auditor and therefore all environmental matters (including the individual management plans) related to the Project must be reviewed by him from a contaminated sites perspective prior to implementation.

3.1.6 Swan and Canning Rivers Management Act 2006 and Draft River Protection Strategy

The Swan River Trust (SRT) provides advice to the Western Australian Planning Commission (WAPC) on developments that are partially within, or abutting waters in, the Development Control Area. Under Part 5 of the *Swan and Canning Rivers Management Act* 2006, approval by the Minister for Environment is required for works wholly contained within the Development Control Area, with recommendations made by the SRT. The Construction Phase works will not encroach into the Swan and Canning Rivers Development Control Area, under the *Swan and Canning Rivers Management Act* 2006 (refer Figure 5). Despite this, consultation has been undertaken with SRT to inform them of the Project.

Golder Associates

CLIENT	Crown Perth
DOCUMENT	127643111-011-R-RevC
DATE	07 Feb 2013
COMPILED	GGW
APPROVED	DRAFT

0 100 200 300 400
metres

SCALE (at A4) 1:9,000

NOTES
Coordinate System: PCG94

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LEGEND
Estimated project boundary
Swan River Trust Development Control Area (October 2004)

Crown Project EMP

SWAN TRUST DEVELOPMENT CONTROL AREA

FIGURE 5

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\011 R\RevC\127643111-011-R-F005-RevC-Swan_River_Trust.mxd

3.1.7 Rights in Water and Irrigation Act 1919

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 *Rights in Water and Irrigation Act 1919* if groundwater abstraction is required.

It is expected that only isolated dewatering will be required during Project works and it is the responsibility of the Lead Contractor for the Construction Phase to obtain a 5C licence to take water from an underground source, if required. Nonetheless, Crown has undertaken consultation with DOW regarding the Project.

3.1.8 Occupational Health, Safety and Welfare Act 1984

Construction of the Project as well as any plant designed to remediate contaminated material on-site must be in accordance with the *Occupation Health, Safety and Welfare Act 1984*. This Act is administered by WorkSafe Western Australia and compliance is required to assess that operations meet standards of workplace safety and protection. The registration of a plant design is required under Part 4 of the regulations.

3.2 Approval Requirements

Crown has been liaising with the relevant Decision Making Authorities and regulatory agencies to obtain necessary environmental approvals advice. When there are cases where an approval is only required for a specific area of work in a Project phase, this will be obtained by the Lead Contractor(s) during the Construction Phase and Crown during the Operations Phase of the Project. This process is outlined in the conditions and commitments detailed in this document and Crown's Operations Environmental Management Plan (OEMP).

Crown is responsible for obtaining the approvals expressly stated to be its responsibility in Table 2. 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 2 is an indicative list only and is not exhaustive. The Lead Contractor(s) must identify and obtain all other required approvals, licences and permits relevant to the Construction Phase works being undertaken.

Table 2: 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 OEPA)	Section 38 Referral under Part IV of the EP Act. If assessed, API or PER.	Crown Perth
Project approval to take action	*Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Commonwealth Minister for the Environment, or Department of Sustainability, Environment, Water, Populations and Communities (SEWPAC) under delegation	EPBC Act Referral of a Proposed Action	Crown Perth
Development Approval	*Planning and Development Act 2005*	Department of Planning and the Western Australian Planning Commission (WAPC)	Development Application	Crown Perth
Contaminated Sites	*Contaminated Sites Act 2003*	Department of Environment and Conservation (DEC)	Auditors Report for Reclassification	Crown Perth
Project Works Plan and CEMP	*Public Works Act 1902*	Crown on behalf of Minister for Works	Design and Construct Contract	Lead Contractor(s)
Dewatering	*Rights in Water and Irrigation Act 1914*	Department of Water (DoW)	5C Licence to Take Water	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/DEC	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)
Noise	*Environmental Protection (Noise) Regulations 1997*	DEC	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*	DEC	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)

3.3 Relevant Environmental Guidelines

A range of State and Federal guidelines and codes of practice provide direction for environmental protection and impact assessments.

The key OEPA position statements and guidelines that are of relevance to the Project include:

- *No. 2: Environmental Protection of Native Vegetation in Western Australia. December 2000.*
- *No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection. March 2002.*
- *No. 4: Environmental Protection of Wetlands. 2004.*
- *No. 6: Towards Sustainability. August 2004.*
- *No. 7: Principles of Environmental Protection. August 2004.*
- *No. 8: Environmental Protection in Natural Resource Management. October 2005.*
- *No. 9: Environmental Offsets. January 2006.*
- *Guide to EIA Environmental Principals, Factors and Objectives. June 2009.*
- *No. 6: Rehabilitation of Terrestrial Ecosystems. June 2006.*
- *No. 8: Environmental Noise. May 2007.*
- *No. 12: Minimising Greenhouse Gases. October 2002.*
- *No. 18: Prevention of Air Quality Impacts from Land Development. 2000.*
- *No. 33: Environmental Guidance for Planning and Development. May 2008.*
- *No. 41: Assessment of Aboriginal Heritage. April 2004.*
- *No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. June 2004.*
- *No. 55: Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process. December 2003.*
- *No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. June 2004.*
- EPA Interim Industry Consultation Guide to Community Consultation. 2003.

The key DEC, DOW and other regulatory agency guidelines that are of relevance to the Project include:

- *Water Quality Protection Note - Toxic and Hazardous Substances* (Storage and Use) (DoW, 2010a).
- *Water Quality Protection Note - Containment Spills- Emergency Response* (DoW, 2010a).
- *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).
- Environmental Protection Heritage Council National Environmental Protection Measures.
- *Kwinana Environment Environmental Protection Policy* (EPP) (DEC).

- *Guidelines for the Assessment, Remediation and Management of Asbestos - Contaminated Sites in Western Australia (DEC).*
- *Odour Methodology Guideline* (DEC, 2000).
- *Review of Waste Classification and Waste Definitions 1996 (as amended)* (DEC).
- *Western Australian Guidelines for Direct Land Application of Biosolids and Biosolids Products, February 2002* (DEC).
- DEC Contaminated Sites Management Series Guidelines.

3.4 Commonwealth Legislation, Approvals and Guidelines

Key Commonwealth legislation and regulations and guidelines that may apply to the Project include, but are not limited to:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Aboriginal and Torres Strait Islander Protection Act 1984.*
- *Australia Heritage Council Act 2003.*
- *ANZECC Guidelines for Fresh and Marine Water Quality 2000.*
- *Native Title Act 1993.*

The key federal guidelines that are of relevance to the Project include:

- Australian Dangerous Goods Code (DIT, 2010).
- National Environmental Protection Measures for Air Quality (EPHC, 2003).

3.5 Other Approvals

The potential for the Project, if implemented, to impact on matters of national environmental significance was considered and accordingly, liaison with SEWPAC under the EPBC Act has taken place. A Referral of a Proposed Action was submitted to SEWPAC for the Project on the 22 December 2012. The delegate for the Minister for SEWPAC decided that the proposed action is not a controlled action on 18 January 2013. This means that the proposed action does not require further assessment and approval under the EPBC Act before it can proceed.

In accordance with the *Aboriginal Heritage Act 1972*, approval is required to use land or water on which Indigenous sites or objects are located. The Project area is not contained within any registered Indigenous Heritage sites, including the boundary of the Swan River mythological site. Despite this, liaison with the Department of Indigenous Affairs (DIA) regarding the planned Project has been undertaken and liaison with the South West Aboriginal Land and Sea Council (SWALSC) is planned. Advice from the DIA indicates that a Section 18 application under the *Aboriginal Heritage Act 1972* will not be required.

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). The EMPs recognise the current environmental conditions of the site and specify management and mitigation measures for potential environmental impacts, including social impacts. The Environmental Management Strategy is illustrated in Figure 6 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 6 specify the Project's environmental objectives and details the environmental commitments, management and mitigation 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 Crown, with Crown 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 Crown through the Contract of Award applicable to each phase of work. Crown, as operators of the Crown Towers during the Operations Phase, will be responsible for the implementation of the required EMPs for during the Operations Phase.

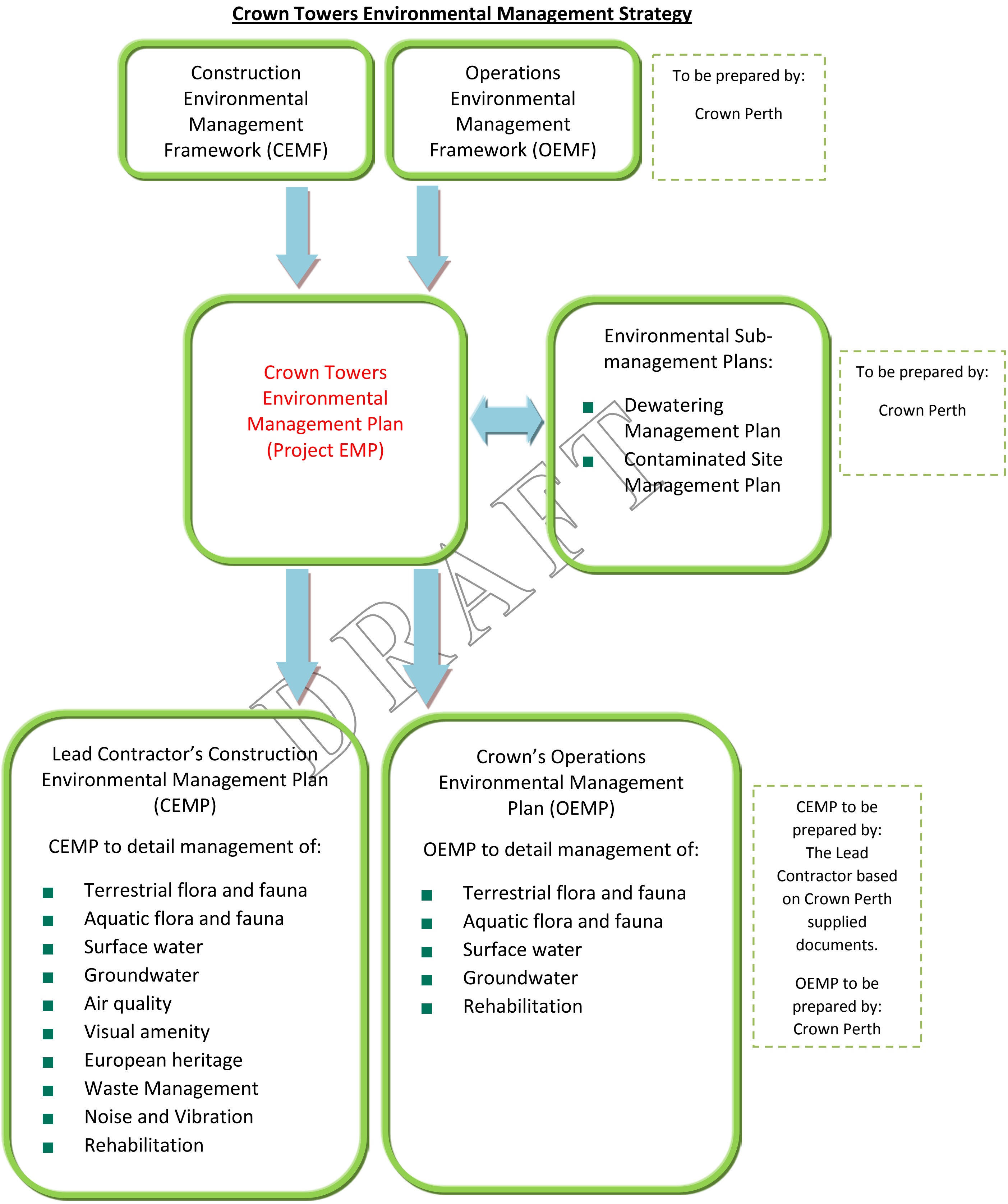

Figure 6: Environmental Management Strategy Structure

5.0 ROLES AND RESPONSIBLITIES

5.1 Overview

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

5.2 Crown

5.2.1 General

The key general responsibilities for Crown include:

- Develop, maintain and continuously improve the Environmental Management Strategy documents to the satisfaction of the regulatory agencies (see Section 4.0).
- Coordinate the delivery of the Project to meet the environmental objectives.
- Prior to commencement of construction work confirm that the successful Lead Contractor(s) for the Construction Phase has developed a detailed CEMP in accordance with the CEMF (Golder, 2013a), Project EMP and Environmental Sub-management Plans.
- Liaise with regulatory agencies where required. Liaison will include, but not be limited to:
  - Reporting of site conditions when requested by the regulatory agencies.
  - Reporting of unexpected conditions where advice on the appropriate mitigation measures may be sought.
  - Reporting of incidents where there is potential for contamination issues, and corrective action is required.
- Coordinate the completion and Contaminated Sites Auditor review of the contamination investigation reports and Lead Contractor(s)' CEMP to the satisfaction of DEC.
- 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.
- Coordinate and manage the contractors engaged to undertake environmental and contamination investigations.
- Being the first point of contact for the Lead Contractor(s) to report environmental incidents and provide assistance in resolving incidents occurring on-site.
- Conduct internal environmental audits to assess conformance with the Lead Contractor's CEMP, the Environmental Sub-management Plans and the OEMP (see Section 12.0).

5.2.2 Operations

The key operations responsibilities for Crown include:

- Establish, implement, maintain and continuously improve an OEMP and any other necessary environmental documentation in accordance with the OEMF (Golder, 2013b) and relevant Environmental Sub-management Plans.
- Conduct internal environmental audits to assess conformance with the Environmental Sub-management Plans and OEMP.
- Obtain relevant work specific environmental approvals, licences and permits prior to commencing certain works.

- Prior to commencement of work; confirm that 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.

5.2.3 Crown's Environmental Advisor

The key responsibilities for Crown's Environmental Advisor include:

- Provide environmental advice and support to Crown during the Construction Phase of the Project.
- Assist in the coordination and management of contractors engaged to undertake environmental and contamination investigations on behalf of Crown, where required.
- Being the first point of contact for the Lead Contractor(s) of the Construction Phase to report environmental incidents and provide assistance to Crown in resolving incidents occurring on-site.
- 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 CEMP/Project EMP, Environmental Sub-management Plans and their CEMP.

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.
- Prior to commencement of work confirm 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 Crown as required.
- Manage the input of 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 appropriate level of training has been provided to all site staff to minimise environmental impacts from Project works and contamination.
- Informing Crown's Environmental Advisor 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 Crown's Environmental Advisor where required.
- The power to stop work on-site where necessary due to foreseen environmental risks.

5.4 Contaminated Sites Auditor

Jason Clay from AECOM Pty Ltd has been appointed as the Contaminated Sites Auditor 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*. Information (e.g. site records, registers and soil and water quality data monitoring results, etc) must be made available to the Contaminated Sites Auditor at his request.

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 classify/re-classify the site. On classification/re-classification of the site, regulation of the Project will be by the relevant regulatory agencies.

6.0 EXISTING PHYSICAL ENVIRONMENT

6.1 Overview

Comprehensive desktop and baseline environmental specialist investigations have been undertaken to establish the existing physical environmental characteristics of the Burswood Peninsula and specifically, the southern portion of the Burswood Park Golf Course which will accommodate the Project.

Assessments have been undertaken in the areas of:

- Geotechnical and other physical environment aspects.
- Groundwater.
- Surface water.

- Native Title and Indigenous heritage
- European heritage.
- Contamination.

The completed studies, methodology and outcomes of the assessments are summarised in the sections below.

6.2 Climate

Climate data for the Burswood Peninsula were obtained from the Bureau of Meteorology, represented by data from the Perth Airport Bureau station located approximately 8.7 kilometres (km) from the Project area.

The climate of the Project area is described as Mediterranean, with cool wet winters and warm dry summers. The station has recorded data from 1944 to present.

The data collected between 1944 and 2011 recorded an average maximum monthly temperature of 31.9°C during February; however, temperature data also show January as having high maximum temperatures at 31.6°C. The majority of minimum average temperatures were recorded at 8.0°C during both July and August.

Mean monthly rainfall over the 67 year period recorded the highest level of rainfall occurring in June with an average of 162.4 mm and the lowest level occurring in January with a minimum of 9.4 mm. An average annual rainfall of 776.4 mm has been recorded at the station.

The recorded data show higher wind speeds being present at 3 pm than at 9 am. For wind speeds at 3 pm, the highest mean was recorded during December at 22.7 kilometres per hour (km/h) and the lowest at 14.7 km/h in May.

6.3 Surface Features and Topography

6.3.1 Overview

The Project area is located on generally low-lying ground located within an ox-bow bend of the Swan River, approximately 3 km to the north-east of the Perth Central Business District (CBD). Features of the site comprise of the following:

- The 1997 Perth Groundwater Atlas indicates that the maximum groundwater level across the site is below RL 3 m AHD.
- Depth to groundwater is typically about 1.3 m below the ground surface. Seasonal variation in the groundwater level up to about 1 m could be expected.
- A landscaped golf course is present over the northern part of the site. The surface comprises manicured lawn, except for a limestone gravel access track along the southern boundary of the course. The ground surface varies from an elevated green at about RL 7.8 m AHD to about RL 2.5 m AHD.
- An asphalt sealed car park (estimated total area of 1.55 ha) is present over the southern part of the site. The ground surface is relatively level and ranges from about RL 2.4 m AHD to RL 3.1 m AHD.
- Four lakes within the Burswood Park Golf Course and one lake in parkland adjacent to the Burswood Park Golf Course. The lakes hold groundwater sourced from deep pumping bore before the water is used for irrigating the Burswood Park Golf Course. The lakes are typically less than 2 m deep.
- Camfield Drive along the strip of land between the Swan River and the westernmost Lake. Camfield Drive has recently (about 2010) been sealed and widened to include car parking bays. The surface elevation of the pavement is about 3 m AHD.

The Burswood Peninsula is elevated outside of the Swan River foreshore flood way; however, like much of the Swan River foreshore areas in Perth, parts of the Burswood Peninsula are within the 100-year flood plain (see Figure 7).

All materials likely to be disturbed during Construction Phase works at the site are considered Acid Sulfate Soils (ASS). Management procedures for ASS are outlined in the Contaminated Site Management Plan (Golder, 2013d) attached as Appendix A.

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 golf course portion of the site largely consists of undulating grass fairways, greens, sand bunkers and "rough" areas containing grass and trees as well as four shallow man-made lakes (Lakes 2 through 5). The western portion of the site consists of a portion of Lake 1. The southern portion of the site consists of a large parking lot used by the nearby Crown Perth complex. None of these lakes are connected via permanent water ways to the Swan River.

The ground surface level over this part of the Burswood Peninsula is largely low lying and is subject to inundation during flooding of the Swan River. During elevated periods of rain the groundwater levels on the golf course may also rise above ground surface resulting in boggy conditions. The current ground surface elevation at the Burswood Park Golf Course generally ranges from RL 2 m AHD near Lake 1 and gently undulates to the east with an overall increase to about RL 4 m AHD. A topographical high point is located on the south-east corner of the golf course with an RL 7.4 m AHD at a recently reconstructed bunker area. In comparison, the parking lot on the southern portion of the site is generally flat with a topographical range of approximately RL 2.4 m AHD to 3.1 m AHD. The topography of the site has changed dramatically over the years due to the importation of various types of fill material which has generally increased the topographically elevation due to the placement of the fill material.

Imported fill will be used so the final design level of the Towers and other infrastructure within the Project area will be at or above RL +3.3 m, which includes an allowance of 0.9 m for sea level rise and 0.5 m freeboard.

Golder Associates

CLIENT	Crown Perth
DOCUMENT	127643111-011-R-RevC
DATE	07 Feb 2013
COMPILED	GGW
APPROVED	DRAFT

0 100 200 300 400 500
metres

SCALE (at A4) 1:15,000

NOTES
Coordinate System: PCG94

COPYRIGHT
Aerial imagery © Nearmap 2012 & Landgate 2012.
Flood plain sourced from DoW 2003.

LEGEND
Estimated project boundary
100 year flood plain

Crown Project EMP

1 IN 100 YEAR FLOOD PLAN

FIGURE 7

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\011 R\RevC\127643111-011-R-F007-RevC-Flood.mxd

6.4 Geology

6.4.1 Completed Studies

Golder has been involved with the development of the Crown Perth complex (formerly known as the Burswood Entertainment Complex (BEC)) since early planning in 1983. A list of reports containing site investigation data prepared by Golder and relevant to the proposed development is provided below:

- *Report to Cameron, Chisholm & Nicol, Architects and Engineers on Geotechnical Investigation For Burswood Island Resort,* May 1985: Golder Reference No. 85640011
- *Results of Electric Friction-cone Probe, October 2005:* Golder Reference No. 05642413 - L02
- *Results of CPT Testing - Proposed VVIP Rooms, Burswood Entertainment Complex, 18 December 2009:* Golder Reference No. 097642482-001-L-Rev0
- *Results of Additional CPT Testing - Proposed VVIP Rooms, Burswood Entertainment Complex, May 2010*: Golder Reference No. 107642196-001-L-Rev0
- *Results of Additional CPT Testing - Proposed Fire Tanks and Food Court, Burswood Entertainment Complex, September 2010:* Golder Reference No. 107642196-003-L-Rev0
- *Preliminary Geotechnical Investigation for Kagoshima Park Area, Burswood Entertainment Complex, December 2010:* Golder Reference No. 107642196-005-R-Rev0
- *Results of Additional CPT Testing - Proposed Swimming Pool Area, Burswood Entertainment Complex, April 2011:* Golder Reference No. 107542196-008-L-Rev0.

Coffey Environments Pty Ltd has undertaken environmental work for a previously proposed ferry terminal which was planned to be located near the development site. Copies of the following reports were provided to Golder by BEC during the study period:

- *Preliminary Site Investigation (PSI) & Detailed Site Investigation (DSI) - Proposed Burswood Ferry Inlet (Lot 301) Burswood, WA:* Coffey Environments Reference ENVIBURW10617AA-R1B, dated 7 April 2008
- *Acid Sulfate Soil Investigation (Sediments) And Addendum Management Plan - Burswood Ferry Inlet Investigation, Burswood, WA*: Coffey Environments Reference ENVIBURW10617AA-R02, dated 31 March 2008
- *Environmental Management Plan Proposed Burswood Ferry Inlet Burswood, WA:* Coffey Environments Reference ENVIBURW10617AA-R4A, dated 31 March 2008.

Geotechnical assessments completed for the Project area include:

- Preliminary Geotechnical Advice and Desk Study New Hotel Development, Burswood Entertainment Complex. 127642102-004-R-Rev0. (Golder, 2012a)
- Geotechnical Factual Report Crown Towers Perth, Burswood. Golder document reference 127642138-001-R-Rev0 (Golder, 2013e)
- Preliminary Geotechnical Advice, Crown Towers Perth, Burswood. Golder document reference 127642138-004-L-Rev0 (Golder, 2013f)
- Geotechnical Interpretive Report Crown Towers Perth. Golder document reference 127642138-003-R-Rev0. (Golder, 2013g).

6.4.2 Overview

The geotechnical conditions underlying the Burswood Peninsula have been investigated through:

- A literature review of previous investigations, and collation and review of all available geotechnical and groundwater data contained within 197 background documents.
- Site investigations and a detailed geotechnical investigation within the Project area.
- 2-D and 3-D hydrogeological modelling of groundwater quantities and movement**.**

The geotechnical investigation fieldwork was conducted between 19 November and 7 December 2012 and comprised of the following:

- Drilling of 10 geotechnical boreholes, designated BH01 to BH10, extended to target depths of between 36.08 m and 52.31 m below surface level.
- Installation of two slotted PVC monitoring wells within BH04 and BH09.
- Undertaking groundwater level measurement and collection of groundwater samples from the groundwater monitoring wells for laboratory analysis to allow for assessment of corrosivity potential of the groundwater.
- Performing cone penetration testing (CPT) at 12 locations, designated CPT1 to CPT12 and CPT12A, generally extending to depths between 22.86 m and 40.2 m (CPT12 refused shallowly at a depth of 0.48 m). CPT1 to CPT11 and CPT12A were all terminated at refusal due to high penetration resistance.
- Excavation of test pits at seven locations, TP01 to TP07, extending to refusal depths of between 1.6 m and 2.5 m depth.

Golder has also undertaken a range of shallow boreholes for environmental purposes. Eleven of these boreholes were developed as monitoring wells (SB001, SB004, SB006, SB0015, SB0017, SB0019, SB0020, SB0024, SB0025, SB0031 and SB0033) to enable the shallow groundwater levels to be measured.

A plan showing the location of the geotechnical test locations, environmental monitoring wells and previous geotechnical investigation points is contained within (Golder, 2013e).

The following information has been reported in the SEWPAC Referral of Proposed Action (Golder, 2012h).

The Burswood Peninsula lies on the sedimentary deposits and rocks of the Swan Coastal Plain and Perth Basin, respectively. The Quaternary period has been characterised by periodic sea level fluctuations largely attributed to glacial and interglacial periods. Sea levels fluctuations are thought to have ranged from 150 m below to 9 m above current sea level.

During glacial periods the sea level is lower, leading to down-cutting of rivers and the formation of deeply incised river channels. With a subsequent rise in sea level during interglacial periods, river channels have been generally in-filled with clay, silt and sandy channel deposits. The ancient river channels are termed ‘palaeochannels’ and it is understood that at least two palaeochannels exist beneath the development site.

For the purpose of this report, channel infill deposits and associated floodplain deposition have been divided into two main units called the Swan River Alluvium (SRA) and the Guildford Formation (GF). The SRA represents the very soft to soft clayey infill materials of the youngest of the palaeochannels from approximately 30 000 years ago to present day. The Guildford Formation represents the medium dense to silt interbedded sandy and clayey materials which in-filled the older of the paleochannels. The basement materials comprise the Kings Park Formation.

The Burswood Peninsula and adjacent Swan River has changed shape and appearance significantly since colonisation. The Burswood Peninsula was originally described as mudflats with a series of island sand bars. The shape and form of the present land surface is a result of river bank works and infilling over the Burswood Peninsula comprising a combination of dredged material sourced from the River, placement of uncontrolled fill whilst the site was used as a refuse tip, and clean sand fill placed as a containment barrier.

A key feature of the site is the ongoing slow movement (some horizontal but mainly vertical) of the SRA and other compressible fill materials which are present. These movements are still ongoing even though in most areas no load has been applied since around 1985.

A generalised subsurface ground profile encountered during the geotechnical investigation (Golder 2012a) is provided below:

- Unit 1 - FILL: Generally granular, but containing varying amounts of landfill comprising brick and brick fragments, plastics and plastic sheeting, timber, rubber tyres, concrete and steel, generally about 3 m to 5 m thick and encountered to levels of between about RL 0.4 and RL 2.5 m AHD, overlying
- Unit 2 - Swan River Alluvium (SRA): Silty CLAY (CH) to Clayey SILT (MH) high plasticity normally consolidated which is very soft to soft but becoming firm with depth. The base of the unit varies significantly across the development site and ranges in level between about RL -4.8 and RL -23.5 m AHD; overlying
- Unit 3A - Guildford Formation: Silty CLAY to Sandy CLAY (CL-CH) medium to high plasticity with fine to coarse grained quartz sand and gravels. Very stiff to stiff becoming soft at the base, not encountered at all locations, extending to a level of between about RL -13.5 and RL -25.6 m AHD; overlying
- Unit 3B - Guildford Formation: SAND (SP)/Gravelly SAND (SP)/Clayey SAND (SC)/Silty SAND (SM): fine to coarse grained sand with trace gravels and well cemented lenses and nodules, generally medium dense to very dense (except BH10 as discussed below), extending to a level of between about RL -22.3 and RL -33.0 m AHD, overlying
- Unit 4A - Mullaloo Sandstone: Silty Clayey SAND (SC-SM): fine to coarse sand with about 15-25% medium plasticity fines, predominantly medium dense with lenses of dense and very dense material, loose in parts (BH05), possesses soil properties, extending to a level of between about RL -30.8 and RL -45.9 m AHD; overlying
- Unit 4B - Mullaloo Sandstone: SAND (SP): very dense, fine to coarse quartz sand, appears to possess soil properties, extending to the maximum depth investigated at RL -49.7 m AHD.

A plan showing the location of the geotechnical test locations, environmental monitoring wells and previous geotechnical investigation points is included in the Dewatering Management Plan (DMP) (Golder, 2013i), attached as Appendix B.

Cross-sections showing the different subsurface units across the development are also included in the DMP (Golder, 2013i).

6.5 Contamination

6.5.1 Completed Studies

The contamination assessments completed for the Project include:

- *Environmental Investigation Proposed Crown Towers Hotel Sampling and Analysis Plan and Data Quality Objectives.* Golder document reference 127642102-008-R-Rev0 (Golder, 2012b).
- *Environmental Investigation Proposed Crown Towers Hotel Detailed Site Investigation.* Golder document reference 127642102-00x-R (Golder, 2013j, currently in preparation).

The following reports have also been competed for the new Perth Stadium Project and are also relevant to the Crown Towers Project:

- *Desktop Study and Review of Previous Environmental Reports, Proposed Burswood Stadium,* 117643077-002-R-RevB-DRAFT, (Golder, 2012c).
- *Preliminary Site Investigation Report, Proposed Perth Major Stadium,* 117643077-005-R-Rev1, (Golder, 2012d).

6.5.2 Sampling and Analysis Plan (SAP)

A SAP was prepared by Golder (2012b) in November 2012. The SAP (Golder, 2012b) provides a comprehensive guide for the collection of soil, landfill gas, groundwater, sediment, surface water and soil gas data for an evaluation of potential risks and remediation requirements.

A DEC Accredited Contaminated Sites Auditor from AECOM has been engaged (the Auditor), and has reviewed the SAP (Golder, 2012b) prior to its implementation.

6.5.3 Detailed Site Investigation (DSI)

A DSI has been undertaken in stages in accordance with the respective stages of the SAP (Golder, 2012b). The DSI has included soil, sediment, surface water, groundwater, acid sulfate soils and landfill gas sampling and analysis.

All sampling undertaken as part of the DSI was completed in December 2012 with the exception of some landfill gas sampling undertaken in early January 2013. The final report for the DSI (Golder, 2013j) is anticipated to be available before the end of February 2013, subject to approval by the Contaminated Sites Auditor.

Consultation with the appointed Contaminated Site Auditor Jason Clay (AECOM) has occurred through each stage of the contaminated site investigation with submittal of each report to the Auditor for comment and clarification.

The results of the DSI (Golder, 2013j) 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.

See the Contaminated Site Management Plan (Golder, 2013d) for a summary of the exceedances of DEC Ecological Investigation Levels (EIL) and DEC Health Investigation Levels (HIL D) in soil samples and the DSI (Golder, 2013j) for detailed results.

The OEPA will be kept advised of development of the contaminated sites investigation as it occurs.

6.6 Acid Sulfate Soils

6.6.1 Completed Studies

In addition to the information in Section 6.5 above, the following information was reviewed to assess the potential ASS risk of the soils at the site:

- DEC centralised ASS risk mapping database (WA Atlas), published by Landgate
- Australian Soil Resource Information System (ASRIS) maps, by CSIRO Land and Water
- Previous consultant reports at the site.

6.6.2 Overview

Information collected from the above sources and their interpretations relating to the potential presence of ASS and hydrogeology are discussed in the sections below.

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 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 (see Figure 8).

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. Consequently, the information derived from the maps cannot be relied upon to confirm whether ASS management will be required for a specific location, even though these maps provide a broad-scale indication of ASS risk.

Investigations including the recently completed DSI (Golder 2012j) have confirmed that ASS is present in areas of the Burswood Peninsula. The high risk natural materials detailed in the DEC 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 Guilford Formation 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 as part of the DSI (Golder 2012j). Acidic 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 greater than 0.5 m below ground level (m bgl) are considered to be ASS and, if disturbed during construction activities, should be managed according to the procedures present in the Contaminated Sites Management Plan (Golder, 2013d). It is advised the top 0.5 m of material excavated at the site can be placed elsewhere on-site without active management, provided it remains within 0.5 m of ground surface and is found to be uncontaminated.

ASS at site will be managed by the Lead Contractor(s) according to the Contaminated Site Management Plan (Golder, 2013d). However, a summary of the relevant matters pertaining to contamination has been summarised below.

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APPROVED	DRAFT

0 100 200 300 400 500
metres

SCALE (at A4) 1:15,000

NOTES
Coordinate System: PCG94

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ASS risk mapping sourced from DEC 2007.

LEGEND
Estimated project boundary
ASS disturbance risk (<3m from surface)
High to moderate
Moderate to low
No known ASS disturbance risk

Crown Project EMP

ACID SULFATE SOILS

FIGURE 8

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6.7 Groundwater

6.7.1 Completed Studies

In addition to the reports listed in Section 6.4.1 the groundwater assessments completed for the Project are:

- Phase 2 Groundwater Investigation, Burswood Park, Burswood, WA. (Aurora Environmental, 2012).

6.7.2 Hydrogeology

The three principal geological units underlying the proposed construction are the Fill, the Swan River Alluvium (SRA) and Guildford Formation. The Fill, SRA and Guildford Formation in the Burswood Peninsula 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. Beneath the Project area, the Kings Park Formation is likely to be represented by an uncemented, very dense sand layer called the Mullaloo Sandstone. These aquifers would not be affected by construction dewatering for Project.

Across the Burswood Peninsula variations in both the thickness and presence of the three superficial units exist. At the site the Guildford Formation and fill are separated by approximately 5 to 25 m of SRA which acts as a semi-confining unit for the Guildford Formation. However, in areas immediately east of the site, the SRA is absent and the fill is in direct contact with the Guildford Formation. 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.

6.7.2.1 Groundwater Levels

Measured groundwater levels within the Fill (Unit 1), as recorded on 12 December 2012, range from about RL 2.8 m AHD to about RL 1.6 m AHD.

Groundwater levels are influenced by rainfall and irrigation resulting in localised changes in level and flow direction. Natural seasonal fluctuation of groundwater levels is likely to be in the order of 0.5 to 1.0 m but this fluctuation range may currently be dampened by irrigation practices.

6.7.2.2 Groundwater Flow

Davidson (1995) and the Perth Groundwater Atlas (2004) indicates that groundwater flow in the vicinity of Burswood is in a north-westerly direction towards the Swan River over the Burswood Peninsula, while at the Project area flow is likely to be west to south-west 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 carpark and buildings to the south and eastern extents of the site.

The tidal influence of the Swan River may change the flow direction in close proximity to the Swan River. On a rising tide a localised reversal of flow direction may be observed; however, this is not likely to extend to within the site boundary with the possible exception of areas west of Lake 1.

See the DMP (Golder, 2013i) for information on the hydraulic properties for the shallow fill layer.

6.7.3 Groundwater Quality

Groundwater quality sampling has been completed as part of environmental investigations, with details of the sampling and test results presented in Golder (2013j).

Laboratory test results for groundwater sampling in November and December 2012 from 14 wells are presented in the DMP (Golder, 2013i). Of these wells, 12 are screened in the fill layer, one is screened in the SRA and one is in the Guildford Unit. Results indicate:

- Field measured pH is generally neutral to slightly basic.

- Total Dissolved Solids (TDS) values range from 878 mg/L to 7210 mg/L in the Fill layer. A higher TDS of 8590 mg/L was reported in the well screened in the SRA.
- Total cyanide was reported above the ANZECC 2000 guideline value at six locations.
- Some metal concentrations were marginally above ANZECC 2000 and SRT guidelines with concentrations of nickel, aluminium, copper, and iron exceeding at least one guideline value for at least one sample at the site.
- Ammonia concentrations exceeded the ANZECC 2000 guideline value in all reported results except one, with maximum values significantly higher than the guideline values. Total phosphorus and total nitrogen levels were reported above the SRT guideline at some locations.
- The chloride:sulfate ratio exceeded the DEC Groundwater Acidification guidelines in both wells sampled.
- Total Petroleum Hydrocarbons (TPH C_{10}-C_{36}) were observed in one sample above the ANZECC 2000 guideline, and was reported above the laboratory detection limit at six other locations.

For more information on the existing groundwater environment, see the DMP (Golder, 2013i).

6.7.4 Potential Impacts to Groundwater from Piling

The current Project design includes the use of piling for support of more heavily loaded areas such as the high rise Crown Towers hotel building, Potential piling solutions have been discussed in Section 2.2.2.2. There is a possibility that should it not be managed appropriately, piling activities may increase potential for cross-contamination between aquifers. This will depend on the depth of columns and the depth to groundwater at the location of columns.

The potential impacts to groundwater and proposed management and mitigation measures are discussed in Section 9.5.

6.8 Surface Water

6.8.1 Completed Studies

A surface water assessment was undertaken for the new Perth Stadium as part of the *Desktop Study and Review of Previous Environmental Reports, Proposed Burswood Stadium* (Golder, 2012c) which is also relevant to the Crown Towers Project. This report was provided to Crown for use by the Department of Treasury Strategic Projects.

6.8.2 Overview

The Swan River is the dominant surface water feature and bounds the Burswood Peninsula to the north, east and west. Additionally, there are five constructed artificial lakes of various sizes within the Project area, the location of these are shown on Figure 3. The lakes are reportedly clay lined and topped up with bore water to maintain constant levels and provide water for irrigation.

Lakes 2 to 5 are irrigation lakes fed by bores connected to the Leederville Aquifer under a licence held by the Burswood Park Board, issued by the DoW. Lake 1 is a stormwater fed lake, receiving stormwater from the Crown Perth complex buildings, and is not used for irrigation.

During summer, the influence of the Swan River is limited to the river's fringe, whereas in winter, river water levels can rise and extend into the Project area. The extent of the floodway from a 1 in 100 year flood for the Burswood Peninsula is illustrated in Figure 7.

Under the current land cover and land-use conditions, the inputs of rainfall will be readily infiltrated into the underlying soil layers. Effective rainfall, net of evaporative losses, will provide recharge to any underlying local groundwater systems. The proportion of rainfall reaching groundwater systems could potentially be reduced by development of the Project area. During extreme storm events, some level of localised surface runoff and ponding may be experienced across the existing site due to high intensity rainfall exceeding the infiltration capacity of the soil. .

6.9 Indigenous Heritage

6.9.1 Overview

A search using the Aboriginal Heritage Inquiry System (AHIS) was performed on 18 October 2011 for identification of Indigenous and other heritage sites and only one site was identified within the immediate vicinity of the Project area; the Swan River, a Mythological site with the registered site number 3536.

Sites identified using the AHIS is not exhaustive as sites may not have been recorded in the Register of Aboriginal Sites, or identified in previous heritage surveys/reports but is still protected under the *Aboriginal Heritage Act 1972*. Community consultation with Indigenous communities and native title claimants is underway.

It is understood development of the Burswood Peninsula would need to have an understanding of local Indigenous interests in the area and also of the possibility of encountering subsurface Indigenous skeletal material or Indigenous cultural material. As a matter of course, liaison with the DIA as to the requirement for Section 18 approval to disturb an Indigenous Heritage Site under the *Aboriginal Heritage Act 1972* has been undertaken as described in Section 3.5.

Liaison with SWALSC is also underway and the consultation process with the respective Aboriginal stakeholders has commenced and is being coordinated through DIA and SWALSC.

6.10 European Heritage

6.10.1 Completed Studies

No specific European heritage assessments were required for the Project.

6.10.2 Overview

Based on the database search performed in October 2011 for the new Perth Stadium Project to identify sites of cultural or historical significance on the State's Register of Heritage Places within the Burswood Peninsula; Table 4 outlines the place is in closest proximity to the Project area:

Table 3: Heritage Place Closest Proximity to the Project Area

Place Name	Location	Status	General Use
Old Burswood Canal	Near Goodwood Place, Burswood	Constructed: 1831 to 1834 Demolished: No	Historical: Transport and Communications Present: Transport and Communications

The Project will not impact on the place identified in Table 3.

History of the Burswood Peninsula land uses providing historic context for the Project is summarised in the following Sections. Figure 9 illustrates European Historic Land Uses.

6.10.2.1 Early Settlement

The European settlement of Perth saw the Burswood Peninsula being granted to Henry Camfield in 1829 for the use of various agricultural activities including market gardens and a piggery, which continued until the turn of the 20th century under various owners and tenants (Gallop, date unknown). It was during this period that the Burswood Canal was constructed (1831) (Gallop, date unknown) (see Figure 9), connecting the deeper waters found at Maylands to the east and East Perth to the west of the Peninsula, allowing larger vessels travelling along the Swan River between Guildford and Perth to circumvent the shallow waters found to the north of the Peninsula. Burswood Canal is generally acknowledged as one of Perth Colony's first public works programs and is included on the Stage Register of Heritage Places pursuant to the *Heritage of Western Australia Act 1990*.

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0 100 200 300 400 500
metres

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NOTES
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LEGEND
Estimated project boundary

Crown Project EMP

EUROPEAN HISTORIC LAND USES

FIGURE 9

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6.10.2.2 Recreational Use

The Burswood Peninsula was used for recreation from its earliest days. In August 1895, the former farm of Henry Camfield made way for Western Australia's first public golf course (Gallop, date unknown), which operated on the Burswood Peninsula until 1900. Soon after the closure of the golf course, the Western Australian gold rush saw horse racing surge in popularity, with Albert Cockram taking a lease over Burswood Peninsula, and starting an unregistered race track. The Burswood Turf Club began as a proprietary club of Albert Cockram, with its first event being held on 9 December 1899 (Gallop, date unknown).

Cockram then established a second race course on the adjoining land to the south of Belmont Park, to be known as the Goodwood Racecourse. This site was first built up with sand and railway cinders before being planted with grass, with the track's first meeting held on 17 August 1912 (Gallop, date unknown).

Both Belmont Park and Goodwood were well patronised until in 1943, when the WATC purchased both tracks, putting an end to proprietary racing in Western Australia (Gallop, date unknown). Goodwood Track closed in 1950.

6.10.2.3 Waste Disposal

In 1906, a portion of the land on the western side of the Burswood peninsula was used for the establishment of filtration beds for sewage, which was siphoned under the Swan River form Claisebrook (Gallop, date unknown). The beds were closed in 1934.

In addition to sewage disposal, the Burswood Peninsular has also been used for the disposal of domestic and industrial waste. The area accepted waste from 1946, and while domestic fill ceased in 1972, other waste continued to be dumped until the early 1980s (Gallop, date unknown). Waste included but was not limited to car bodies, building rubble, household garbage, cinders, clay, and bitumen.

6.11 Sensitive Receptors

The Project area is currently used as a section of the southern portion (southern nine holes) of the Burswood Park Golf Course and a car park.

The nearest residences to the Burswood Park Golf Course are the apartment blocks within the Mirvac Burswood Peninsula development and adjacent townhouses off Victoria Park Drive. Residences on Bow River Crescent within the Mirvac development are immediately adjacent to the northern portion of the Project area.

Other surrounding land uses include the:

- Northern portion of the Burswood Park Golf Course (holes 9 to 18), Kagoshima Park and Charles Patterson Park.
- The Burswood Park Golf Course associated buildings including the service area, restaurants and clubhouse.
- Former Swan Portland Cement and James Hardie Industries area (currently Mirvac Fini Development) are located south of the Burswood Tennis Centre.
- Crown Perth complex and the Dome.
- The Swan River to the west of the Project area which is used for recreational purposes, including boating and fishing.

6.12 Air Emissions and Greenhouse Gases

The Burswood Peninsula is not considered to be a dusty environment as it is highly developed and landscaped. Ambient particulate levels in the vicinity of the Burswood Park Golf Course are not routinely monitored. However, airshed data are measured roughly every five to ten years by the DEC for the National Pollutant Inventory (NPI).

According to the latest airshed dataset of 2010/2011, the top five substances emitted to air, their volume and their sources from the Perth airshed, which includes Burswood, are outlined in Table 4.

Due to the proximity of the nearest residences (see Section 6.10.1) and the potential for dust generating activities due to construction works associated with the Project, potential dust impacts on sensitive receptors from the Project are high. Ambient dust levels however are likely to be highly variable and linked to factors such as prevailing climatic conditions and the levels of traffic movements.

The six greenhouses gases that are regulated under the Kyoto protocol are carbon dioxide (CO_2), methane (CH_4), perfluorocarbons (CF_x), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6) and nitrous oxide (N_2O). To compare the warming potential of the different gases, their impact is usually expressed in terms of CO_2 equivalents (CO_2e), by which the potential of each gas to heat the atmosphere is expressed in terms of carbon dioxide equivalents.

Sources of existing greenhouse generated from the Burswood Peninsula include:

- Combustion of fuel to generate electricity for power requirements.
- Combustion of fuel used in light vehicles travelling within and around the Burswood Peninsula.
- Methane from algal ponds and landfill gas.

Table 4: Top Five Air Emissions, Volume and Sources from the Perth Airshed for 2010/2011

Substance	Volume per Annum	Source									
		Motor Vehicles	Solid Domestic Fuel Burning	Lawn Mowing	Aeroplanes	Cigarettes	Architectural Surface Coatings	Domestic/ Commercial Solvents and Aerosols	Service Stations	Biogenics	Gaseous Domestic Fuel Burning
Carbon Monoxide	2 551 131	✓	✓	✓	✓	✓					
Total Volatile Organic Compounds	475 215	✓	✓				✓	✓	✓		
Oxides of Nitrogen	233 335	✓	✓		✓					✓	✓
Particulate Matter 10 µm	43 970	✓	✓	✓	✓						✓
Toluene	29 866	✓		✓			✓	✓			

(National Pollutant Inventory, 2012)

6.13 Noise

Ambient noise levels at the Burswood Park Golf Course are generally low given the current land use, with some audible traffic noise emanating from Victoria Park Drive and potentially some noise generated from Swan River recreational users. The adjacent land use is a mix of generally quiet residential areas and potentially noisy commercial/entertainment areas. The Crown Perth complex is a casino and entertainment venue operating until late seven days per week. The Dome was predominantly a music concert venue however, has recently been decommissioned. The Crown Perth complex and Dome, including associated parking facilities and train stations can be the source of public ambient noise generation, particularly over the weekends.

The potential sensitive receptors in the proximity of the Project are the residential areas located adjacent the Project area to the east. The Project operations are expected to increase the existing ambient noise levels based on the increase in the volume of people and traffic to access the area. Following the Construction Phase, traffic levels may increase marginally from current levels.

6.14 Traffic

The two main roads allowing access into and out of the Crown Perth complex are Victoria Park Drive and Great Eastern Highway in Burswood. Victoria Park Drive is accessible via two major roads, namely Graham Farmer Freeway (east and west) and Great Eastern Highway (east and west). Graham Farmer Freeway is a 6.4-kilometre inner-city freeway in Perth, Western Australia. It links Rivervale and Burswood with West Perth and Leederville, providing an east-west bypass of Perth's central business district. The Great Eastern Highway is a major road between the Western Australian cities of Perth and Kalgoorlie. It is a key route for vehicles accessing the eastern Wheatbelt and the eastern goldfields. It also forms the westernmost 595 km of the main road transportation link between Perth and the east coast of Australia. Both the Graham Farmer Freeway and the Great Eastern Highway are considered high congestion roads, particularly during peak traffic periods (from 5.45 am to 9:00 am and 3:30 pm to 6:30 pm Monday to Friday (Main Roads, 2012)). Victoria Park Drive can also have busy periods during peak traffic periods and during major events held at the Crown Perth complex.

The two minor roads allowing access to the Crown Perth complex are Bolton Avenue and Glenn Place, accessible via the Great Eastern Highway and/or Victoria Park Drive. Bolton Avenue provides access to the Plaza and Glenn Place provides riverside access. The proposed Project is anticipated to increase the volume of traffic accessing the Crown Perth complex via Victoria Park Drive and from the Great Eastern Highway feeding into Bolton Avenue and Glenn Place. The Crown Perth complex is also accessible by public transport via train.

The report *Burswood Entertainment Complex Microsimulation Traffic Modelling* (Arup, 2012), was completed for the proposed Project to model future traffic demand and predict key concerns for traffic performance. This report indicates that significant traffic congestion is already an issue along Glenn Place and Bolton Avenue in peak periods (6pm to 8pm), so any additional traffic due to the proposed Project may contribute to this congestion.

It is estimated that traffic volume increases will be minimal during the Construction Phase; regular increases in traffic are likely to be in the form of trucks delivering fill and removing waste material off-site and these are not expected to operate during peak periods. Traffic volumes are likely to increase significantly during the Operations Phase due to the availability of accommodation for more than 500 people as well as the provision of new retail and hospitality options. The Project proposes to create new access to the Crown Perth complex from the west with the modification of Glenn Place; however, if access to Glenn Place is to remain via Bolton Avenue, congestion may potentially be an issue.

6.15 Visual Amenity

There are no current visual amenity issues within the Burswood Peninsula as the area is highly developed, landscaped and could be considered picturesque due to views of the city of Perth and the Swan River.

Future aesthetics and visual amenity issues associated with the Construction Phase works within the Project area, and with the construction of a 25 storey hotel complex, may be unfavourable to some residents in the area. This is predominantly due to the clearing of flora and vegetation associated with the works and the height of the proposed building.

Increased traffic volumes within the Project area as well as surrounding roads could also cause concern to local residents and users of the public spaces and surrounding entertainment venues. The local community group BRAG have been consulted with regard to the proposed development design, with a response to comments available on request.

7.0 EXISTING ECOLOGICAL ENVIRONMENT

7.1 Completed Studies

The following reports completed for the new Perth Stadium project, provided to Crown by the Department of Treasury Strategic Projects also apply to the proposed Crown Project and have been reviewed to provide baseline ecology information:

- *Desktop Study and Review of Previous Environmental Reports: Proposed Burswood Stadium.* (Golder 2012c).
- *Proposed Burswood Stadium - Level 1 Flora Survey*. (Golder, 2012e).
- *Assessment of the importance of Burswood Peninsula and Claisebrook for Migratory and other Significant Birds.* (Bamford, 2012a).
- *Assessment of the importance of Burswood Peninsula and Claisebrook for Non-Avian Fauna*. (Bamford 2012b).

The ecological assessments undertaken for the Crown Project area are:

- *Crown Perth Aquatic Fauna Survey* (Golder, 2013k)
- *Avian Fauna Survey, Proposed Crown Towers, Burswood* (ENV. Australia, 2012).

Figure 10 illustrates the location of prominent avian fauna, aquatic fauna, flora and vegetation and social impact areas, as discussed in the following sections. The information in the following sections is extracted from the reports listed above.

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0 50 100 150 200 250
metres

SCALE (at A4) 1:8,000

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LOCATION OF PROMINENT AVIAN FAUNA, FLORA & VEGETATION, AND SOCIAL IMPACT AREAS

FIGURE 10

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7.2 Desktop and Database Searches

7.2.1 EPBC Act Protected Matters Database

A search of the EPBC Act Protected Matters Register was conducted on 29 November 2012 for the Project area including a 1 km buffer radius. One item was identified on the Register of National Estate as summarised in Table 5 and Figure 11; however, this site was not located directly within the Project area.

Table 5: Burswood Peninsula: Summary of Environmental Protected Areas within a 1 km Radius of the Project Area

Matters of National Environmental Significance	
World Heritage Properties	None
National Heritage Places	None
Wetlands of International Significance (Ramsar Lakes)	None
Great Barrier Reef Marine Park: Commonwealth Marine Areas	None
Threatened Ecological Communities	None
Threatened Species	16
Migratory Species	12
Other Matters Protected by the EPBC Act	
Commonwealth Lands	None
Commonwealth Heritage Places:	None
Listed Marine Species	9
Whales and Other Cetaceans	None
Critical Habitats	None
Commonwealth Reserves	None
Additional Information	
Place on the Register of the National Estate (RNE)	1
State and Territory Reserves	None
Regional Forest Agreements	None
Invasive Species	16
Nationally Important Wetlands	1

There are no threatened ecological communities listed in the vicinity of the Project or nearby surrounds; however, listed threatened species have been indicated as occurring within the vicinity of the Project.

Table 6 outlines the results of the EPBC Act Protected Matters Search Tool for listed threatened fauna identified with the vicinity of the Project area.

Table 6: Results of the EPBC Act Protected Matters Search Tool for Listed Threatened Fauna Identified within the Vicinity of the Project Area

Scientific Name	Common Name	EPBC Act Listing
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo	Endangered
Leipoa ocellata	Mallee fowl	Vulnerable
Rostratula australis	Australian Painted Snipe	Vulnerable
Sternula nereis nereis	Fairy Tern (Australian)	Vulnerable

Scientific Name	Common Name	EPBC Act Listing
Synemon gratiosa	Graceful Sun Moth	Endangered
Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable
Caretta caretta	Loggerhead Turtle	Endangered
Chelonia mydas	Green Turtle	Vulnerable
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle	Endangered

Table 7 outlines the results of the EPBC Act Protected Matters Search Tool for listed threatened flora identified with the vicinity of the Project area.

Table 7: Results of the EPBC Act Protected Matters Search Tool for Listed Threatened Flora Identified within the Vicinity of the Project Area

Scientific Name	Common Name	EPBC Act Listing
Andersonia gracilis	Slender Andersonia	Endangered
Centrolepis caespitosa	Matted Centrolepis	Endangered
Darwinia foetida	Muchea Bell	Critically endangered
Lepidosperma rostratum	Beked Lepidosperma	Endangered
Thelymitra manginii K.Dixon & Batty ms.	Cinnamon Sun Orchid	Endangered
Villarsia calthifolia	Mountain Villarsia	Endangered

Table 8 outlines the results of the EPBC Act Protected Matters Search Tool for listed migratory species identified within the vicinity of the Project area.

Table 8: Results of the EPBC Act Protected Matters Search Tool for Listed Migratory Species Identified within the Vicinity of the Project Area

Scientific Name	Common Name	EPBC Act Listing
Apus pacificus	Fork-tailed Swift	Threatened
Ardea alba	Great Egret, White Egret	Threatened
Ardea ibis	Cattle Egret	Threatened
Haliaeetus leucogaster	White-bellied Sea-Eagle	Vulnerable
Leipoa ocellata	Malleefowl	Vulnerable
Merops ornatus	Rainbow Bee-eater	Vulnerable
Rostratula benghalensis (sensu lato)	Painted Snipe	Vulnerable
Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable
Caretta caretta	Loggerhead Turtle	Endangered
Chelonia mydas	Green Turtle	Vulnerable
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Endangered

An interpretation of these results and an assessment of the potential impact of the proposed Project on the species listed above are being managed under state and Commonwealth referral advice and applications.

7.2.2 ENV Database Review

Golder engaged ENV. Australia Pty Ltd (ENV) to undertake a Level 1 Avian Fauna Survey for the Project area. The survey included a database review, undertaken on 3 December 2012, and a field survey, undertaken on 6 and 7 December 2012.

The literature review and database search was undertaken by ENV to determine avian and other fauna species potentially within the vicinity of the Project area based on known patterns of distribution. The following databases were searched on 3 December 2012 based on the boundary of the Project area:

- Birdlife Australia's Birdata database, one degree square buffer (Birdlife Australia, 2012a)
- Birdlife Australia's Shorebird 2020 database, Swan Estuary Marine Park (Birdlife Australia, 2012b)
- DEC combined biological database NatureMap, 5 km buffer (DEC 2012a)
- DEC Threatened and Priority Fauna Database , 5 km buffer (DEC, 2012b)
- SEWPAC Protected Matters Search Tool, 5 km buffer (SEWPAC, 2012)
- Previous biological survey reports by Bamford Consulting Ecologists (2012)
- Ornithological Technical Services (2012).

The results of these database searches are included as Appendix C.

7.2.3 Australian Bilateral Migration Agreements

A search was undertaken to determine which of the migratory and threatened species identified as potentially occurring within the Project area also fell under the following Australian bilateral migration agreements:

- JAMBA: Japan - Australia Migratory Bird Agreement
- CAMBA: China - Australia Migratory Bird Agreement
- ROKAMBA: Republic of Korea - Australia Bird Agreement.

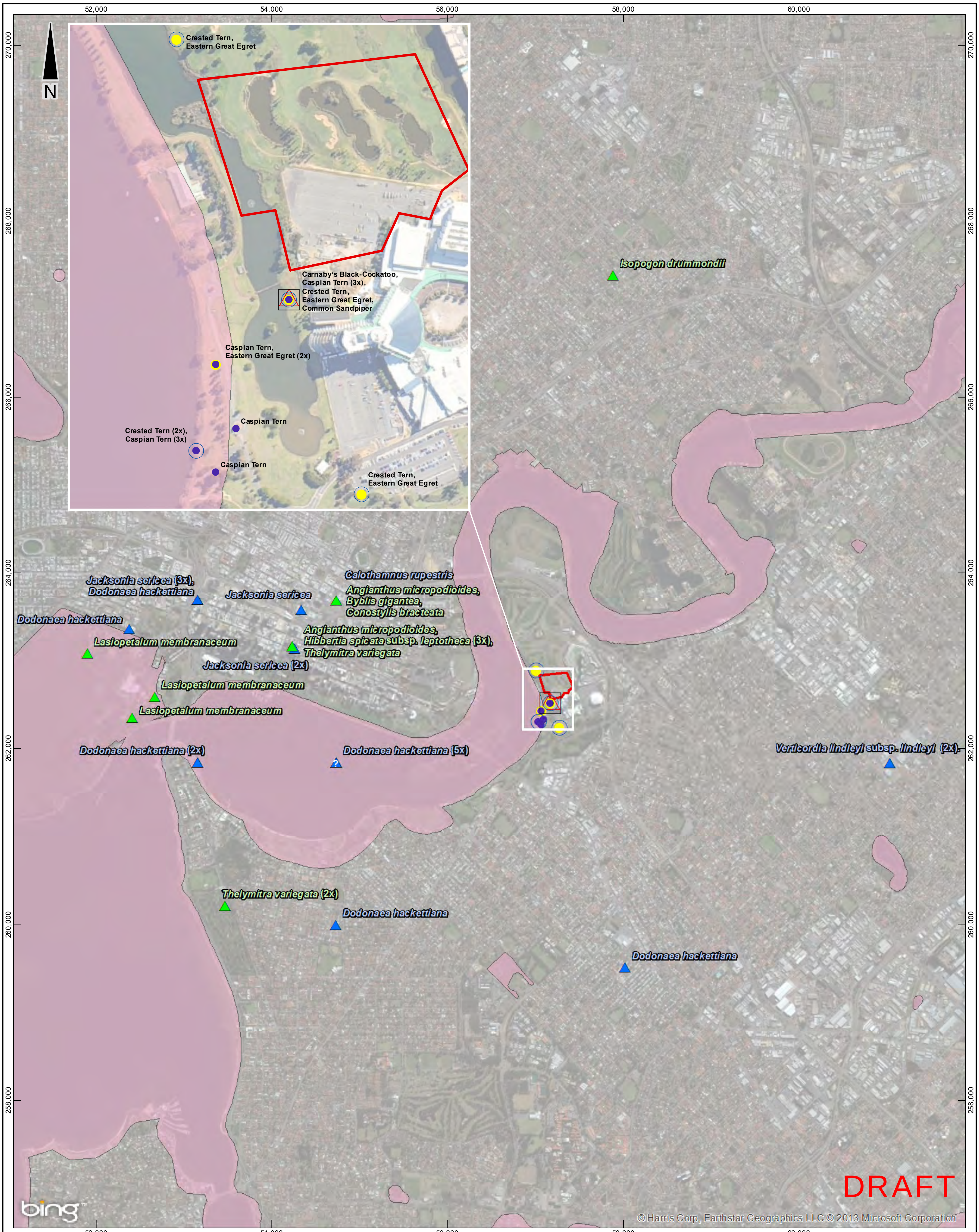
The results of the database searches listed above and the results of the avian fauna surveys completed for the Project, including the database search results and previous survey results are included as Appendix C.

7.2.4 DEC Threatened Flora Species Database for Declared Rare Flora and Priority Listed Taxa

The results from the Threatened Flora Database (DEFL), the WA Herbarium database (WAHerb), and the Declared Rare and Priority Flora Species List for the Project identified no occurrences of, threatened flora, declared rare flora or priority listed taxa within the Project area (Golder, 2012c).

7.2.5 DEC Threatened Ecological Community and Priority Ecological Communities Databases

The results from the DEC Flora and Fauna Divisions search for flora and threatened ecological communities (TEC) database found no known occurrences of TEC recorded within the Project area (Golder, 2012c).



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0 390 780 1,170 1,560 1,950
metres

SCALE (at A3) 1:40,000

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Flora locations sourced from DEC & WA Herbarium 2011.
Bird Records sourced from Birds Australia 2012.
ESA sourced from DEC 2011.

NOTES
Coordinate System: PCG94

LEGEND
Estimated project boundary
Envrionmentally Sensitive Area

Flora of Conservation Significance
Priority 3
Priorty 4

Birds of Conservation Significance
Carnaby's Black-Cockatoo
Caspian Tern
Common Sandpiper
Crested Tern
Eastern Great Egret

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LOCATION OF ENVIRONMENTAL DATABASE SEARCH RESULTS

FIGURE 11

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7.3 Flora and Vegetation

Golder was commissioned on behalf of the Department of Treasury Strategic Projects, to complete a Level 1 Flora survey (Golder, 2012e) for the new Perth Stadium Project proposed for the northern nine holes of the Burswood Park Golf Course, which was conducted in early February 2012. Despite the survey being scoped for the new Perth Stadium Project, the survey focused on the lake and riparian vegetation of 15 river sites and 10 lake sites over the Burswood Peninsula, which also included the area proposed for the Crown Project. The Department of Treasury Strategic Projects have provided the Level 1 Flora Survey to Crown. The locations of the 15 river sites, 10 lake sites and the Survey area for the Golder (2012e) are shown in Figure 12.

The Survey area consisted of constructed lakes with fringing riparian vegetation, Swan River riparian vegetation, stands and individual trees and palms. Most of the trees appeared to be less than 30 years old and were generally garden specimen trees. Much of the riparian vegetation of the lakes was likely to be sourced from surrounding water bodies by birds and wind transfer of propagules.

Aside from mixed native and mixed exotic hardwood composition, no clear vegetation units were identified due to the extremely modified and variable nature of vegetation along the River margin and amongst the lakes (Golder, 2012e). No units or even individuals of remnant native vegetation were identified. This lack of remnant vegetation was probably due to the historical highly disturbed nature of the Survey area due to previous use as a landfill facility, evidenced by debris along the shoreline and other eroded areas.

A summary of the findings within each area is provided below and additional information is provided in Golder (2012e).

7.3.1 Summary of Findings

The Survey area contained little vegetation that was ecologically significant in itself (Golder, 2012e). Much of the vegetation observed was introduced and not representative of regional flora or vegetation, or consisted of species common to wetlands within the region. All lake and riparian sites surveyed demonstrated significantly degraded conditions. This finding was not surprising given that much of the land comprising these areas was historically used for landfill (Golder 2012e). Although some basic ecological wetland functions were likely to be demonstrated within the artificial lakes, given their vegetation assemblage and expected water qualities, these were not likely to be of high conservation or ecological value.

Nonetheless, much of the Survey area was likely to have significant habitat value for many common waterfowl and amphibian species. Despite primarily hosting common species, these lakes still remain as wetland representation within the greater Perth area, which was significant as wetlands within the Perth region are very depauperate (Golder, 2012e).

In summation:

- The current Swan River riparian ecological values were very depauperate and demonstrated degradation and little remaining original vegetation. Soils were visibly showing landfill wastes along the foreshore and high erosion from boat activity. Conversely, clean landfill waste such as brick and masonry may act as bank armouring and facilitate riparian vegetation establishment.
- Lake vegetation demonstrates little intrinsic conservation significance, however, is of regional value and displayed many vegetation assemblages typical of the region such as *Melaleuca* canopies and *Typha*/*Juncus* understoreys.
- Lake vegetation may further provide valuable habitat to bird fauna in the absence of any other being available within the wider Perth area.
- Due to the lack of any remnant vegetation, it is unlikely that a native vegetation clearing permit will be required from the DEC unless clearing of the riparian flora of the Swan River is proposed.

Additional information is provided in Golder (2012e).

Golder Associates

CLIENT Crown Perth
DOCUMENT 127643111-011-R-RevC
DATE 07 Feb 2013
COMPILED GGW
APPROVED DRAFT

0 50 100 150 200 250
metres

SCALE (at A4) 1:8,000

NOTES
Coordinate System: PCG94

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LEGEND
Estimated project boundary
Fauna survey location / Burswood lake site
Flora survey location
Swan River riparian survey site

Crown Project EMP

STUDY AREA FOR FLORA AND FAUNA SURVEYS

FIGURE 12

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\011 R\RevC\127643111-011-R-F012-RevC-Flora_Fauna_Surveys.mxd

7.4 Avian Fauna

Golder engaged ENV. Australia Pty Ltd (ENV) to undertake a Level 1 avian survey for the Project area. The Level 1 avian fauna survey included a database review, undertaken on 3 December 2012, and a field survey, undertaken on 6 and 7 December 2012. The field survey was consistent with EPA guidelines for environmental surveying and reporting for fauna in Western Australia, and consisted of:

- Avian fauna habitat mapping.
- A systematic avian census.
- Targeted roost/nest assessment.
- Opportunistic sightings.

7.4.1 Summary of Findings

The Project area contained three broad habitat types: Moderate Value Habitat; Low Value Habitat; and Lakes. These areas are artificial and widespread throughout the Burswood Park Golf Course and parks surrounding the Project area. A large car park area, classified as Cleared Land, was included in the Project area but provided no avian fauna habitat of any value.

- Moderate Value Habitat was mapped to cover approximately 2.15 ha of the study area, and was confined to the shoreline of the lakes within the study area. These areas contained typical wetland vegetation and grassed areas.
- Low Value Habitat was mapped to cover approximately 4.02 ha of the study area, and consisted of grassed areas, and some areas that included trees and ornamental gardens.
- Lakes were mapped to cover approximately 1.63 ha of the study area, which provide foraging habitat for waterbirds.
- The avian census recorded a total of 46 avian fauna species from 22 families within the study area.

With regard to avian fauna of Conservation Significance, the following observations were of note:

- No species of conservation significance were recorded roosting or nesting within the Project area.
- Four species of conservation significance were recorded during the survey:
  - Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*), listed as Vulnerable under the EPBC Act (five birds opportunistically spotted flying overhead)
  - Great Egret (*Ardea alba*), listed as Migratory under the EPBC Act
  - Black-backed Bittern (*Ixobrychus dubius*), listed as “Priority 4” by the DEC
  - Caspian Tern (*Hydroprogne caspia*), listed as Migratory under the EPBC Act
- Database searches revealed an additional 52 conservation significant avian fauna species that have been previously recorded within the vicinity of the study area. Of these, two species were considered likely to occur within the Project area:
  - Eastern Osprey (Pandion cristatus)
  - Rainbow Bee-Eater (Merops ornatus)
- Based on ecology, habitat present and known fauna records, a further 41 species were considered “Possible” to occur, eight species were considered “Unlikely” to occur and one species was classified as “Highly Unlikely” to occur.

ENV reported that the clearing of the Project area was unlikely to have an impact on the species occurring or potentially occurring within the Project area. The majority of the species recorded during the survey were common and wide spread with good dispersal abilities therefore could easily move to new habitats in the local area. In the local region there are a number of large fresh water lakes which provide suitable habitat. However, further development to the surrounding Burswood Park Golf Course was expected to impact on the local populations of avian fauna in the area.

The results of the avian fauna surveys, including the database search results are outlined in Section 7.2.

7.5 Non-Avian Fauna

Ecologist specialists Bamford Consulting Services (Bamford) completed a non-avian fauna survey for the Burswood Park Golf Course in February 2012. The site inspection was carried out by Dr Mike Bamford and Mrs Mandy Bamford, with the site traversed and any observed fauna counted. Observations and environmental values of the survey area are summarised below, with survey locations shown on Figure 12. More information is provided in Bamford (2012b) and Golder (2012e).

7.5.1 Summary of Findings

- Invertebrates - Based on the flora and vegetation values observed within the Survey area, there is likely no suitable habitat to host any of these significant invertebrates.
- Fish - The lakes in the Survey area contained a number of common fish species including native Wallace's Hardyhead (also common to the Swan River), and native Freshwater Shrimp (*Palaemonetes australis*) and introduced pest Mosquitofish (*Gambusia holbrooki*) both present in high numbers. Native Swan River Goby (*Pseudogobius olorum*) were also common in both lakes and large introduced pest fish Koi Carp (*Cyprinus carpio*) were sighted in Lakes 3 and 4 (Golder, 2013k).
- Reptiles - The Fence Skink (*Cryptoblepharus buchanani*), was observed during the field survey, while Long-necked Tortoises (*Chelodina oblonga)* are known to inhabit the lakes.
- Mammals - One mammal, the introduced Brown (or Ship) Rat (*Rattus norvegicus*), was observed during the field survey and is reported by golf course staff to be abundant in the area.

The assemblage of non-avian fauna in the Survey area is expected to be very depauperate. This is related to the location of the Survey area (being isolated from areas of native vegetation and surrounded by urban development), its history (long periods of disturbance and degradation) and ecological condition (re-planted with often non-native plant species and broad open lawns with little habitat for fauna). Most of the fauna species will have been lost due to the history of the Survey area, and even where suitable habitat has been recreated there is limited scope for unassisted re-colonisation. The habitat that has been recreated is also often unsuitable for native mammals which often require hollow logs, leaf-litter, dense understorey vegetation or similar.

The Survey area provides little habitat for significant invertebrates, frogs, reptiles and mammals.

7.6 Aquatic Fauna

Golder was commissioned to undertake an aquatic fauna survey of artificial Lakes 1 to 5 located within the Burswood Park Golf Course for the Project (see Figure 3). Lakes 1 to 5 are artificial irrigation lakes, north of the Crown Perth complex, within the southern portion of the Burswood Park Golf Course. The objective of the aquatic fauna surveys was to assess the values of aquatic fauna and flora inhabiting Lakes 1 to 5, and the requirement for species of conservation significance, if identified, to be relocated prior to Project works being undertaken.

A survey to assess the in-lake aquatic fauna inhabiting Lakes 1 to 5 including fish, frogs, aquatic macroinvertebrates, crustacea and turtles was completed over three days during 30 November and 3 to 4 December 2012. Golder personnel, Dr Clint McCullough and Sarah Brown undertook the aquatic fauna survey, which involved netting of targeted aquatic fauna types.

7.6.1 Summary of Findings

All lakes showed few aquatic fauna values due to their artificial nature, depauperate littoral (shallows) and riparian (edge vegetation) habitats and only moderate water quality. Lake 1 received storm water run-off (this lake is currently the receival body for Crown's stormwater) and the habitat in this Lake was very good for native Oblong Turtles (*Chelodina oblonga*).

No Priority Species or species listed under the EPBC Act were observed in Lakes 1 to 5. All lakes had a number of common fish species including native Wallace's Hardyhead (also common to the Swan River), and native Freshwater Shrimp (*Palaemonetes australis*) and introduced pest Mosquitofish (*Gambusia holbrooki*), both present in high numbers. Native Swan River Goby (*Pseudogobius olorum*) were also common in both lakes and large introduced pest fish Koi Carp (*Cyprinus carpio*) were sighted in Lakes 3 and 4. Native Oblong Turtles were common in most lakes, especially Lake 1. The introduced pest Yabby crayfish (*Cherax destructor*) and native marron (*Cherax tenuimanus*) were also common in almost all lakes.

The Oblong Turtle (*Chelodina oblonga*), classified as Near-Threatened on the IUCN Red List of Threatened Species (ICUN Red List, 2012), was found in Lakes 1, 2 and 3 and this species is likely to be resident there with some potential for breeding as well. Golder (2013k) therefore recommended capture and relocation of Oblong Turtles (*Chelodina oblonga*) prior to the development or major disturbance of these lakes in a short period prior to any planned disturbance.

Yabby crayfish were found in most lakes. Yabbies are considered an invasive species in Western Australia and are known to predate upon Oblong Turtle hatchlings (Bradsell et al. 2003).

Aquatic macroinvertebrates recorded in the lakes comprised common species to the region, and none were conservation-listed. Some taxa (such as mayfly and caddisfly larvae) indicated moderately good lake water quality. All species found are potential food items for lake fishes and birds; and Chironomid larvae, in particular, are known food items for turtles (Giles *et al.* 2008). Indeed, turtles were found in high abundance in the Lake 1, which had a high abundance of Chironomid larvae.

More details are available in the report *Crown Perth Aquatic Fauna Survey* (Golder, 2013k).

8.0 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.
- Manage existing and future contamination including monitoring of groundwater, surface water, soil, air and landfill gas during the Construction Phase of the Project and into the Operations Phase in accordance with the *Contaminated Sites Act 2003* and the DEC *Contaminated Sites Guideline 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.
- 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.
- Minimise and manage waste through the adoption of waste reduction and disposal procedures consistent with the EPA waste hierarchy.

9.0 CONSTRUCTION PHASE ENVIRONMENTAL IMPACTS, MANAGEMENT AND MONITORING

9.1 Overview

An EMF has been developed for each phase of the Project, with 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 (Golder, 2013a), 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 environmental commitments have been drafted based on regulatory requirements, baseline studies completed, and discussions held during working groups and with the regulatory stakeholders.- Mitigation measures listed are minimum requirements and are not exhaustive, Additional environmental issues may be identified or alternative mitigation measures may become available as the project progresses.

Monitoring procedures will be approved by Crown prior to being implemented and Crown will; engage the regulatory agencies to review the monitoring procedures to determine if their requirements are addressed. Where not otherwise specified, all monitoring procedures are based on Golder's professional experience in consideration of the environmental baseline of the Project area.

9.2 Terrestrial Flora and Fauna

9.2.1 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, 2010).

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

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

9.2.2 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:

- 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 Position Statement No 3 Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002a)
- 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, 2010).

9.2.3 Potential Environmental Impacts

Potential negative effects of the Project to terrestrial flora and fauna during the Construction Phase may be though 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 loss resulting from vegetation clearance.
- Loss of faunal habitat movement corridors leading to difficulty for animals to access feeding and breeding areas.
- Indirect impacts to terrestrial fauna in the Project area due to loss of habitat and food sources.
- 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 Operations noise (see noise and vibration management in Section 9.7).
- 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.

9.2.4 Management and Mitigation 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 Crown 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 felling of habitat trees and vegetation clearance. Visual monitoring and recording of any indigenous or otherwise protected avian fauna species sighting known to the area is to be undertaken.

Management and mitigation 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:

- Prevent or mitigate dust emissions impacts to flora and fauna by implementing the air quality management measures listed in Section 9.6.
- Prevent or mitigate noise and vibration impacts to flora and fauna by implementing the noise and vibration management measures listed in Section 9.7
- Prevent or mitigate light disturbance to flora and fauna by implementing the visual amenity management measures listed in Section 9.8
- Stage flora and vegetation clearing to the minimum necessary, where practicable.
- Retention of Lake 2 and a portion of Lakes 3 and 4 (Figure 3) to maintain habitat for fish and local waterfowl as well as habitat for any migratory birds that utilise the Project area and to assist with stormwater management of the Project.
- Manage contamination to land, groundwater and surface water and spills and contamination risks, potentially impacting vegetation, by implementing the waste management and mitigation measures listed in Section 9.10 which include a spill clean-up and remediation procedure and the Contaminated Site Management Plan.
- Construct a fence around the Project area to keep activities and vehicle movements within a designated area and discourage terrestrial fauna from entering. This fence is to remain in place for the duration of the Project until the Operations Phase.
- 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.

Mitigation measures 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 9.

Table 9: Terrestrial Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
A weed outbreak occurs on-site	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issues and if required, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities.
Condition of any vegetation in close proximity to the Project area declines in comparison to baseline conditions.	■ Advise Crown and Crown's Environmental Advisor. ■ Increase vegetation-monitoring frequency to weekly 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. ■ Seek feedback from the relevant regulatory agency on proposed mitigation measures. ■ Undertake rehabilitation activities in affected area (e.g. revegetation with local provenance species, if practicable). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Vegetation in close proximity to the Project area shows a build-up of dust on leaves,	■ Advise Crown and Crown's Environmental Advisor. ■ Relocate the watering truck used for dust suppression to the relevant site and spray vegetation to remove dust particles. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
An incidence of death or injury to fauna occurs within the Project area due to Project Construction Phase works.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Collect or capture dead/injured fauna and treat or preserve specimen based on DEC advice. ■ Investigate mitigation measures (such as fauna crossings) in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Individuals or populations of species of conservation significance are at risk from Construction works	■ Advise Crown and Crown's Environmental Advisor. ■ Crown to advise relevant regulatory agencies if required. ■ Investigate relocation of populations and species in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.2.5 Monitoring Procedures

Fauna monitoring will be conducted as part of daily environmental checks and inspections (see Appendix D 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 dead or 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 Crown 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 Crown's Environmental Advisor 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 and mitigation measures outlined in the Lead Contractor's CEMP and approved by Crown.

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.

9.3 Aquatic Flora and Fauna

9.3.1 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 (OEPA, 2010).

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

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 (OEPA, 2010).

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 Lakes 2, 3 and 4 and in the Swan River.
- Minimise and manage the impacts on aquatic vegetation not requiring clearing for site works.

9.3.2 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 2004a).
- EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA, 2002a).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

Due to the heavily disturbed nature of the site (Golder, 2012e), most Project area aquatic values are associated with waterfowl and long-necked tortoises.

9.3.3 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.
- 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 Operations noise (see air quality Section 9.6 and noise and vibration Section **Error! Reference source not found.**).
- Smothering of aquatic foliage from dust mobilised through excavation and other soil disturbances.
- Introduction of aquatic flora and fauna pests.
- 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.

9.3.4 Management and Mitigation Measures

The Lead Contractor’s Environmental Advisor and/or designated qualified subcontractor 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.
- Provide ongoing advice in relation to aquatic fauna management issues.

Management and mitigation 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 inhabiting the Project area constructed lakes. The program will focus on trapping fish and turtles that might inhabit Lakes 1, 2, 3, 4 and 5 proposed for partial or complete infill as outlined in Golder (2013k).
- Undertake groundwater and surface water management and mitigation measures and monitoring procedures as outlined in Sections 9.4 and 9.5 and as per the Contaminated Site Management Plan (Golder, 2013d) to manage impacts to groundwater and surface water which provide habitat to dependent aquatic flora and fauna.
- Retention and protection of portions of Lakes 2, 3 and 4 to provide habitat for aquatic fauna and local waterfowl that utilise the Project area.
- Management of lakes within the Project area to prevent the transference of any feral aquatic fauna to the Swan River. This includes the prevention of:
  - Transport of aquatic flora or sediments, which may contain eggs or larvae, from the lakes to the Swan River.
  - Water flows from the lakes into the Swan River.
- Construction of a fence around the Project area to keep activities and vehicle movements within a designated area and discourage waterfowl from entering. This fence will remain in place for the duration of the Project until the Operations Phase.
- Manage contamination to land, groundwater and surface water and spills and contamination risks that may potentially impact vegetation, by implementing the waste management and mitigation measures listed in Sections 9.4 and 9.5 and the Contaminated Site Management Plan. The Contaminated Site Management Plan Golder, 2013d) also includes a spill clean-up and remediation procedure.
- Prevent or mitigate dust emissions impacts to aquatic flora and fauna, by implementing the air quality management measures listed in Section 9.6
- Prevent or mitigate noise and vibration impacts to aquatic fauna by implementing the noise and vibration management measures listed in Section 9.7
- 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.

Mitigation measures 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 10.

Table 10: Aquatic Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
Sediment plume or discharge is visually evident within any retained lakes or the Swan River.	■ Advise Crown, DEC, SRT and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Condition of aquatic vegetation remaining within Project area or in close proximity of the Project area declines in comparison to baseline conditions.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. revegetation with local provenance species, if practicable). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Aquatic vegetation remaining within Project area or in close proximity of the Project area shows a build-up of dust on surface.	■ Advise Crown and Crown's Environmental Advisor. ■ Relocate the watering truck used for dust suppression to the relevant site and spray vegetation to remove dust particles. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
An incidence of Fishkill occurs within the Swan River or any retained lakes.	■ Advise Crown, DEC, SRT and Crown's Environmental Advisor. ■ Identify any sources of contamination if Fishkill occurs in retained lakes. ■ Investigate mitigation measures in consultation with the DEC and SRT. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger for Action	Mitigation Measure
Individuals or populations of species of conservation significance within any retained lakes are at risk from Construction works.	■ Advise Crown and Crown's Environmental Advisor. ■ Crown to advise relevant regulatory agencies if required and/or the Contaminated Sites Auditor (if impacts are due to contamination). ■ Investigate relocation of populations and species in consultation with the DEC and/or Contaminated Sites Auditor (if impacts due to contamination). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Erosion of the riparian environment of any retained lakes is visually worse than background levels.	■ Advise Crown and Crown's Environmental Advisor. ■ 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 above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.3.5 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 turtles will be conducted as part of daily environmental checks and inspections (see Appendix D for the Daily Construction Environmental Inspection Checklist).

Aquatic monitoring procedures will include a daily site walk around any retained lakes within the Project area, if applicable, before works commence each day for dead/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. In addition to water quality monitoring that will be undertaken, general water quality should be observed and excessive algal blooms and the presence of any odours also recorded. High rates or individual erosion events will also be noted.

Any observations of fauna or riparian vegetation damage or injury should be recorded and submitted weekly to Crown's Environmental Advisor by the Lead Contractor' Environmental Representative. All recorded observations of injured or trapped terrestrial fauna will be provided to Crown 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 and mitigation measures outlined in the Lead Contractor's CEMP and approved by Crown. 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. A description of the physical appearance and call of these species should be covered in the environmental inductions.

9.4 Surface Water

9.4.1 Management Objectives

The EPA 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.

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

- Protect the ecosystem surrounding the Project area.
- 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.
- Manage the continued use of water resources.

9.4.2 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, 2000).
- *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, 2000).

Appendix E 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 rigger 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.

Table 11 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 11: Trigger Values for Reporting Chemical Stressors in the Swan River South of the Project area ^

Water Quality Indicator	Trigger Value
Chl a*	3
Total Phosphorus (TP)*	30

Water Quality Indicator	Trigger Value
Free Reactive Phosphorus (FRP)*	5
Total Nitrogen*	750
Nitrogen oxides (NO_x)*	45
Ammonia (NH_4)*	40
Dissolved oxygen (DO) (% saturation) *	90-110
pH* (pH units)	7.5-8.5
Turbidity (NTU) Ω	≤10% increase above reference site, or no visible reduction in colour or light penetration of the receiving environment.
Salinity (as TDS) Ω	≤10% increase above reference site.
Temperature	≤10% increase above reference site.
Other contaminants Ω	≤10% increase above reference site , or exceed levels for which there is evidence of lethal or sub-lethal toxic effects or undesirable physiological responses in humans, plants, birds, animals, fish or other aquatic life.

^ All values are in mg/L unless otherwise stated.

* 90% Aquatic Ecosystem Protection Trigger Values (ANZECC/ARMCANZ, 2000)

Ω Swan River acceptable water quality (SRT, 2000).

Table 12 provides the guideline trigger levels for the constructed lakes within the Project area.

Table 12: Trigger Values for Reporting Chemical Stressors in the Constructed Lakes within the Project area^

Water Quality Indicator	Trigger value
Chl a*	30
Total Phosphorus (TP)*	60
Free Reactive Phosphorus (FRP)*	30
Total Nitrogen*	1500
Nitrogen oxides (NO_x)*	100
Ammonia (NH_4)*	40
Dissolved oxygen (DO) (% saturation) *	90-120
pH* (pH units)	7.0-8.5
Turbidity (NTU)	10-100
Salinity (as TDS)	300-1500
Temperature	≤10% increase above seasonal baseline conditions.
Other contaminants	80% ANZECC/ARMCANZ (2000) Aquatic Ecosystem Protection Guidelines

^ All values are in mg/L unless otherwise stated.

* 90% Aquatic Ecosystem Protection Trigger Values (ANZECC/ARMCANZ, 2000)

Ω Swan River acceptable water quality (SRT, 2000).

Trigger levels such as those in Table 11 and Table 12, 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 is provided as Appendix E.

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

The protection level for the artificial lakes within the Project area is set at 80%. This is due to the lakes constructed nature and their low intrinsic aquatic ecosystem values (Golder, 2013k).

9.4.3 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 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.

9.4.4 Management and Mitigation Measures

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

- Control of contamination to land, groundwater and surface water due to spills and contamination risks, by implementing the waste management measures as outlined in Section 9.4.4 and the Contaminated Site Management Plan (Golder, 2013d).
- Retention and protection of portions of Lakes 2, 3, and 4 to provide habitat for aquatic fauna 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 9.4 and the Contaminated Site Management Plan (Golder, 2013d).
- Design and implementation of an appropriate stormwater capture and disposal program based on specific site works, including measures such as:
  - Deviation of stormwater around infrastructure to specified, bunded collection points.
  - Deviation of stormwater from disturbed areas to avoid undisturbed areas.
  - Direction of stormwater to stormwater collection drains/sewer.
  - Prevention of stormwater pooling.
  - Prevention of stormwater flow from disturbed areas into surface water bodies, unless the surface water body is specifically designed for the retention of stormwater.

- Location and design of bulk fuel and chemical storage facilities to avoid stormwater flow paths, and to minimise potential for contamination of stormwater.

- Implementation of an awareness program as part of the inductions to educate all personnel on the importance of protecting the Swan River and any retained lakes and the related management measures. This induction should 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 (Golder, 2013i) and Contaminated Site Management Plan (Golder, 2013d) 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 9.6

Mitigation measures 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 13.

Table 13: Surface Water Mitigation Measures

Trigger	Mitigation Measures
Runoff from stockpiles flows into undisturbed areas or surface water bodies..	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Confirm that risk assessment is still valid. ■ Mitigate spill area and alter stockpile bund design accordingly to prevent from reoccurring. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Contaminated surface water is discharged to the surrounding environment.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Confirm that risk assessment is still valid. ■ Prevent further flow of contaminated water to the surrounding environment. ■ Remove/stop the source of contamination. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Surface water quality is in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of water quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Sediment plume or discharge is visually evident downstream of a disturbed area or within the remaining lakes.	■ Advise Crown, DEC, SRT and Crown's Environmental Advisor. ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify potential cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area as per DEC/SRT advice. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Surface water in remaining lakes or in the Swan River is visually impacted by dust or contains large volumes of sediment due to dust emissions.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Stormwater system is blocked and/or overflowing.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify location and source of blockage. ■ Remove blockage. ■ Clean-up spilt or pooling storm water as required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.4.5 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 due to Construction Phase works. Surface water monitoring will be conducted with reference to the trigger levels in the ANZECC Guidelines where practicable and at least include the parameters listed in Table 14. Additional analytes may be included pending the outcomes of the DSI (Golder, 2013j).

Monitoring locations will be established in each of the constructed lakes and in the Swan River. Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in Golder (2012b).

Table 14: 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 & SO_4	Weekly	Weekly
Total metals (Fe and Al)	Weekly	Weekly
Total suspended solids (TSS)	Weekly	Weekly
Organochlorine and organophosphate pesticides	Fortnightly	Fortnightly
Polyaromatic hydrocarbons (including naphthalene)	Fortnightly	Fortnightly

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

Surface water monitoring will be reviewed based on DSI (Golder, 2013j) and baseline results 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 and mitigation measures outlined in this Project EMP and the Contaminated Site Management Plan (Golder, 2013d).

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

9.5 Groundwater

9.5.1 Management Objectives

The EPA 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.

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.

- 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.

9.5.2 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, 2000)
- 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, 2000)
- Drinking Water Aesthetic Values (DEC, 2010)
- Drinking Water Health Values (DEC, 2010)
- Unpublished trigger values provided by the Swan River Trust (2012).

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

Trigger levels such as those in Appendix F, 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.

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 water is proposed to be discharged into the Swan River, the Swan River Trust guidelines for disposal of dewater into the Swan River are outlined in **Table 15.**

Table 15: Swan River Trust Guideline Trigger Values for Dewatering Disposal into the Swan River

Item	Trigger Value	Source
Total nitrogen	>1.0mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total phosphorus	>0.1mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total iron (Fe+ and Fe_3+)	>1.0mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Dissolved aluminium	>150ug/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Total aluminium	>1.0mg/L	Treatment and management of soils and water in acid sulfate soil

		landscapes (DEC, 2009)
TTA (Acidity)	>40mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Odours and colours	No objectionable odours or visible colour changes in the receiving water	Swan River Trust policy SRT/DE6 Dewatering
Floatable matter	No visible floating oil, grease, scum, litter or other objectionable material	Swan River Trust policy SRT/DE6 Dewatering
Settleable matter	No deposits which adversely affect the recreation and ecosystem values of the receiving waters	Swan River Trust policy SRT/DE6 Dewatering
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
Temperature	Not to vary more than 2 degrees Celsius from the background level (in the receiving environment)	Swan River Trust policy SRT/DE6 Dewatering
Salinity	Not to alter the background level in the receiving environment by more than 10%	Swan River Trust policy SRT/DE6 Dewatering
Dissolved Oxygen	>4mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
pH	Should not fall outside the range of 6-8.5	ANZECC Guidelines for freshwater
All other toxicants	As per ANZECC Guidelines for freshwater or marine water ecosystems. Minimum 95% protection level to be used.	ANZECC Guidelines

9.5.3 Potential Environmental Impacts

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

- The potential for cross-contamination between aquifers due to piling activities. 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.
- Impacts to water 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.
- Should dewatering be required during the Construction Phase, potential impacts will be dependent on the water quality of extracted groundwater and the groundwater disposal location. There is potential for discharge of contaminated water to a surface water body or other location if not managed appropriately.

9.5.4 Management and Mitigation Measures

Management and mitigation 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 9.5.4 and the Contaminated Site Management Plan (Golder, 2013d).
- Development and implementation of a groundwater monitoring program to monitor for any potential adverse impacts on the Swan River as per Section 9.5, the Dewatering Management Plan (Golder, 2013i) and the Contaminated Site Management Plan (Golder, 2013d).
- Design and implementation of appropriate stormwater capture and disposal program based on specific site works including measures such as:
  - Deviation of stormwater around infrastructure to specified, bunded collection points.
  - Deviation of stormwater from disturbed areas to avoid undisturbed areas.
  - Direction of stormwater to stormwater collection drains/sewer.
  - Prevention of stormwater pooling.
  - Prevention of stormwater flow from disturbed areas into surface water bodies, unless the surface water body is specifically designed for the retention of stormwater.
- Should dewatering be required, the management of dewatering treatment and disposal will be detailed in a separate plan entitled Dewatering Management Plan (Golder, 2013i).
- 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 should 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.
- Construction Phase activities will be conducted in accordance with the Project's Dewatering Management Plan (Golder, 2013i) and Contaminated Site Management Plan (Golder, 2013d) to manage hydrology and hydrogeology impacts and related indirect impacts to surface water bodies.

Mitigation measures 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 16.

Table 16: Groundwater Mitigation Measures

Trigger	Mitigation Measures
Measured decline/increase in groundwater levels is at variance to the modelled change.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Groundwater quality is in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ 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 the Dewatering Management Plan (Golder, 2013i) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Identified deteriorating groundwater quality.	■ Advise Crown and Crown's Environmental Advisor. ■ 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 the Dewatering Management Plan (Golder, 2013i) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Groundwater quality monitored in the groundwater wells east of the Swan River, with potential for discharge to the Swan River, is identified as being in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Assess validity of risk assessment. ■ If ecological risk is considered unacceptable, consider mitigation options such as installing a trench with in-pit sump pump(s), pumping well(s) or dewatering spears for preventing contaminated groundwater from entering the Swan River as per the Dewatering Management Plan (Golder, 2013i). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Extracted groundwater volume increases from modelled predictions.	■ Advise Crown and Crown's Environmental Advisor. ■ Crown and the Lead Contractor to discuss increased groundwater extraction volumes with DOW and other relevant regulatory agencies as required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Survey of adjacent structures shows settlement or abnormalities.	■ Advise Crown and Crown's Environmental Advisor. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.5.5 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 Agriculture and Food *Guidelines for Groundwater Monitoring* (2008)
- 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, 2000)
- 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
- DEC Contaminated Sites Management Series Guidelines.

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

Monitoring of the groundwater (using monitoring wells) and dewatering discharge (if applicable) is required during the Construction Phase. The monitoring will have to commence prior to Construction Phase activities and continue after the cessation. Details of the proposed monitoring may be dependent on the nature and extent of any dewatering and will need to be outlined in the Phase specific DMP(s) and/or CEMP(s). The requirement for any other new monitoring well locations would need to be assessed during the preparation of the Phase specific DMP(s).

The following sections outline likely monitoring requirements based on the guidelines from DOW (2006) and DEC (2011).

9.5.5.1 Groundwater

A groundwater monitoring well network is currently being established as part of the ongoing geotechnical and environmental investigation and the network will be monitored as part of this Project Environmental Management Plan. 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 based during the preparation of the specific Dewatering Management Plan.

Field Monitoring

Groundwater level, pH, electrical conductivity, TTA, total alkalinity oxygen redox potential and dissolved oxygen should 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 should be compared to estimates from the groundwater modelling to provide early indication of the likelihood that groundwater levels could daylight.

Laboratory Analysis

Groundwater samples should 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 water samples taken during the ongoing environmental investigation will be used as background water quality.

The proposed analytes to test for are presented in Table 15.. Field pH, electrical conductivity, dissolved oxygen, redox potential, TTA and temperature should be measured in the field when collecting the water samples.

Table 17: Proposed Analytes for Laboratory Suite for Groundwater

Miscellaneous Parameters	**Total Titratable Acidity, Total Actual Acidity, Total Alkalinity, pH, TDS, turbidity, ORP, EC.**
Major Ions	Cations (Ca, Mg, Na, K), Anions (Cl, SO_4, HCO_3)
Dissolved Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Total Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Nutrients	Ammonia as N, Total Nitrogen, reactive Phosphorous, Total Phosphorus
Additional contaminants of concern	*Polycyclic Aromatic Hydrocarbons (including naphthalene) and Organo Chlorine and Organo Phosphate Pesticides.**

Note: * required analytes may be dependent on the location of dewatering

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.

9.5.5.2 Dewatering Discharge

If dewatering is required, then dewatering discharge monitoring should be undertaken as detailed within the Dewatering Management Plan (Golder, 2013i).

9.5.5.3 Monitoring in Accordance with ASS Guidelines

ASS monitoring should be undertaken as detailed within the Contaminated Sites Management Plan (Golder, 2013d).

9.5.5.4 Other Monitoring

Additional contaminants of concern may be required to be monitored based on results of DSI (Golder, 2013j) 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 1.0 mg/L
- Total phosphorus - trigger level 0.1 mg/L
- Total iron - trigger level 1.0 mg/L
- Odours and colours - No objectionable odours or visible colour
- Floatable matter - No visible floating oil, grease, scum, litter or other objectionable material
- Total aluminium - trigger level >1.0mg/L

It is proposed that photos are taken regularly of the dewatering effluent to document the visual quality of the water.

9.5.5.5 Settling Effects

The DMP must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. Proximity to nearby infrastructure including the Crown Perth complex and residential buildings to the north and east 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 be determined at an interval during the dewatering period. Survey data should be recorded and reviewed and the reasons for any changes or movements identified.

9.6 Air Quality

9.6.1 Management Objectives

The EPA 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 (GHG) 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 GHG 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).

9.6.2 Limits and Targets

9.6.2.1 Overview

Current approaches to air quality management at development sites are contained in "*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).

The DEC guideline presents a risk based approach to air quality management at a development site. The guideline notes that for potentially contaminated sites, a health risk assessment (HRA) should be conducted in accordance with the HRA requirements of the Department of Health (DOH).

Noting the above, a preliminary site classification has been undertaken using the site classification chart for uncontaminated sites, as contained in the DEC guideline document (DEC, March 2011). The assessment is preliminary and may need to be revisited pending the outcome of the DSI (Golder, 2013j). This Project EMP will be updated as required following these studies.

The nuisance potential for dust generation during the Construction Phase is considered to be moderate due to the landscaped nature of the site, and that little screening is located around the site to minimise dust migration off-site. Preliminary assessment using the DEC guidance (DEC, March 2011) indicated a site classification of medium/high, as there is potential for adverse dust impacts during site clearing if site activities are not closely managed. This rating should be used as guidance only, as the site is undergoing a detailed investigation to determine the presence/and or extent of contamination on the site.

9.6.2.2 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 Crown Towers, provided that other site features including bare areas and material stockpiles are appropriately managed.

The DEC guidance (DEC, March 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 DEC. These are presented in Table 18, Table 19 and Table 18.

Table 18: 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 19: 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 20: Kwinana EPP, TSP Ambient Air Quality Standards and Limits for Area C (rural/residential area)

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

9.6.2.3 Asbestos

Asbestos may be present on-site. Asbestos presents a risk to human health rather than a risk to the environment. The main area which may be identified in the DSI (Golder, 2013j) as being impacted by asbestos is the former landfill area, which has the potential to contain asbestos containing material (ACM). Due to the nature and age of the landfill, asbestos fibre cannot be discounted.

Mitigation measures will be put in place by the Lead Contractor(s) to remove or contain asbestos and ACM from the site prior to construction works commencing. 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 21.

Table 21: Air Quality Limit for Asbestos (DOH, 2009)

Pollutant	Limit
Asbestos	0.01 fibres/mL

9.6.2.4 Landfill Gas

There is the potential for landfill gases to be emitted from the site during Construction Phase works. Construction workers in the immediate vicinity of works are those most likely to be impacted by the presence of landfill gas. The ambient air environment in surrounding areas may be impacted by the odour impacts of landfill gas. Potential hazards from landfill gas are due to high levels of hydrogen sulfide (H_2S), carbon dioxide (CO_2) and methane (CH_4). Lower explosive limit (LEL) and toxic gas monitors may be required for workers in the immediate area.

Guidelines for landfill gas are 500 ppm (permanent gas level limit).

9.6.2.5 Odour

There is the potential for odour to be emitted from the site during construction due to the release of landfill gas and the excavation of odorous material. The 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.

9.6.3 Potential Environmental Impacts

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

- An increase in GHG emissions to the environment due to the combustion of fuel, and decomposition of soil and organic matter following 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 could potentially become airborne under certain meteorological conditions (i.e. wind direction, number of days since last rainfall).
  - 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 GHG 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). Given the potential for site contamination, there is also the potential for other contaminants to be associated with windblown particulates. Potential contaminants will be identified following completion of the DSI (Golder, 2013j).
- 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, and has potential to smother vegetation and impact fauna.
- Uncontrolled landfill gas impacts due to the disturbance of *in situ* landfill material may result in:
  - Subsurface migration, the underground movement of landfill gas from landfills to other areas within the landfill property or outside the landfill property.
  - Emissions of landfill 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.

9.6.4 Management and Mitigation Measures

Management and mitigation 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 to spray 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 forecasts, weather monitoring results and types of activities being undertaken.
- Development and implementation of an air quality monitoring program (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 fuel-efficient vehicles and plant where practicable to reduce the use of machinery causing emissions of GHG's.
- Management of asbestos and potential emission of asbestos fibres to air due to construction works by administering appropriate personal protective equipment (PPE), adhering to the site's Occupational Health and Safety Procedure as developed by the Lead Contractor in conjunction with the asbestos handling standards in the *Occupational Safety and Health Act 1984.* The results of the DSI (Golder, 2013j) and the Contaminated Site Management Plan (Golder, 2013d) are to also be consulted in the development of asbestos handling and management measures.
- Daily monitoring of weather conditions to manage 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.
- Implementation of a landfill gas recovery system (combustion by flare/electricity generation equipment or another system use) if landfill gas is identified on-site, to reduce overall air and GHG emissions from landfills, reduce odour and manage subsurface migration.
- Should odours occur, works will be undertaken during suitable weather conditions, ensuring that odours are kept away from residents and other users of the surrounding area.

Mitigation measures 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 22.

Table 22: Air Quality Mitigation Measures

Trigger	Potential Mitigation Measures
Portable landfill gas levels are in excess of the time weighted average (TWA): ■ 10 ppm hydrogen sulfide ■ 5000 ppm carbon dioxide ■ 5% Lower Explosive Limit (LEL) of methane	■ Advise Crown and Crown's Environmental Advisor. ■ Check that source of emissions is from the open hole or excavation. ■ Evaluate the concentrations against the Short Term Exposure Limit (STEL). ■ Stop work. ■ Implement appropriate emergency evacuation procedures. ■ Implement the appropriate emergency incident response procedures. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Permanent landfill gas levels are reported to be in excess of 500 ppm.	■ Advise Crown and Crown's Environmental Advisor. ■ Confirm elevated concentrations of landfill gas. ■ Stop work. ■ Implement appropriate emergency evacuation procedures. ■ Implement the appropriate emergency incident response procedures. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Visible dust is generated from potentially contaminated material.	■ Advise Crown and Crown's Environmental Advisor. ■ Increase dust management measures. ■ Stop work. ■ Wait until wind conditions improve. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Airborne concentrations of asbestos are reported above recommended concentrations.	■ Advise Crown and Crown's Environmental Advisor. ■ Stop work. ■ Identify source of airborne asbestos. ■ Increase dust management measures. ■ Wait until wind conditions improve.

Trigger	Potential Mitigation Measures
	■ Remove source to an off-site location. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Air quality is in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of air quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Dust emissions complaint is received.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase dust management measures. ■ Wait until wind conditions improve. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Odour complaint is received.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate reason for complaint. ■ Undertake additional training. ■ Increase odour management measures. ■ Wait until wind conditions improve. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.6.5 Monitoring Procedures

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

9.6.5.1 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:

- DEC's *Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities* (2011)
- 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)*
- DEC's *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 9.6.2.

9.6.5.2 Asbestos

The requirement for asbestos management and monitoring will depend on the Construction Phase 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 and mitigation measures and monitoring procedures in this Project EMP. If prepared, the asbestos management and monitoring procedure will be submitted to the Department of Health for review prior to implementation.

9.6.5.3 Landfill Gas

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

- DEC's *Siting, Design, Operation and Rehabilitation of Landfills*
- *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).

Landfill gas monitoring should be undertaken regularly by a qualified specialist via the installation of permanent landfill gas monitors. Landfill gas monitoring assessing the presence of landfill gas will be undertaken according to the specifications and procedures detailed in this document, the Contaminated Site Management Plan (Golder, 2013d) and as per the Lead Contractor's CEMP. Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in Golder (2012b). Landfill gas monitoring procedures will be approved by Crown prior to being implemented and Crown may engage relevant regulatory agencies or the Contaminated Sites Auditor to review the monitoring procedures.

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

See the Contaminated Sites Management Plan (Golder, 2013d) for more information.

9.6.5.4 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 Crown 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 landfill gas monitoring results and assist in the implementation of air quality and landfill gas management and mitigation measures.

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

9.7 Noise and Vibration

9.7.1 Management Objectives

The EPA 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.

9.7.2 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) (OEPA, 2007).

9.7.2.1 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 between 7 am and 7 pm on any day which is not a Sunday or public holiday, under certain conditions.
- Work may be undertaken between 7 pm and 7 am and on Sundays and public holidays, under a stricter set of conditions.

Construction Out of Hours

For construction work done outside the hours 7 am and 7 pm on any day which is not a Sunday or public holiday the:

- Work must be carried out in accordance with Section 2 and 3 of AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.*
- Equipment used for the construction work will be the quietest practically available and economically viable.
- Lead Contractor(s) must advise all nearby occupants of the work to be carried out at least 24 hours before it commences.

- Lead Contractor(s) must show it was reasonable necessary for the work to be performed out of hours.
- Lead Contractor(s) must submit to the chief executive officer (CEO) a noise management plan at least seven 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.

Project Noise Evaluation

In order to manage potential noise impacts of the hotel during operations, the Lead Contractor(s) designing and constructing the Project is required to:

- Study and measure existing noise sources such as vehicular, rail and aircraft traffic and advise on building design, layout and construction method to assess compliance with minimum acoustical performance.
- Analyse construction specifications, details and methodology to assess compliance with minimum acoustical performance.
- Analyse MEP systems design including components location and distribution network, provide recommendations and specifications to assess compliance with minimum acoustical performance and where necessary specify specific construction techniques such as vibration isolators or floating floors.
- Select interior finishes for special function spaces such as meeting rooms, ballrooms, gaming areas, offices, etc, to insure an adequate acoustical environment which supports the activities of that space.

Construction Materials and Methodology

Crown recommends that all construction materials are sourced from manufacturers who are able to provide validated certification of product compliance with the project's acoustical criteria.

Installation methodology and quality achieved must assess compliance with the minimum acoustical performance.

Table 23: Minimum Acoustical Performance Matrix

Performance Standard	Sound Absorption 1	Sound Transmission Loss 2	Sound Transmission Loss 2	Sound Transmission Loss	Open Office	Open Office	HVAC Spectrum Noise
Class	**Noise Reduction Class (NRC)**	**Sound Transmission Class (STC)**	**Outdoor-Indoor Transmission Class (OITC)**	**Noise Isolation Class (NIC)**	**Articulation Class (AC)**	**Articulation Index (AI)**	**Room Criteria**
Areas							
Public Areas, Lobby Circulation	.40 ± .10	40dB ± 2dB	40dB	35dB ± 2dB	N/A	N/A	35 (N)
Restaurant and Bar	.60 ± .10	40dB ± 2dB	40dB	35dB ± 2dB	180dB ± 10dB	.10	45 ®
Convention/Meeting Rooms	.60 ± .10	55dB ± 2dB	50dB	50dB ± 2dB	N/A	N/A	45 (N)
Offices	.60 ± .10	40dB ± 2dB	40dB	35dB ± 2dB	180dB ± 10dB	.10	35 (N)
Support Areas	.50 ± .10	40dB ± 2dB	40dB	35dB ± 2dB	N/A	N/A	35 (N)

Note:

1) To provide adequate interior acoustics for a space, an evaluation of the required surface area of absorptive material must be performed.

2) Non-typical adjacencies may require a higher STC rating than stated in the table. These adjacencies should be identified, and an adequate STC rating should be determined.

9.7.3 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 will cause an increase in localised noise concerns to neighbouring properties (residential, commercial and recreational), terrestrial and aquatic fauna and heritage buildings/structures.
- Vehicle and machinery operation may cause an increase in vibration concerns to neighbouring properties (residential, commercial and recreational), terrestrial and aquatic fauna and heritage buildings/structures.

9.7.4 Management and Mitigation Measures

Management and mitigation 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 2 and 3 of AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.*
- All construction work will be carried out within 7 am and 7 pm on any day which is not a Sunday or public holiday; 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 reasonably available and economically viable consistent with Operations requirements, and will be routinely maintained to assess effectiveness of noise suppression systems and equipment.
- Implementation of 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 Operations/management procedures by Crown's Environmental Advisor and the Lead Contractor's Environmental Representative as a basis for development and implementation of appropriate modified practices.

Mitigation measures 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 24.

Table 24: Noise Mitigation Measures

Trigger	Potential Mitigation Measures
Measured noise or vibration levels are reported to be in exceedance of trigger values.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of increase in noise or vibration levels. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Noise or vibrations complaint is received.	■ Advise Crown and Crown's Environmental Advisor. ■ Investigate reason for complaint. ■ Undertake additional training if applicable. ■ Increase noise management measures if applicable. ■ Wait until wind conditions improve if applicable. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.7.5 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 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 and mitigation measures outlined in this Project EMP and the Lead Contractor's CEMP.

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

9.8 Visual Amenity

9.8.1 Management Objectives

The EPA 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 objectives with regard to the management of visual amenity during the Construction Phase are to:

- Minimise and manage impacts to the visual amenity of the Swan River, Burswood Park recreational area and the Burswood Peninsula.

9.8.2 Potential Environmental and Social 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 may be unfavourable to some residents in the area.

9.8.3 Management and Mitigation Measures

Management and mitigation 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 Complaints Management Procedure detailed in Section 19.0 of this document.
- 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.
- 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, dependent on DSI results and soil classification.
- 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 and mitigation measures.

9.8.4 Monitoring Procedures

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

- Review complaints as they are 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.

9.9 Indigenous Heritage

9.9.1 Overview

No Indigenous heritage sites have been identified within the Project area.

In the event that a previously unknown/unregistered Indigenous heritage site is disturbed during the Construction Phase works, the mitigation measures that will 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 25.

Table 25: Indigenous Heritage Mitigation Measures

Trigger	Potential Mitigation Measures
Indirect contamination to Indigenous heritage sites.	■ Advise Crown and Crown's Environmental Advisor. ■ Identify source of contamination and cease source if able. ■ Crown to work with the DIA in consultation with a representative of the Noongar people to remediate the area. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Ground disturbance resulting in disturbance of unknown Indigenous sites of significance.	■ Advise Crown and Crown's Environmental Advisor. ■ Cease disturbance activity and fence off area around site including a 20 m buffer. ■ Crown to work with the DIA in consultation with a representative of the Noongar people to assess and remediate the area. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

9.10 Waste Management

9.10.1 Management Objectives

The environmental objective adopted for the Project relating to solid and liquid waste requires 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 DEC policy - Review of Waste Classification and Waste Definitions 1996 (as amended).

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 DEC and other regulatory requirements.

9.10.2 Limits and Targets

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

- *Environmental Protection (Controlled Waste) Regulations 2004.*

- EP Act.
- Review of Waste Classification and Waste Definitions 1996 (as amended).
- *Litter Act 1979* (currently under review by DEC 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.

9.10.3 Potential Environmental and Social 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 may result in an inefficient use of resources.

9.10.4 Management and Mitigation Measures

Management and mitigation 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.
- 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 or anaerobic treatment system.
- The waste management hierarchy of elimination, reduction, reuse, recycling, treatment and disposal will be adhered to where possible. Disposal should only be considered as a last resort.
- All waste generated will be managed in a manner which minimises any potential impacts to the environment.
- Waste management will comply 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, including the preferred remediation process for all contaminated material on-site, including diesel, used preconstruction water, stormwater.
- Spill clean-up procedures will be implemented, including the preferred remediation process for all contaminated material on-site, including diesel, used preconstruction water and stormwater.
- Testing and treatment of any cut and fill material will be undertaken in accordance with regulator guidelines and the requirements in the Contaminated Site Management Plan (Golder, 2013d).
- Soils proposed for re-use on-site will be classified as suitable for re-use, with sampling results assessed against the criteria outlined in the *Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*. This document also outlines the number of samples required for adequate waste soil classification. Further details are available in the Contaminated Site Management Plan (Golder, 2013d).

- Disposal of waste, including any cut and fill material deemed unsuitable for reuse on-site, will be undertaken in accordance with relevant guidelines, in particular, *Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*.
- Waste soils requiring disposal off-site will be classified as required by the *Landfill Waste Classification and Waste Definitions 1996 (DEC, 2005)*, prior to disposal, with the appropriate disposal facility identified based on the soil classification results.
- Disposal of contaminated soil and other material is managed under the conditions in the Contaminated Site Management Plan (Golder, 2013d).
- Disposal of contaminated soil and other material will be managed under the conditions included in the Contaminated Site Management Plan (Golder, 2013d).

Mitigation measures to be taken by the Lead Contractor(s) to manage potential waste impact triggers include, but are not limited to those outlined in Table 26.

Table 26: Waste Mitigation Measures

Trigger	Potential Mitigation Measures
Complaints from relevant regulatory bodies are received regarding the disposal of waste in an environmentally unacceptable manner.	■ Advise Crown and Crown's Environmental Advisor. ■ 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.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Implement Emergency Incident Response Procedure (refer Section 16.0). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Leak or spill of sewage waste occurs within the Project area.	■ Advise Crown, DEC and Crown's Environmental Advisor. ■ Implement Emergency Incident Response Procedure (refer Section 16.0). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
The volume of non-recyclable wastes disposed (following the first year of the Construction Phase) has exceeded that of the previous year.	■ Advise Crown and Crown's Environmental Advisor. ■ 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.
Excessive litter is observed within the Project area	■ Advise Crown and Crown's Environmental Advisor. ■ Deploy on-site personnel to clean-up litter. ■ Re-educate on-site personnel of waste management procedures.

9.10.5 Monitoring Procedures

The Lead Contractor(s) will be required to monitor for contamination based on the outcomes of the DSI (Golder, 2013j) as part of the Contaminated Site Management Plan (Golder, 2013d). 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 frequency and techniques for monitoring are provided in the Contaminated Site Management Plan (Golder, 2013d).

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

9.11 Dewatering Management

For management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures, see the Dewatering Management Plan (Golder, 2013i).

9.12 Contaminated Site Management

For management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures, see the Contaminated Site Management Plan (Golder, 2013d).

10.0 REHABILITATION MANAGEMENT PLAN

10.1 Overview

Rehabilitation of the environment from impacts caused by the Project will be a joint effort between Lead Contractor(s) and Crown. 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 Operations Phase. It is expected that the Operations Phase will be tasked with monitoring the rehabilitation undertaken by the Lead Contractor and undertaking maintenance where required.

Rehabilitation will be required within the landscaped areas and the retained lakes, and other undeveloped areas within the Project area. A Rehabilitation Management Plan will be prepared by the Crown Towers Construction Phase Lead Contractor. The role of the Lead Contractor(s) in preparing the site for rehabilitation is outlined in this Project EMP and will be included in the contract documents for the Construction Phase works.

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 Construction Phase 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).

10.2 Construction Phase

The Lead Contractor for the Construction Phase 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 relevant regulatory agencies and will be approved by Crown prior to being implemented.

Prior to clearing for earthworks to be undertaken, a suitably qualified environmental professional should undertake a walkover of the Project area to 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 determine they are not located in stormwater flow ways, are not being disturbed by works and are free of weeds.

Protection of designated preservation areas (if any) will be undertaken as part of the rehabilitation procedures throughout the Construction Phase.

The Lead Contactor(s) along with Crown's Environmental Advisor 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.

10.3 Operations Phase

Crown will be required to implement the rehabilitation monitoring and maintenance components of the Rehabilitation Management Plan developed by the Lead Contractor. This will involve monitoring the status of the landscaping and rehabilitation as well as undertaking measures should rehabilitation be unsuccessful.

11.0 ENVIRONMENTAL REPORTING REQUIREMENTS

11.1 Project Compliance

Monthly compliance reports will be provided to Crown by the Lead Contractor(s) covering as a minimum:

- Environmental activities.
- Environmental monitoring results.
- Compliance auditing and tracking.
- Rehabilitation progress.
- Public complaints.
- Any exceedances and corrective actions.
- Environmental incidents.
- Non-conformances.

In addition to the monthly compliance reports, annual environmental compliance reports will be completed by the Lead Contractor(s) during the Construction Phase, and submitted to Crown.

11.2 Compliance Tracking

A corrective actions and compliance tracking program will be developed by the Lead Contractor(s) to manage and track Project compliance with the commitments in the Project EMP, Environmental

Sub-management Plans and CEMP. The tracking document will be a standalone document and will be provided to Crown as part of the monthly compliance reports.

11.3 Management of Non-compliance

Non-compliance will be managed by the Lead Contractor(s) responsible for each phase and Crown under the implementation of the Project EMP, Environmental Sub-management Plans and CEMP. Procedures for managing non-compliance including the recording, reporting and implementation of mitigation measures or corrective action and responsible persons will be detailed in the CEMP. A non-conformance register will be maintained by the Lead Contractor(s) which should include, at a minimum:

- A description of the non-conformance.
- Any mitigation actions implemented.
- Reporting details, including date and who the non-conformance was reported to.

11.4 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 for the Construction Phase will be provided in the monthly compliance reports and provided to Crown.

12.0 AUDITING

12.1 Contaminated Sites Auditor

Jason Clay from AECOM Pty Ltd has been appointed as the Contaminated Sites Auditor for the Project. The 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*. Information (e.g. site records, registers, etc) must be made available to the Contaminated Sites Auditor at his request.

12.2 Audits and Inspections

The Lead Contractor's Environmental Representative, is to conduct daily inspections as outlined within this Project EMP.

A qualified (e.g. RABQSA) Environmental Auditor (Lead or Principal Auditor level) will be engaged by the Lead Contractor to conduct environmental audits during the Construction Phase of the Project as outlined within this Project EMP.

From the commencement of the Construction Phase, environmental audits will be undertaken weekly for the duration of the first quarter of Construction Phase. Environmental audits will then be held monthly thereafter. The objective of the monthly environmental audits is to assess the Lead Contractors' compliance with the Project EMP, Environmental Sub-management Plans and CEMP. The results of the monthly environmental audits will be recorded and any non-conformances identified against the Project EMP, Environmental Sub-management Plans and CEMP, along with proposed corrective actions, will be reported to Crown in the monthly environmental compliance report. Crown and Crown's Environmental Advisor will manage the Construction Phase Lead Contractor to implement suitable corrective actions.

13.0 COMMUNICATION OF ENVIRONMENTAL MATTERS

13.1 Toolbox Meetings

A "Toolbox" meeting shall be held daily, prior to the commencement of work each day, by the Lead Contractor during the Construction Phase of the Project. Discussion of the following items, as a minimum, 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.
- Reiteration of specific environmental management procedures which have already been communicated to site personnel.

Regular meetings between the Lead Contractor's Construction Manager and Crown's Environmental Advisor 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 prior to the commencement of work for the 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 of the Project EMP, CEMP and Environmental Sub-management Plans.
- Assess compliance with all relevant licence conditions.
- Review of the monitoring of key performance indicators outlined in the individual EMPs.
- Review of relevant records which include the Environmental Complaints and Incident Register.
- Review of the previous week's Construction Environmental Inspection Checklists.

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 D and the checklist format is to be based on the format outlined in Appendix D.

The Construction Environmental Inspection Checklist is to be kept on record by the Lead Contractor and provided to Crown on request.

13.3 Phase Handover

An important element in the successful implementation of the Project is the handover between the Lead Contractor(s) and Crown. The Lead Contractor(s) will contractually be required to prepare a Handover Management Plan (separate to the CEMP). At least two months prior to the completion of the Construction

Phase the appropriate Lead Contractor(s) will liaise with Crown and coordinate at least two meetings to discuss handover. As a minimum, the handover should cover:

- Monitoring data storage and system use.
- Other data storage and system use.
- Stakeholder consultation undertaken.
- Environmental issues observed and management measures undertaken.
- Risk management.
- Rollover of environmental management and monitoring measures.

14.0 MANAGEMENT OBJECTIVES AND KEY PERFORMANCE INDICATORS

The CEMP and OEMP outline the specific environmental management objectives, targets and key performance indicators for the respective environmental aspect (see Sections 9.2 to 9.10). Environmental management objectives are to be based on those developed by Crown as listed in Section 6.0. 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.

15.0 MATERIAL TRACKING

A material tracking system (MTS) shall be prepared and implemented by the Lead Contractor(s) during the Construction Phase as per information contained within the Contaminated Site Management Plan (Golder, 2013d) to document:

- All materials brought onto the site and all stockpiling.
- Placement of all materials (whether clean or unacceptable) on the site.
- Placement and movement of all materials (whether clean or unacceptable) going off-site, including quantities.

For specific MTS requirements, refer to the Contaminated Site Management Plan (Golder, 2013d).

16.0 EMERGENCY RESPONSE PROCEDURE

The Lead Contractor(s) will be responsible for preparing an Emergency Response Standard Operation Procedure (ERSOP) (independent of the CEMP).

The ERSOP will outline emergency and incident response procedures and situations where works should be promptly ceased. The ERSOP will also establish an emergency contact number which can be telephoned 24 hours a day, seven days per week. The ERSOP should also 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 should result in stopping of works/operations.

17.0 ENVIRONMENTAL INCIDENTS MANAGEMENT PROCEDURE

An environmental incident is any of the following:

- A breach or non-conformance of statutory requirements or procedures which have been prescribed in this Project EMP and CEMP/OEMP (Golder, 2013d).
- A failure to meet targets or key performance indicators which have been outlined in the individual management plans.
- A breach or non-conformance of relevant licence conditions.

The relevant regulatory agencies will be notified of any major incidents with actual or potential environmental impacts as soon as practicable after the occurrence of the incident.

Environmental incidents are to be managed in accordance with the contingency procedures outlined in the individual Emergency Response Procedure. However, the following general procedure (illustrated in Figure 13 is to be followed in the event of an environmental incident during the Construction Phase:

1) The Lead Contractor(s)' Construction Manager and Environmental Representative shall be notified immediately upon the occurrence of an environmental incident and they shall immediately notify Crown's Environmental Advisor and Crown's Environmental Advisor.

2) Subject to the nature and extent of the environmental incident, the Lead Contractor(s)' Construction Manager or Environmental Representative in conjunction with Crown's Environmental Advisor shall issue a work order to halt and/or rectify the environmental impact/harm caused as a result of the environmental incident.

3) Within 24 hours of the environmental incident having been reported to the Lead Contractor(s)' Construction Manager and/or Environmental Representative, written notification of the time, date and nature of the environmental incident, plus the corrective action if required, shall be forwarded to Crown's Environmental Advisor, who will inform regulatory agencies where required.

4) The Lead Contractor(s)' Construction Manager in conjunction with Crown's Environmental Advisor shall assess the environmental incident report and shall assess the nature of further corrective action to be taken and shall state 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 by Crown's Environmental Advisor and Crown's Environmental Advisor.

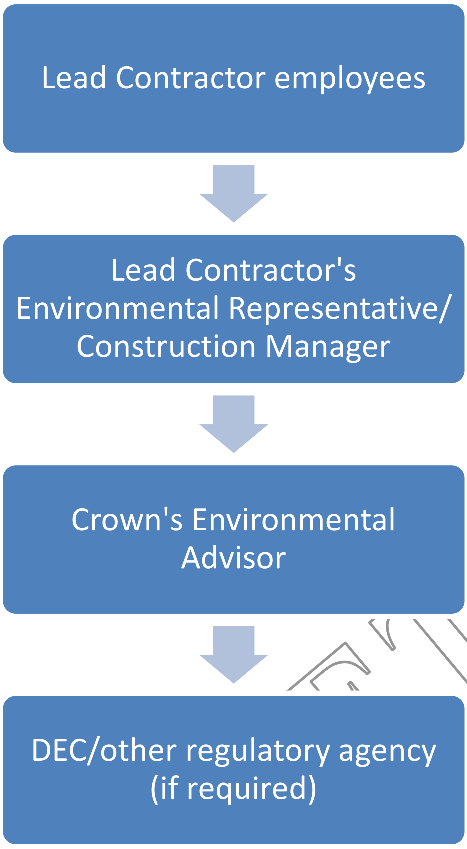

Figure 13: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Construction Phase

It should be stressed that at any point during the development of the site any site personnel have the right to halt work if human health is at risk.

Environmental incidents and complaints are to be recorded in an Environmental Complaint and Incident Register to be kept by the Lead Contractor(s) and Crown's Environmental Advisor and are to be made available to Crown upon request. The register must also be made available to the DEC officers and any other authorised parties to view upon request.

Crown and/or the Lead Contractor(s) if directed by Crown, will notify the relevant regulatory agencies if required by law of any major incidents with actual or potential 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 and mitigation measures in the CEMP/OEMP (Golder, 2013d) and/or the Emergency Response Procedure.

18.0 PUBLIC COMPLAINT MANAGEMENT

All complaints received Crown from the public, in relation to impacted sensitive receptors or the environment will be recorded in the Environmental Complaint and Incident Register which will record the following information:

- **Contact details**: Name, address and phone number of party raising concern.
- **Nature of concern**: Details of issue/incident.
- **Action taken or required**: Details of action proposed or undertaken to address the concern, including time and date.

- **Response to action**: Was the party raising the concern satisfied with the outcome. If not, what else needs to be done, or is it outside the scope of the development works.
- **Prevention of reoccurrence**: If the concern relates directly to an Operations problem, what action has been taken to prevent the problem from reoccurring.

All complaints shall be referred to Crown for the purpose of investigation.

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.

19.0 ENVIRONMENTAL 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.
- Project communication.
- OHS requirements such as the site evacuation procedure.

The Dewatering Management Plan (Golder, 2013i) and Contaminated Sites Management Plan (Golder, 2013d) specify specific training required applicable to identifying acid sulfate soils, managing dewatering and contaminated sites issues.

Prior to the presentation of the induction, Crown will review and approve the content to asses if it meets the requirements of the Project EMP, the Environmental Sub-management Plans and this document, as well as regulatory requirements.

The Lead Contractor(s) shall see that 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.

20.0 REVIEW

The Project EMP, the Environmental Sub-management Plans and the CEMP 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 the Project to assess that the documents 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 or mitigation measures, or monitoring procedures.

- Where unpredicted adverse environmental impact necessitates a change in environmental management or mitigation 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.

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Report Signature Page

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APPENDIX A

Contaminated Site Management Plan

APPENDIX B

Dewatering Management Plan

APPENDIX C

Avian Fauna Survey and Database Search Results

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
CASUARIIFORMES												
Dromaiidae	**Emu**											
Dromaius novaehollandiae	Emu				x	x						
GALLIFORMES												
Megapodiidae	**Megapodes**											
Leipoa ocellata	Malleefowl	VU	S1					x				
Phasianidae	**Pheasants, Fowl & Allies**											
Coturnix pectoralis	Stubble Quail				x	x						
Coturnix ypsilophora	Brown Quail					x						
ANSERIFORMES												
Anatidae	**Ducks, Geese & Swans**											
Anas castanea	Chestnut Teal				x	x						
Anas gracilis	Grey Teal				x	x				x	x	
Anas platyrhynchos	Northern Mallard				x	x			x	x		x
Anas rhynchotis	Australasian Shoveler				x	x				x	x	x
Anas superciliosa	Pacific Black Duck				x	x			x	x	x	x
Aythya australis	Hardhead				x	x			x	x	x	x
Biziura lobata	Musk Duck				x	x			x	x	x	x
Chenonetta jubata	Maned Duck				x	x			x	x		x
Cygnus atratus	Black Swan				x	x			x	x	x	x
Malacorhynchus membranaceus	Pink-eared Duck				x	x				x	x	
Oxyura australis	Blue-billed Duck				x	x			x	x		x
Stictonetta naevosa	Freckled Duck				x	x						
Tadorna tadornoides	Australian Shelduck				x	x				x	x	x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
PODICIPEDIFORMES												
Podicipedidae	**Grebes**											
Podiceps cristatus	Great Crested Grebe				x				x	x	x	x
Poliocephalus poliocephalus	Hoary-headed Grebe				x				x		x	x
Tachybaptus novaehollandiae	Australasian Grebe				x	x			x	x		x
PELECANIFORMES												
Threskiornithidae	**Ibises, Spoonbills**											
Platalea flavipes	Yellow-billed Spoonbill				x	x				x	x	
Platalea regia	Royal Spoonbill					x						
Plegadis falcinellus	Glossy Ibis	Mi	S3			x						
Threskiornis moluccus	Australian White Ibis				x	x			x	x	x	x
Threskiornis spinicollis	Straw-necked Ibis				x	x			x	x	x	
Ardeidae	**Herons, Bitterns**											
Ardea garzetta	Little Egret					x				x	x	
Ardea alba	Great Egret	Mi	S3			x		x		x	x	x
Ardea Ibis	Eastern Cattle Egret	Mi	S3		x	x		x				
Ardea pacifica	White-necked Heron				x	x						
Botaurus poiciloptilus	Australasian Bittern	EN	S1		x			x				
Dupetor flavicollis	Black Bittern			P3	x							
Egretta novaehollandiae	White-faced Heron				x				x	x	x	x
Egretta sacra	Eastern Reef Egret	Mi	S3			x						
Ixobrychus dubius	Black-backed Bittern			P4	x	x						x
Nycticorax caledonicus	Nankeen Night Heron				x	x				x		x
Pelecanidae	**Pelicans**											

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Pelecanus conspicillatus	Australian Pelican				x	x			x	x	x	x
SULIFORMES												
Phalacrocoracidae	**Cormorants, shags**											
Microcarbo melanoleucos	Little Pied Cormorant					x			x		x	x
Phalacrocorax carbo	Great Cormorant				x	x				x	x	x
Phalacrocorax fascescens	Black-faced Cormorant					x						
Phalacrocorax sulcirostris	Little Black Cormorant				x					x	x	x
Phalacrocorax varius	Australian Pied Cormorant				x	x				x	x	
Anhingidae	**Anhingas, darters**											
Anhinga novaehollandiae	Australasian Darter					x			x	x	x	x
ACCIPITRIFORMES												
Pandionidae	**Ospreys**											
Pandion cristatus	Eastern Osprey				x	x				x		
Accipitridae	**Kites, Hawks & Eagles**											
Accipiter cirrocephalus	Collared Sparrowhawk				x	x						
Accipiter fasciatus	Brown Goshawk				x	x						
Aquila audax	Wedge-tailed Eagle					x						
Circus approximans	Swamp Harrier				x	x						
Circus assimilis	Spotted Harrier					x						
Elanoides axillaris	Black-shouldered Kite				x	x				x		
Haliaeetus leucogaster	White-bellied Sea Eagle	Mi	S3			x		x		x		
Haliastur sphenurus	Whistling Kite				x	x						
Hieraaetus morphnoides	Little Eagle				x	x				x		
Lophoictinia isura	Square-tailed Kite				x	x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
FALCONIFORMES												
Falconidae	**Caracaras, Falcons**											
Falco berigora	Brown Falcon				x	x						
Falco cenchroides	Nankeen Kestrel				x	x				x		
Falco hypoleucos	Grey Falcon		S1	VU	x							
Falco longipennis	Australian Hobby				x	x				x		x
Falco peregrinus	Peregrine Falcon		S4		x	x				x		
OTIDIFORMES												
Otididae	**Bustards**											
Ardeotis australis	Australian Bustard			P4	x							
GRUIFORMES												
Rallidae	**Rails, Crakes & Coots**											
Fulica atra	Eurasian Coot				x	x			x	x		x
Gallinula tenebrosa	Dusky Moorhen				x	x			x	x		x
Gallirallus philippensis	Buff-banded Rail				x	x				x		
Porphyrio porphyrio	Purple Swamphen				x				x	x		x
Porzana fluminea	Australian Crake				x	x						
Porzana pusilla	Baillon's Crake				x	x						
Porzana tabuensis	Spotless Crake				x	x				x		
Tribonyx ventralis	Black-tailed Native-hen				x	x				x		x
CHARADRIIFORMES												
Turnicidae	**Buttonquail**											
Turnix varius	Painted Buttonquail				x	x						
Turnix velox	Little Buttonquail					x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Burhinidae	**Stone-curlews**											
Burhinus grallarius	Bush Stone-curlew				x							
Haematopodidae	**Oystercatchers**											
Haematopus fuliginosus	Sooty Oystercatcher					x						
Haematopus longirostris	Pied Oystercatcher				x	x						
Recurvirostridae	**Stilts, Avocets**											
Cladorhynchus leucocephalus	Banded Stilt				x	x						
Himantopus leucocephalus	White-headed Stilt				x	x		x		x		
Recurvirostra novaehollandiae	Red-necked Avocet					x		x		x		
Charadriidae	**Plovers**											
Charadrius bicinctus	Double-banded Plover	Mi	S3					x				
Charadrius dubius	Little Ringed Plover	Mi	S3			x						
Charadrius leschenaultii	Greater Sand Plover	Mi	S1; S3	VU		x		x			x	
Charadrius mongolus	Lesser Sand Plover	Mi	S1; S3	VU		x		x			x	
Charadrius ruficapillus	Red-capped Plover				x	x		x		x	x	
Elseyornis melanops	Black-fronted Dotterel					x				x	x	
Erythrogonys cinctus	Red-kneed Dotterel				x	x						
Pluvialis fulva	Pacific Golden Plover	Mi	S3					x			x	
Pluvialis squatarola	Grey Plover	Mi	S3		x	x		x			x	
Thinornis rubricollis	Hooded Dotterel			P4		x					x	
Vanellus tricolor	Banded Lapwing					x						
Rostratulidae	**Painted Snipes**											
Rostratula australis	Australian Painted Snipe	VU	S1	EN		x		x				
Scolopacidae	**Sandpipers, Snipes**											

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Actitis hypoleucos	Common Sandpiper	Mi	S3		x	x		x		x	x	
Arenaria interpres	Ruddy Turnstone	Mi	S3			x		x			x	
Calidris acuminata	Sharp-tailed Sandpiper	Mi	S3		x	x		x		x	x	
Calidris alba	Sanderling	Mi	S3			x		x				
Calidris canutus	Red Knot	Mi	S1; S3	VU		x		x			x	
Calidris ferruginea	Curlew Sandpiper	Mi	S1; S3	VU	x	x		x			x	
Calidris melanotos	Pectoral Sandpiper	Mi	S3					x			x	
Calidris ruficollis	Red-necked Stint	Mi	S3		x	x		x		x	x	
Calidris tenuirostris	Great Knot	Mi	S1; S3	VU		x		x			x	
Limicola falcinellus	Broad-billed Sandpiper	Mi	S3								x	
Limosa lapponica	Bar-tailed Godwit	Mi	S1; S3	VU		x		x			x	
Limosa limosa	Black-tailed Godwit	Mi	S3			x		x			x	
Numenius arquata	Eurasian Curlew	Mi	S1; S3	VU	x							
Numenius minutus	Little Curlew	Mi	S3			x						
Numenius phaeopus	Whimbrel	Mi	S3			x		x			x	
Phalaropus lobatus	Red-necked Phalarope	Mi	S3					x				
Philomachus pugnax	Ruff	Mi	S3			x						
Tringa brevipes	Grey-tailed Tattler	Mi	S3			x		x			x	
Tringa glareola	Wood Sandpiper	Mi	S3			x						
Tringa nebularia	Common Greenshank	Mi	S3		x	x		x		x	x	
Tringa stagnatilis	Marsh Sandpiper	Mi	S3			x		x			x	
Tringa totanus	Common Redshank	Mi	S3					x				
Xenus cinereus	Terek Sandpiper	Mi	S3			x		x			x	
Phalaropus lobatus	Red-necked Phalarope	Mi	S3					x				

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Laridae	**Gulls, Terns & Skimmers**											
Chlidonias hybrida	Whiskered Tern					x						
Chroicocephalus novaehollandiae	Silver Gull				x	x			x	x	x	x
Gelochelidon nilotica	Gull-billed Tern					x						
Hydroprogne caspia	Caspian Tern	Mi	S3			x				x	x	x
Larus pacificus	Pacific Gull					x						
Onychoprion anaethetus	Bridled Tern	Mi	S3			x						
Sterna dougallii	Roseate Tern					x						
Sterna paradisaea	Arctic Tern					x						
Sternula nereis	Fairy Tern	VU			x	x		x			x	
Thalasseus bergii	Greater Crested Tern				x	x				x	x	
COLUMBIFORMES												
Columbidae	**Pigeons, Doves**											
Columba livia	Rock Dove				x	x			x	x		
Ocyphaps lophotes	Crested Pigeon					x						
Phaps chalcoptera	Common Bronzewing				x	x						
Spilopelia senegalensis	Laughing Dove				x	x			x	x		x
Streptopelia chinensis	Spotted Dove				x	x				x		x
PSITTACIFORMES												
Cacatuidae	**Cockatoos**											
Cacatua galerita	Sulfur-crested Cockatoo					x						
Cacatua pastinator	Western Corella				x	x						
Cacatua sanguinea	Little Corella				x	x			x	x		x
Cacatua tenuirostris	Long-billed Corella					x				x		

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S1		x	x		x		x		x
Calyptorhynchus baudinii	Baudin's Black Cockatoo	VU	S1		x	x						
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	EN	S1		x	x		x		x		
Eolophus roseicapilla	Galah					x				x		
Lophochroa leadbeateri	Major Mitchell's Cockatoo		S4		x							
Nymphicus hollandicus	Cockatiel				x	x						
Psittacidae	**Parrots**											
Barnardius zonarius	Australian Ringneck				x	x				x		
Glossopsitta porphyrocephala	Purple-crowned Lorikeet				x	x						
Melopsittacus undulatus	Budgerigar				x							
Neophema elegans	Elegant Parrot				x	x						
Platycercus icterotis	Western Rosella					x						
Polytelis anthopeplus	Regent Parrot				x	x						
Purpureicephalus spurius	Red-capped Parrot				x	x						
Trichoglossus moluccanus	Rainbow Lorikeet				x	x				x		x
CUCULIFORMES												
Cuculidae	**Cuckoos**											
Cacomantis flabelliformis	Fan-tailed Cuckoo					x						
Cacomantis pallidus	Pallid Cuckoo					x						
Chrysococcyx basalis	Horsfield's Bronze Cuckoo					x						
Chrysococcyx lucidus	Shining Bronze Cuckoo					x						
STRIGIFORMES												
Tyto delicatula	Eastern Barn Owl				x	x						
Tyto novaehollandiae	Australian Masked Owl			P3	x							

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Strigidae	**Owls**											
Ninox boobook	Southern Boobook				x	x				x		
Ninox connivens	Barking Owl					x						
CAPRIMULGIFORMES												
Podargidae	**Frogmouths**											
Podargus strigoides	Tawny Frogmouth					x						
Caprimulgidae	**Nightjars**											
Eurostopodus argus	Spotted Nightjar				x					x		
APODIFORMES												
Apodidae	**Swifts**											
Apus pacificus	Pacific Swift	Mi	S3		x	x		x				
CORACIIFORMES												
Alcedinidae	**Kingfishers**											
Dacelo novaeguineae	Laughing Kookaburra				x	x				x		
Todiramphus sanctus	Sacred Kingfisher				x	x						
Meropidae	**Bee-eaters**											
Merops ornatus	Rainbow Bee-eater	Mi	S3		x	x		x		x		
PASSERIFORMES												
Climacteridae	**Australasian Treecreepers**											
Climacteris rufus	Rufous Treecreeper					x						
Maluridae	**Australasian Wrens**											
Malurus elegans	Red-winged Fairywren					x						
Malurus lamberti	Variegated Fairywren				x	x						
Malurus leucopterus	White-winged Fairywren					x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Malurus pulcherrimus	Blue-breasted Fairywren					x						
Malurus splendens	Splendid Fairywren				x	x						
Stipiturus malachurus	Southern Emu-wren					x						
Meliphagidae	**Honeyeaters**											
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					x						
Acanthorhynchus superciliosus	Western Spinebill				x	x						
Anthochaera carunculata	Red Wattlebird				x	x			x			
Anthochaera lunulata	Western Wattlebird				x	x						
Epthianura albifrons	White-fronted Chat				x	x						
Epthianura tricolor	Crimson Chat					x						
Gliciphila melanops	Tawny-crowned Honeyeater				x	x						
Lichenostomus leucotis	White-eared Honeyeater					x						
Lichenostomus ornatus	Yellow-plumed Honeyeater				x	x						
Lichenostomus virescens	Singing Honeyeater				x	x			x			x
Lichmera indistincta	Brown Honeyeater				x	x			x			x
Manorina flavigula	Yellow-throated Miner				x	x						
Melithreptus brevirostris	Brown-headed Honeyeater				x	x						
Melithreptus lunatus	White-naped Honeyeater				x	x						
Phylidonyris niger	White-cheeked Honeyeater				x	x						
Phylidonyris novaehollandiae	New Holland Honeyeater				x	x						x
Purnella albifrons	White-fronted Honeyeater					x						
Pardalotidae	**Pardalotes**											
Pardalotus punctatus	Spotted Pardalote				x	x						
Pardalotus striatus	Striated Pardalote				x	x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Acanthizidae	**Australasian Warblers**											
Acanthiza apicalis	Inland Thornbill				x	x						
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				x	x						
Acanthiza inornata	Western Thornbill				x	x						
Calamanthus campestris	Rufous Fieldwren			P4		x						
Gerygone fusca	Western Gerygone				x	x						
Sericornis frontalis	White-browed Scrubwren					x						
Smicrornis brevirostris	Weebill				x	x						
Cracticidae	**Butcherbirds and Allies**											
Cracticus nigrogularis	Pied Butcherbird				x	x						
Cracticus torquatus	Grey Butcherbird				x	x						
Gymnorhina tibicen	Australian Magpie				x	x			x			x
Strepera versicolor	Grey Currawong				x	x						
Artamidae	**Woodswallows**											
Artamus cinereus	Black-faced Woodswallow				x							
Artamus cyanopterus	Dusky Woodswallow					x						
Artamus personatus	Masked Woodswallow				x							
Campephagidae	**Cuckooshrikes**											
Coracina maxima	Ground Cuckoo-shrike				x							
Coracina novaehollandiae	Black-faced Cuckooshrike				x	x						x
Lalage tricolor	White-winged Triller				x							
Neosittidae	**Sittellas**											
Daphoenositta chrysoptera	Varied Sittella				x	x						
Pachycephalidae	**Whistlers and Allies**											

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Colluricincla harmonica	Grey Shrikethrush				x							
Pachycephala pectoralis	Australian Golden Whistler				x							
Pachycephala rufiventris	Rufous Whistler				x							
Rhipiduridae	**Fantails**											
Rhipidura albiscapa	Grey Fantail				x	x						
Rhipidura leucophrys	Willie Wagtail				x	x			x			x
Monarchidae	**Monarchs**											
Grallina cyanoleuca	Magpie-lark				x	x			x			x
Myiagra inquieta	Restless Flycatcher					x						
Corvidae	**Crows, Jays**											
Corvus bennetti	Little Crow				x	x						
Corvus coronoides	Australian Raven				x	x			x			x
Petroicidae	**Australasian Robins**											
Eopsaltria georgiana	White-breasted Robin					x						
Eopsaltria griseogularis	Western Yellow Robin				x	x						
Melanodryas cucullata	Hooded Robin				x	x						
Microeca fascinans	Jacky Winter					x						
Petroica boodang	Scarlet Robin				x	x						
Petroica goodenovii	Red-capped Robin					x						
Hirundinidae	**Swallows, Martins**											
Cheramoeca leucosterna	White-backed Swallow					x						
Hirundo neoxena	Welcome Swallow				x	x			x			x
Petrochelidon ariel	Fairy Martin					x						
Petrochelidon nigricans	Tree Martin				x	x						x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Acrocephalidae	**Reed Warblers and Allies**											
Acrocephalus australis	Australian Reed Warbler				x	x			x	x		x
Locustellidae	**Grassbirds and allies**											
Cincloramphus cruralis	Brown Songlark					x						
Cincloramphus mathewsi	Rufous Songlark				x	x						
Megalurus gramineus	Little Grassbird				x	x			x	x		x
Zosteropidae	**White-eyes**											
Zosterops lateralis	Silvereye				x	x			x			
Dicaeidae	**Flowerpeckers**											
Dicaeum hirundinaceum	Mistletoebird				x	x						
Estrildidae	**Waxbills, Munias & Allies**											
Lonchura castaneothorax	Chestnut-breasted Mannikin					x						
Stagonopleura oculata	Red-eared Firetail					x						
Motacillidae	**Wagtails, Pipits**											
Anthus australis	Australian Pipit					x			x			

APPENDIX D

Construction Daily Inspection Checklist

APPENDIX E

Guideline Trigger Levels for Surface Water Monitoring

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Field Parameters	Oxidation Reduction Potential	mV	-						
	Temperature	°C	-						
	pH		-			6.5-8.5	8-8.4		6-9.0
	Conductivity	ms/cm	-						
	Dissolved oxygen	mg/L	-		90-110 (% saturation)				
Sample Quality Parameters	pH (Lab)	pH_Units	0.1	7.5-8.5	7.5-8.5	6.5-8.5	8-8.4		6-9.0
	Sodium (Filtered)	mg/L	0.5						
	Potassium (Filtered)	mg/L	0.1						
	Calcium (Filtered)	mg/L	0.2						
	Magnesium (Filtered)	mg/L	0.1						
	Chloride	mg/L	1					2500	
	Sulfate (as SO4)	mg/L	1					5000	
	Sulfate (as SO3)	mg/L	1						
	Bicarbonate Alkalinity as (HCO3)	mg/L	5						
	Carbonate Alkalinity (as CO3)	mg/L	1						
	Total Alkalinity (as CaCO3)	mg/L	5						
	Hardness (as CaCO3) (Filtered)	mg/L	5						
	Sum of Ions	mg/L	10						
	TFSS	mg/L	10						
	Anion-Cation Balance	%	-100						

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Heavy Metals	Arsenic	mg/L	0.001					0.07	0.1
	Arsenic (Filtered)	mg/L	0.001					0.07	0.1
	Boron	mg/L	0.005			0.37		40	0.5
	Boron (Filtered)	mg/L	0.005			0.37		40	0.5
	Cadmium	mg/L	0.0001			0.0002	0.0007	0.02	0.01
	Cadmium (Filtered)	mg/L	0.0001			0.0002	0.0007	0.02	0.01
	Chromium	mg/L	0.001				0.027(4)		0.1
	Chromium (Filtered)	mg/L	0.001				0.027(4)		0.1
	Copper	mg/L	0.001			0.0014	0.0013	20	0.2
	Copper (Filtered)	mg/L	0.001			0.0014	0.0013	20	0.2
	Lead	mg/L	0.001			0.0034	0.0044	0.1	2
	Lead (Filtered)	mg/L	0.001			0.0034	0.0044	0.1	2
	Manganese	mg/L	0.001			1.9		5	0.2
	Manganese (Filtered)	mg/L	0.001			1.9		5	0.2
	Mercury (filtered)	mg/L	0.00005			0.00006	0.0001	0.01	0.002
	Mercury	mg/L	0.0001			0.00006	0.0001	0.01	0.002
	Molybdenum	mg/L	0.001					0.5	0.01
	Molybdenum (Filtered)	mg/L	0.001					0.5	0.01
	Nickel	mg/L	0.001			0.011	0.007	0.2	0.2
	Nickel (Filtered)	mg/L	0.001			0.011	0.007	0.2	0.2
	Selenium	mg/L	0.002			0.005		0.1	0.02
	Selenium (Filtered)	mg/L	0.002			0.005		0.1	0.02
	Tin	mg/L	0.001						
	Tin (Filtered)	mg/L	0.001						
	Zinc	mg/L	0.001			0.008	0.015	30	2
	Zinc (Filtered)	mg/L	0.001			0.008	0.015	30	2

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Organochlorine Pesticides	a-BHC	mg/L	0.00005						
	Aldrin	mg/L	0.00001						
	Aldrin & Dieldrin (Sum of total)	mg/L						0.003	
	b-BHC	mg/L	0.00005						
	cis-Chlordane	mg/L	0.000002						
	gamma-Chlordane	mg/L	0.000002						
	d-BHC	mg/L	0.00005						
	DDD (1)	mg/L	0.00001						
	DDE (2)	mg/L	0.00001						
	DDT (3)	mg/L	0.000002			0.000006		0.2	
	DDT+DDE+DDD (Sum of total)	mg/L							
	Dieldrin	mg/L	0.000002						
	Endosulfan I	mg/L	0.000005						
	Endosulfan II	mg/L	0.000005						
	Endosulfan sulfate	mg/L	0.000005						
	Endrin	mg/L	0.000004			0.00001	0.000004		
	Endrin ketone	mg/L	0.00005						
	g-BHC	mg/L	0.00005					0.2	
	Heptachlor	mg/L	0.00001			0.00001			
	Heptachlor & heptachlor epoxide (Sum of total)	mg/l						0.003	

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Heptachlor epoxide	mg/L	0.00002						
	Methoxychlor	mg/L	0.0001						
	Hexachlorobenzene	mg/L	0.00001						
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005						
	Bromophos-ethyl	mg/L	0.00005						
	Chlorpyriphos	mg/L	0.000009			0.00001	0.000009	0.01	
	Diazinon	mg/L	0.00001			0.00001		0.001	
	Dichlorvos	mg/L	0.0005						
	Ethion	mg/L	0.00005						
	Fenitrothion	mg/L	0.0002			0.0002		0.01	
	Malathion	mg/L	0.00005			0.00005			
	Methidathion	mg/L	0.00005						
	Parathion	mg/L	0.000004			0.000004		0.01	
PCBs	PCB 101	mg/L	0.0001						
	PCB 138	mg/L	0.0001						
	PCB 153	mg/L	0.0001						
	PCB 28	mg/L	0.0001						
	PCB 52	mg/L	0.0001						
	PCB 118	mg/L	0.0001						
	PCB 180	mg/L	0.0001						
Total Recoverable Hydrocarbons	TRH C_{10}-C_{14} Fraction	mg/L	0.05						
	TRH C_{15}-C_{28} Fraction	mg/L	0.2						
	TRH C_{29}-C_{36} Fraction	mg/L	0.2						
	TRH >C_{10}-C_{16} F2	mg/L	0.06						
	TRH >C_{16}-C_{34} F3	mg/L	0.5						
	TRH >C_{34}-C_{40} F4	mg/L	0.5						

APPENDIX F

Guideline Trigger Levels for Groundwater Monitoring

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Sample Quality Parameters	pH (Lab)	pH Units	0.01	6.0-8.5	7.5-8.5	6.5-8.5	8.0-8.4		6.5-8.5		6-8.5
	Total Dissolved Solids @180°C	mg/L	10								
	Sodium (Filtered)	mg/L	0.5								
	Potassium (Filtered)	mg/L	0.1								
	Calcium (Filtered)	mg/L	0.2								
	Magnesium (Filtered)	mg/L	0.1								
	Chloride	mg/L	1					2500	250		
	Sulfate (as SO4)	mg/L	1					5000	250	500	
	Sulfide	mg/L	0.1								
	Bicarbonate Alkalinity as (HCO3)	mg/L	5								
	Carbonate Alkalinity (as CO3)	mg/L	1								
	Total Alkalinity (as CaCO3)	mg/L	1								
	Hardness (as CaCO3) (Filtered)	mg/L	5						200		

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Nitrate (as NO3-)	mg/L	0.05			0.7		500		50	-
	Nitrite (as NO2-)	mg/L	0.05					30		3	-
	Nitrogen (Total Oxidised)	mg/L	0.005		0.045						-
	Ammonia	mg/L	0.005		0.049	0.9	0.91	5	0.5		-
	Total Kjeldahl Nitrogen (as N)	mg/L	0.05								-
	Nitrogen (Inorganic)	mg/L	0.05								-
	Nitrogen (Total)	mg/L	0.05	>1.0	0.75						5
	Cyanide (total)	mg/L	0.004			0.007	0.004	0.8		0.08	-
	Reactive Phosphorus (as P)	mg/L	0.002		0.005						-
	Phosphorus	mg/L	0.01	>0.1	0.03	0.2					0.05
	Ionic Balance	%	-100								
	Sum of Ions (calc.)	mg/L	10								
	Thiocyanate	mg/L	0.1								
	Methane	mg/L	0.005								
Microbiologic	Coliform	cfu/100	1								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
al		ml									
	E. coli	cfu/100 ml	1								10(1)
Heavy Metals	Arsenic (Filtered)	mg/L	0.001					0.07		0.007	0.1
	Boron (Filtered)	mg/L	0.005			0.37		40		4	0.5
	Cadmium (Filtered)	mg/L	0.0001			0.0002	0.0055	0.02		0.002	0.01
	Chromium (Filtered)	mg/L	0.001								0.1
	Copper (Filtered)	mg/L	0.001			0.0014	0.0013	20	1	2	0.2
	Lead (Filtered)	mg/L	0.001			0.0034	0.0044	0.1		0.01	2
	Manganese (Filtered)	mg/L	0.001			1.9		5	0.1	0.5	0.2
	Mercury	mg/L	0.00005			0.00006	0.0001	0.01		0.001	0.002
	Molybdenum (Filtered)	mg/L	0.001					0.5		0.05	0.01
	Nickel (Filtered)	mg/L	0.001			0.011	0.07	0.2		0.02	0.2
	Selenium (Filtered)	mg/L	0.002			0.005		0.1		0.01	0.02
	Tin (Filtered)	mg/L	0.001								-
	Zinc (Filtered)	mg/L	0.001			0.008	0.015	30	3		2
MAH	1,2,4-	mg/L	0.0005								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	trimethylbenzene										
	1,3,5-Trimethylbenzene	mg/L	0.0005								-
	Benzene	mg/L	0.0005			0.95	0.5	0.01		0.001	-
	Ethylbenzene	mg/L	0.0005					0.003	0.003	0.3	-
	Isopropylbenzene	mg/L	0.0005								-
	n-Butylbenzene	mg/L	0.0005								-
	n-Propylbenzene	mg/L	0.0005								-
	p-Isopropyltoluene	mg/L	0.0005								-
	sec-Butylbenzene	mg/L	0.0005								-
	Styrene	mg/L	0.0005					0.004	0.004	0.03	-
	tert-Butylbenzene	mg/L	0.0005								-
	Toluene	mg/L	0.0005					0.025	0.025	0.8	-
	Xylenes (m & p)	mg/L	0.001			0.2 (2)		0.02	0.02	0.6	-
	Xylene (o)	mg/L	0.0005			0.35		0.02	0.02	0.6	-
Organochlorine Pesticides	a-BHC	mg/L	0.00001								-
	Aldrin	mg/L	0.00001								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Aldrin & Dieldrin (Sum of total)	mg/L						0.003	0.0003	0.00001	-
	b-BHC	mg/L	0.00001								-
	Chlordane (Sum of total)	mg/L	0.00001			0.00003		0.01	0.001	0.00001	-
	cis-Chlordane	mg/L	0.000002								-
	gamma-Chlordane	mg/L	0.000002								-
	trans-Chlordane	mg/L	0.00001								-
	d-BHC	mg/L	0.00001								-
	DDD	mg/L	0.00001								-
	DDE	mg/L	0.00001								-
	DDT	mg/L	0.000002			0.00001		0.2	0.02	0.00006	-
	DDT+DDE+DDD (Sum of total)	mg/L	0.00001								-
	Dieldrin	mg/L	0.000002								-
	Endosulfan I	mg/L	0.000005								-
	Endosulfan II	mg/L	0.000005								-
	Endosulfan sulfate	mg/L	0.000005								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Endrin	mg/L	0.000004			0.00001	***0.000004***				-
	Endrin ketone	mg/L	0.00001								-
	g-BHC	mg/L	0.00001			0.0002		0.2	0.02	0.00005	-
	Heptachlor	mg/L	0.000005			0.00001					-
	Heptachlor & heptachlor epoxide (Sum of total)	mg/l						0.003	0.0003	0.00005	-
	Heptachlor epoxide	mg/L	0.00001								-
	Methoxychlor	mg/L	0.00001								-
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005			0.00002					-
	Bromophos-ethyl	mg/L	0.00005								-
	Chlorpyriphos	mg/L	0.000009			0.00001	0.000009	0.01	0.01		-
	Diazinon	mg/L	0.00001			0.00001		0.001	0.003	0.001	-
	Dichlorvos	mg/L	0.0001								-
	Ethion	mg/L	0.00005								-
	Fenitrothion	mg/L	0.0002			0.0002		0.01	0.01		-
	Malathion	mg/L	0.00005			0.00005					-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Methidathion	mg/L	0.00005								-
	Parathion	mg/L	0.000004			0.000004		0.01	0.01		-
Pesticides - Others	Carbaryl	mg/L	0.0005								-
Herbicides	Carbofuran	mg/L	0.0005			0.00006		0.005	0.01	0.005	-
	Atrazine	mg/L	0.0005			0.013		0.0001	0.04	0.0001	-
	Cyanazine	mg/L	0.0005								-
	Hexazinone	mg/L	0.001								-
	Metribuzin	mg/L	0.0005								-
	Prometryn	mg/L	0.0005								-
	Propazine	mg/L	0.0005								-
	Simazine	mg/L	0.0005			0.0032		0.0005	0.02	0.0005	-
	Terbutryn	mg/L	0.0005								-
	Terbutylazine	mg/L	0.0005								-
Polychlorinated Biphenyls	PCB 101	mg/L	0.0001								-
	PCB 138	mg/L	0.0001								-
	PCB 153	mg/L	0.0001								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	PCB 28	mg/L	0.0001								-
	PCB 52	mg/L	0.0001								-
	PCB 118	mg/L	0.0001								-
	PCB 180	mg/L	0.0001								-
PAH	Acenaphthene	mg/L	0.00001								-
PAH	Acenaphthylene	mg/L	0.00001								-
PAH	Anthracene	mg/L	0.00001								-
PAH	Benz(a)anthracene	mg/L	0.00001								-
PAH	Benzo(a)pyrene	mg/L	0.00001					0.0001		0.00001	-
PAH	Benzo(b)&(k)fluoranthene	mg/L	0.00002								-
PAH	Benzo(g,h,i)perylene	mg/L	0.00001								-
PAH	Chrysene	mg/L	0.00001								-
PAH	Dibenz(a,h)anthracene	mg/L	0.00001								-
PAH	Fluoranthene	mg/L	0.00001								-
PAH	Fluorene	mg/L	0.00001								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Indeno(1,2,3-c,d)pyrene	mg/L	0.00001								-
	Naphthalene	mg/L	0.00002			0.016	0.05				-
	Phenanthrene	mg/L	0.00001								-
	Pyrene	mg/L	0.00001								-
PAH - Others	1-Methylnaphthalene	mg/L	0.00001								
	2-Methylnaphthalene	mg/L	0.00001								
Halogenated Benzenes	1,2,3-Trichlorobenzene	mg/L	0.0005			0.003		0.005	0.005	0.003	-
	1,2,4-Trichlorobenzene	mg/L	0.0005			0.085	0.02	0.005	0.005	0.003	-
	1,2-Dichlorobenzene	mg/L	0.0005			0.16		0.001	0.001	1.5	-
	1,3-Dichlorobenzene	mg/L	0.0005			0.26		0.02	0.02		-
	1,4-Dichlorobenzene	mg/L	0.0003			0.06		0.003	0.003	0.04	-
	2-Chlorotoluene	mg/L	0.0005								-
	4-Chlorotoluene	mg/L	0.0005								-
	Bromobenzene	mg/L	0.0005								-
	Chlorobenzene	mg/L	0.0005					0.01	0.01	0.3	-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Hexachlorobenzene	mg/L	0.00001								-
Phenolics	2,4-Dimethylphenol	mg/L	0.0001								-
	2,4-Dinitrophenol	mg/L	0.0001								-
	2-Methylphenol	mg/L	0.0001								-
	2-Nitrophenol	mg/L	0.00005								-
	3- & 4- Methylphenol	mg/L	0.0002								-
	3,4-Dimethylphenol	mg/L	0.0002								-
	4-Nitrophenol	mg/L	0.00005								-
	Phenol	mg/L	0.0001			0.32	0.4				-
Phenolics-Halogenated	2,3,4,6-Tetrachlorophenol	mg/L	0.00001			0.01					-
	2,3,5,6-Tetrachlorophenol	mg/L	0.00001								-
	2,4,5-Trichlorophenol	mg/L	0.00001								-
	2,4,6-Trichlorophenol	mg/L	0.00001			0.003		0.2	0.002	0.02	-
	2,4-Dichlorophenol	mg/L	0.00001			0.12		2	0.0003	0.2	-
	2,6-Dichlorophenol	mg/L	0.00001								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	2,3,4,6 & 2,3,5,6-Tetrachlorophenol	mg/L	0.00002								-
	2-Chlorophenol	mg/L	0.0001			0.34		3	0.0001	0.3	-
	Pentachlorophenol	mg/L	0.00001			0.0036	0.011				-
Solvents	Methyl Ethyl Ketone	mg/L	0.01								-
	2-Hexanone	mg/L	0.005								-
	4-Methyl-2-pentanone	mg/L	0.005								-
	Acetone	mg/L	0.01								-
	Acrylonitrile	mg/L	0.0005								-
	Methyl-t-butyl ether	mg/L	0.0005					0.012	0.012		-
	Vinyl acetate	mg/L	0.01								-
Total Recoverable Hydrocarbons	TRH C_6-C_9 Fraction	mg/L	0.02								-
	TRH C_{10}-C_{14}	mg/L	0.05								-
	TRH C_{15}-C_{28}	mg/L	0.1								-
	TRH C_{29}-C_{36}	mg/L	0.05								-
	TRH C_6-C_{10} minus BTEX (F1)	mg/L	0.02								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	TRH >C_{10}-C_{16} F2	mg/L	0.06								-
	TRH >C_{16}-C_{34} F3	mg/L	0.5								-
	TRH >C_{34}-C_{40} F4	mg/L	0.5								-
Total Petroleum Hydrocarbons	TPH >C_{16}-C_{28} Aliphatic	ug/L	250								-
	TPH >C_{16}-C_{28} Aromatic	ug/L	250								-
	TPH >C_{16}-C_{35} Aliphatic (Sum)	ug/L	500								-
	TPH >C_{28}-C_{35} Aliphatic	ug/L	250								-
	TPH >C_{28}-C_{35} Aromatic	ug/L	250								-
	TPH >C_{9}-C_{16} Aliphatic	ug/L	150								-
	TPH >C_{9}-C_{16} Aromatic	ug/L	150								-
	Aliphatic Hydrocarbons>C_{35}-C_{40}	mg/L	0.5								-
	TPH C_{16}-C_{35} Aromatic	mg/L	0.5								-
Volatile Organic Compounds	1,1,1,2-Tetrachloroethane	mg/L	0.0005								-
	1,1,2,2-	mg/L	0.0005								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Tetrachloroethane										
	1,1,1-Trichloroethane	mg/L	0.0005								-
	1,1,2-Trichloroethane	mg/L	0.0005			6.5	1.9				-
	1,2,3-Trichloropropane	mg/L	0.0005								-
	1,2-Dibromo-3-chloropropane	mg/L	0.0005								-
	1,2-Dibromoethane	mg/L	0.0005								-
	1,1-Dichloroethane	mg/L	0.0005								-
	1,2-Dichloroethane	mg/L	0.0005					0.03		0.003	-
	1,1-Dichloroethene	mg/L	0.0005					0.3		0.03	-
	cis-1,2-Dichloroethene	mg/L	0.0005								-
	trans-1,2-dichloroethene	mg/L	0.0005								-
	1,2-Dichloropropane	mg/L	0.0005								-
	1,3-Dichloropropane	mg/L	0.0005								-
	2,2-Dichloropropane	mg/L	0.0005								-
	1,1-Dichloropropene	mg/L	0.0005								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	cis-1,3-Dichloropropene	mg/L	0.0005								-
	trans-1,3-dichloropropene	mg/L	0.0005								-
	cis-1,4-Dichloro-2-butene	mg/L	0.001								-
	trans-1,4-Dichloro-2-butene	mg/L	0.001								-
	Allyl chloride	mg/L	0.0005								-
	Bromochloromethane	mg/L	0.0005								-
	Bromodichloromethane	mg/L	0.0005								-
	Bromoform	ug/L	0.5								-
	Bromomethane	mg/L	0.01								-
	Carbon disulfide	mg/L	0.0005								-
	Carbon tetrachloride	mg/L	0.0005					0.03		0.003	-
	Chlorodibromomethane	mg/L	0.0005								-
	Chloroethane	mg/L	0.005								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Chloroform	mg/L	0.0005								-
	Chloromethane	mg/L	0.005								-
	Dibromomethane	ug/L	0.5								-
	Dichlorodifluoromethane	mg/L	0.005								-
	Dichloromethane	mg/L	0.005					0.04		0.004	-
	Hexachlorobutadiene	mg/L	0.001					0.007		0.0007	-
	Iodomethane	mg/L	0.005								-
	Trichloroethene	mg/L	0.0005								-
	Tetrachloroethene	mg/L	0.0005					0.5		0.05	-
	Trichlorofluoromethane	mg/L	0.001								-
	Vinyl chloride	mg/L	0.0003					0.003		0.0003	-

APPENDIX G

Project Glossary and Definition

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
DMAs	Decision Making Authorities
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	Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPP	Environmental Protection Policy
Golder	Golder Associates
IF	Influencing Factor
KPF	Kings Park Formation
Lead Contractor	Contractor engaged to undertake Construction Phase works
MP	Management Plan
NEPM	National Environmental Protection Measure
NPI	National Pollutant Inventory
OEMF	Operations Environmental Management Framework
OEMP	Operations Environmental Management Plan
OEPA	Office of the Environmental Protection Authority
OHS	Occupational Health and Safety
Operations Phase	The phase of the Project during which operations will be undertaken
PER	Public Environmental Review
PM_{10}	Particulate Matter 10 µm
$PM_{2.5}$	Particulate Matter 2.5 µm
ppm	Parts per million
Project	The Crown Towers Project

Term	Definition
Project EMP	Crown Towers Environmental Management Plan
PSI	Preliminary Site Investigation
RFP	Request for Proposal
RL	Reduced Levels
SCD	Sandy Channel Deposit
SEWPAC	Department of Sustainability, Environment, Water, Populations and Communities
SRA	Swan River Alluvium
SRT	Swan River Trust
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.

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APPENDIX B

Indicative Operations Environmental Management Plan

February 2013

CROWN PERTH

Crown Towers Indicative Operations Environmental Management Plan

Submitted to:
James Noel
Crown Perth
PO Box 500
VICTORIA PARK WA 6979

REPORT

Report Number. 127643111-018-R-RevC

Distribution:

3 copies - Environmental Protection Authority
2 copies - Crown Perth (+1 electronic copy)
1 electronic copy - Golder Associates Pty Ltd

Golder Associates

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1.0 INTRODUCTION

1.1 Overview

This Crown Towers Indicative Operations Environmental Management Plan (OEMP) has been prepared for the Crown Towers project (the Project) as part of an Environmental Management Strategy to guide Crown Perth (Crown) in establishing and maintaining controls to manage potential environmental and social impacts during the Operations Phase of the Project.

This document is to be read in consultation with the Operations Environmental Management Framework (OEMF) (Golder, 2013a) and the Crown Towers Environmental Management Plan (Project EMP) (Golder, 2013b) which provides the following:

- A description of each Environmental Management Plan (EMP) document that comprises the Environmental Management Strategy of the Project.
- Crown's Environmental Objectives and Environmental Commitments for the Project.
- The Environmental Commitments for the Project for the Lead Contractor(s) and Crown.
- A description of the Project's existing environment and results of specialist studies undertaken.

This OEMP is a live document and will be revised as needed prior to the implementation of the Operations Phase of the Project (estimated to be in 2016).

1.2 Background

The scope is to operate, manage and maintain the Project located within the Burswood Peninsula, Western Australia. The Project is a new world class hotel added to Crown's Integrated Entertainment Resort in Perth, Western Australia. The Project consists of a six-star quality 25-storey hotel constructed on the banks of the Swan River with views of the central business district in Perth and the Indian Ocean in the distance. The towers accommodate a total of 500 rooms and will be branded as Crown Towers which is Crown Limited's premium hotel brand. A low-rise podium contains a large convention and meeting complex, restaurants, retail and public spaces which have been integrated into the existing property.

The design of the property capitalizes on the unique nature of the site and leverages the Mediterranean climate in Perth to create a true unique resort setting. The property caters to affluent business and leisure clientele and supports a VIP gaming component which will integrate into the hotel tower through the Suite/Villa accommodations and VIP Gaming salons. The Project also incorporates an expansion of Crown's existing pools and landscaped areas.

For planning purposes the Project is to be delivered in two phases:

- **Construction Phase:** the construction of the Crown Towers, Podium and associated infrastructure, which will include the use of deep piles inserted into the ground to provide building support for the main structures.
- **Operations Phase:** the operation of the Crown Towers. The transition from the Construction Phase to the Operations Phase will occur once the all Construction Phase work has been completed and the Lead Contractor has left site, handing the development infrastructure over to Crown. Ongoing environmental monitoring of the site and management of site facilities will continue during the Operations Phase.

Delivery of the Project has potential for environmental and social impacts (primarily surrounding the works proposed during the Construction Phase) and will therefore be referred to the Office of the Environmental Protection Authority (OEPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (EP Act).

1.3 OEMP Scope

The scope of this OEMP focuses on the operation of the Project including:

- Crown Tower's six-star, 25 level, 500 room hotel development.
- Podium structure, linking the hotel to adjoining buildings and properties (approximately 25 000 m^2 footprint).
- Associated services buildings (for generators, bins, refuse, hoist and loading bay under croft).
- Porte cocheré.
- Pedestrian access ways.
- Landscaping.
- Stormwater catchment lake(s).

Hotel facilities including:

- New function/conference facilities which complement the existing function room.
- A new resort swimming pool, exclusively for Crown Towers Perth guests. The new resort pool is integrated with the existing Crown Metropol Perth pools and VIP enclave pool.
- A mix of standard guest rooms and suites in the Crown Towers. The VIP/Crystal Club facilities, including salon gaming VIP lounge and pool areas, located on the levels above the standard guest rooms, in effect, separating the standard guest room floors from the floors containing the suites.
- Gaming salons forming part of the VIP offering, and supported by a VIP lounge, Crystal Club, VIP Club pool, and bar.
- Back of house facilities located on a number of levels, including the basement, which will also incorporate a loading bay, generators, bins, refuse and a hoist.
- Plant rooms required to operate the hotel facilities.
- Guest and staff uniform laundry operations which take place on-site in the hotel, whilst hotel and food and beverage linen will be taken off-site.

Figure 1 illustrates the indicative Project layout.

LEGEND

Estimated project boundary

NOTES

Coordinate System: GDA 1994 MGA Zone 50

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0 10 20 30 40 50
metres

SCALE (at A3) 1:1,700

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CLIENT Crown Perth
DOCUMENT 127643111-018-R-RevC
DATE 07 Feb 2013
COMPILED GGW
APPROVED DRAFT

Crown Towers Indicative Operations EMP

INDICATIVE PROJECT LAYOUT

FIGURE 1

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\018 R\127643111-018-R-F001-RevC-Project_Layout.mxd

1.4 Objective

This OEMP has been drafted by Golder Associates Pty Ltd (Golder) in consultation with Crown based on the findings of a Detailed Site Investigation (DSI) (Golder, 2013c) and the content of the Environmental Management Frameworks (EMFs). This OEMP is one document within 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 and mitigation measures.
- Monitoring procedures.
- Incident management.
- Training.
- Auditing procedures.
- Reporting procedures.
- Environmental management document review procedures.

This OEMP is to be implemented by Crown as the owner and operator of the Project. References in this OEMP to Crown being responsible for certain tasks also extend to subcontractors where engaged by Crown. This document will be revised closer to the implementation of the Operations Phase (Q1 2016).

1.5 Project Location and Tenure

The Crown Perth complex is located at 201 Great Eastern Highway on the Burswood Peninsula in the City of Perth, Western Australia. The Project will be located within the southern nine holes of the Burswood Park Golf Course located on the Burswood Peninsula, as shown in Figure 1.

The Burswood Peninsula extends over an area of approximately 280 ha and is located approximately 2.9 km east of the Perth CBD. A variety of land uses are located within the Burswood Peninsula including the State Tennis Centre, the Crown Perth complex, the Dome, the Mirvac Burswood Peninsula residential development, the Belmont Racecourse and assorted parklands and car parks. The Burswood Peninsula is accessed by road from the Graham Farmer Freeway, Victoria Park Drive and the Great Eastern Highway, with Belmont and Burswood train stations also servicing the area.

The Crown Perth complex is surrounded by land zoned for parks and recreation, residential, and public purposes - special uses (Crown Perth Complex). The Swan River, which is in close proximity but not directly adjacent the Project area is managed by the Swan River Trust (SRT), a state government agency that protects, manages and enhances the Swan Canning Riverpark.

The Project area is shown in Figure 1 and Figure 2 (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 Burswood Park Golf

Course to the north; the Mirvac residential development to the east; the Crown Perth complex to the south; and the Burswood Water Sports Centre and the Swan River to the west.

Included within the Project area are the Crown Towers, which include the hotel structure and associated infrastructure including bars, restaurants, entertainment facilities and conference facilities.

The proposed Project Area is comprised of the following four lots (see Table 1) which extend over an area of approximately 7.8 ha.

Table 1: Land Tenure

Lot	Deposited Plan (DP)	CT (vol/folio)	Address	Owner	Total Approx. Area (ha)	Total Area within Project Area (ha)
301	DP42394	LR3139/329	201 Great Eastern Hwy, Burswood	State of Western Australia – proposed to be purchased by Crown	50.8	5.8
10	DP25931	2694/975	63 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	1.8	1.8
12	DP25931	2694/977	61 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	2.4	0.1
15	DP60786	2696/429	23 Bolton Ave, Burswood	Burswood Nominees Ltd of Burswood Entertainment Complex	5	0.1

Note: The portion of the proposed Project area contained in Lot 301 of which Crown is proposing to buy is located within the Burswood Park "C" Class Reserve. This is Lot 301 on Deposited Plan 42394 (CT LR 3139-329).

A plan showing the location of each lot is set out in Figure 3.

It has been identified that the Project area has had an extensive history of potentially contaminating land use activities. Therefore, an environmental DSI was conducted in accordance with the Department of Environment and Conservation (DEC) Contaminated Sites Management Series Guidelines and the implications of the DSI findings are discussed throughout this document. Landfill gas and leachate monitoring has been undertaken throughout the Construction Phase of the Project and will continue for a minimum of the first two years of Operations as per the Contaminated Sites Management Plan (Golder, 2013d) and the Project EMP (Golder, 2013b).

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0 100 200 300 400
metres

SCALE (at A4) 1:10,000

NOTES
Coordinate System: PCG94

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Aerial imagery © Nearmap (2012).

LEGEND
Estimated project boundary

Crown Towers Indicative Operations EMP

REGIONAL LOCATION

FIGURE 2

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\018 R\127643111-018-R-F002-RevC-Regional_Location.mxd

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CLIENT	Crown Perth
DOCUMENT	127643111-018-R-RevC
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COMPILED	GGW
APPROVED	DRAFT

0 30 60 90
metres

SCALE (at A4) 1:2,500

NOTES
Coordinate System: PCG94

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Cadastres © Western Australian Land Information Authority trading as Landgate (2012).

LEGEND
Estimated project boundary
Cadastral boundary

Crown Towers Indicative Operations EMP

LAND TENURE

FIGURE 3

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\018 R\127643111-018-R-F003-RevC-Land_Tenure.mxd

2.0 PROJECT SCOPE

2.1 Operations

The Operations Phase of the Project involves the transition of the Towers, Podium and other infrastructure from construction to operation and being opened to the public. The Operations Phase will include ongoing environmental management and monitoring by Crown. Crown will also be responsible for the maintenance of the facilities and infrastructure and the monitoring of the site which is anticipated to be ongoing for a period of at least two years as detailed in Section 7.0 of this OEMP.

The potential environmental impacts, proposed management and mitigation measures and monitoring procedures associated with the operations are also detailed in Section 7.0.

3.0 APPLICABLE LEGISLATION

3.1 State Legalisation and Regulations

Crown is responsible for obtaining any approvals expressly stated to be its responsibility throughout the Operations Phase and all required approvals, licenses and permits required to operate the Crown Towers.

Key Western Australian legislation and regulations that apply to the Project include, but are not limited to:

- *Casino (Burswood Island) Agreement Act 1985*
- *Contaminated Sites Act 2003*
- *Environmental Protection Act 1986*
- *Health Act 1911*
- *Occupational Safety and Health Act 1984*
- *Planning and Development Act 2005*
- *Rights in Water and Irrigation Act 1914*
- *Swan and Canning Rivers Management Act 2006*
- *Water Supply Sewerage and Drainage Act 1912*

Additional Western Australian legislation and regulations that may apply to the Project include, but are not limited to:

- *Aboriginal Heritage Act 1972*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Electricity Act 1945*
- *Electricity Industry Act 2004*
- *Energy Coordination Act 1994*
- *Environmental Protection (Controlled Waste) Regulations 2004*
- *Environmental Protection (Noise) Regulations 1997*
- *Environmental Protection (Unauthorised Discharges) Regulations 2004*
- *Heritage of Western Australia Act 1990*
- *Heritage of Western Australia Amendment Regulations 2012*
- *Land Administration Act 1997*
- *Litter Act 1979* (currently under review by DEC and will be incorporated into the EP Act)
- *Local Government Act 1995*
- *Main Roads Act 1930*
- *Metropolitan Water Supply, Sewage & Drainage Act 1909*
- *Pollution of Waters by Oil and Noxious Substances Act 1987*
- *Pollution of Waters by Oil and Noxious Substances Regulations 1993*
- *Road Traffic Act 1974*
- *Soil and Land Conservation Act 1945*
- *Waterways Conservation Act 1976*
- *Wildlife Conservation Act 1950*

This list is an indicative list only, it is not exhaustive, and Crown must identify and obtain any other required approvals.

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 Project area and specifies management and mitigation measures for potential environmental impacts (which also considers social impacts). The Environmental Management Strategy is illustrated in Figure 4 and described in detail in the Environmental Management Frameworks (EMFs). The position of this OEMP is highlighted in red text.

The series of EMFs and EMPs outlined in Figure 4 specify the Project's environmental objectives and details the environmental commitments, management and mitigation 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 Crown, with Crown preparing most of the listed documents in consultation with the regulatory agencies. Crown, as the operator of the Crown Towers during the Operations Phase will be responsible for the implementation of the required EMPs applicable to the Operations Phase.

More information on the Environmental Management Strategy is contained within the Project EMP (Golder, 2013b). Crown's existing Environmental Management System (Crown Perth, 2012a) contains their Environmental Policy, planning, implementation and operations, checking and review for their existing site.

Crown Towers Environmental Management Strategy

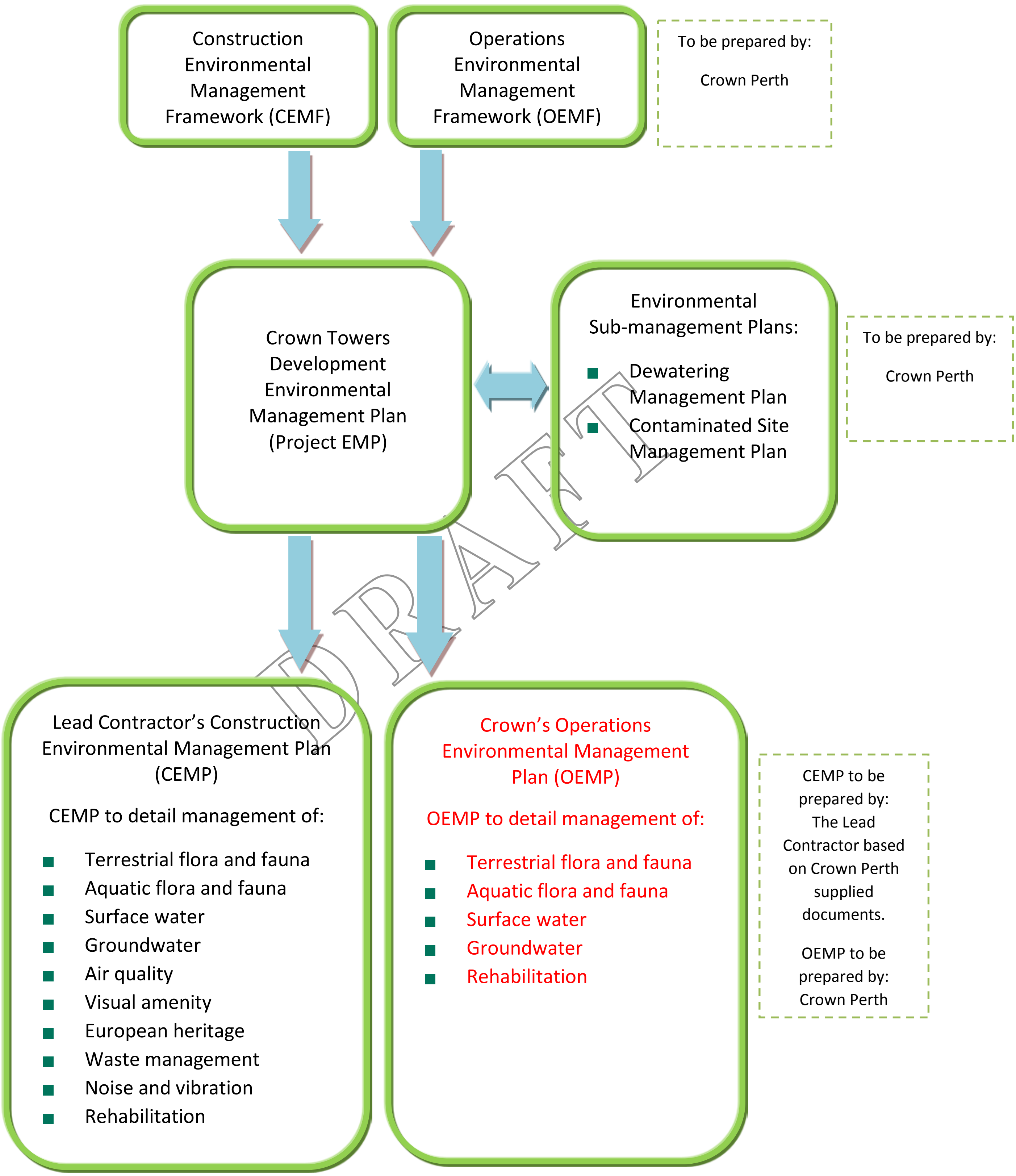

Figure 4: Environmental Management Strategy Structure

5.0 ROLES AND RESPONSIBLITIES

5.1 Overview

Fulfilling the responsibilities of the Environmental Management Strategy involves the participation of Crown and their subcontractors. The key responsibilities for Crown and their subcontractors are outlined in the sections below.

5.2 Crown

5.2.1 General

The key general responsibilities for Crown include:

- Develop, maintain and continuously improve the Environmental Management Strategy documents to the satisfaction of the regulatory agencies (see Section 15.0).
- Coordinate the delivery of the Project to meet the environmental objectives.
- Prior to commencement of work; confirm that the successful Lead Contractor(s) for the Construction Phase has developed a detailed CEMP in accordance with the CEMF (Golder, 2013e), Project EMP (Golder, 2013b) and Environmental Sub-management Plans.
- Liaise with regulatory agencies where required. Liaison will include, but not be limited to:
  - Reporting of site conditions when requested by the regulatory agencies.
  - Reporting of unexpected conditions where advice on the appropriate mitigation measures may be sought.
  - Reporting of incidents where there is potential for contamination issues, and corrective action is required.
- Coordinate and manage the contractors engaged to undertake environmental and contamination monitoring.
- Being the first point of contact for contractors to report environmental incidents and provide assistance in resolving incidents occurring on-site.
- Conduct internal environmental audits to assess conformance with the Lead Contractor's CEMP, the Environmental Sub-management Plans and the OEMP (see Section 10.0).

5.2.2 Operations

The key operations responsibilities for Crown include:

- Establish, implement, maintain and continuously improve an OEMP and any other necessary environmental documentation in accordance with this document, the OEMF (Golder, 2013a) and relevant Environmental Sub-management Plans.
- Conduct internal environmental audits to assess conformance with the Environmental Sub-management Plans and OEMP.
- Obtain relevant work specific environmental approvals, licences and permits prior to commencing certain works.
- Prior to commencement of work; confirm that subcontractors have complied with the relevant requirements of the Project EMP (Golder, 2013b), Environmental Sub-management Plans and OEMP.

- Regularly review subcontractors' performance against the requirements of the OEMP and take corrective action as necessary.

5.2.3 Crown's Environmental Advisor

The key responsibilities for Crown's Environmental Advisor include:

- Provide environmental advice and support to Crown during the Operations Phase of the Project.
- Assist in the coordination and management of contractors engaged to undertake environmental and contamination monitoring on behalf of Crown, where required.
- Be the first point of contact for the contractors of the Operations Phase to report environmental incidents and provide assistance to Crown in resolving incidents occurring on-site.
- Stop work on-site where necessary due to foreseen environmental risks.
- Review and assess environmental monitoring procedures, results and monthly compliance reports.
- Conduct environmental audits to assess compliance with this OEMP, the CEMP/Project EMP (Golder, 2013b) and Environmental Sub-management Plans.

6.0 ENVIRONMENTAL MANAGEMENT OBJECTIVES

The environmental management objectives for the Project are to:

- Minimise and manage the environmental and social impacts arising from the Project.
- Manage impacts to the Swan River and other ecosystems surrounding the Project area.
- Manage contamination including monitoring of groundwater, surface water, soil, air and landfill gas during the Operations Phase in accordance with the *Contaminated Sites Act 2003* and the DEC *Contaminated Sites Guideline Series.*
- Manage and monitor 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.
- Minimise and 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 heritage sites from impacts during the Operations Phase of the Project.
- Minimisation of waste through the adoption of waste reduction and disposal procedures consistent with the EPA waste hierarchy.

7.0 OPERATIONS PHASE ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Overview

A risk assessment was undertaken for the Project against the Operations Phase of the Project and the key environmental factors that have the potential to be impacted by the proposed operations include:

- Terrestrial flora and fauna.
- Aquatic flora and fauna.
- Surface water (including any retained lakes and the Swan River).
- Groundwater.
- Landfill gas.

This phase assumes that all clearing and loss of vegetation will have occurred during the Construction Phase of the Project. Heritage has also been determined not to be a key risk as there will be no ongoing impacts to heritage sites once the Project is constructed and in the Operations Phase.

Crown has conducted phase specific risk assessments for each environmental and social factor and receptor to identify phase specific predicted environmental and social impacts.

The following environmental impact assessment sections outline the Project:

- Environmental Management Objectives.
- Potential Environmental Impacts.
- Proposed Limits and Targets (where applicable).
- Proposed Management and Mitigation Measures.
- Proposed Monitoring Procedures.

Where not otherwise specified, all monitoring procedures have been developed using Golder's professional experience in consideration of the environmental baseline of the Project area.

7.2 Terrestrial Flora and Fauna

7.2.1 Management Objectives

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

- Minimise and manage impacts to 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 impacts to indigenous or otherwise protected fauna that are located on-site, including the protection of remaining terrestrial fauna habitats.

7.2.2 Potential Environmental Impacts

Potential impacts to terrestrial flora and fauna during the Operations Phase are particularly dependent on the conservation and preservation of remaining undisturbed avian fauna habitat (such as the remaining lakes, the adjacent Swan River environment and any remaining vegetation habitats) and newly vegetated environment.

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

- Indirect terrestrial flora and fauna habitat conservation risks, including habitat disturbance associated with a large commercial entertainment venue operating adjacent a river habitat including habitat disturbance.
- Indirect terrestrial flora and fauna habitat contamination risks associated with a large commercial entertainment venue operating adjacent terrestrial fauna habitat. Contamination risks could include increased risk of pollution due to incidents such as poor waste management, stormwater discharge, increased respiratory impacts due to high traffic volumes and increased greenhouse gas emissions contributed by the operation of new buildings and associated vehicle emissions.
- Aural and other impacts to aquatic fauna due to noise and vibration impacts as a result of increased vehicle operation and Operations noise associated with a large commercial entertainment venue.
- Indirect effects from light pollution affecting circadian rhythms and migratory activity patterns.
- Introduction of terrestrial flora and fauna pests.

7.2.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to terrestrial flora and fauna during the Operations Phase are:

- Maintenance and upkeep of rehabilitated terrestrial fauna habitat within the Project area.
- Maintain vegetation around the remaining lakes established during the rehabilitation phase to offset habitat loss and predator protection.
- Manage contamination to land, groundwater and surface water, spills and contamination risks potentially impacting remaining habitat areas (both terrestrial and aquatic), by implementing waste management measures and the Contaminated Site Management Plan (Golder, 2013d). These include a spill clean-up and remediation procedure. Maintenance and upkeep of rehabilitated terrestrial flora and vegetation within the Project area.
- Maintenance and upkeep of rehabilitated terrestrial flora and vegetation within the Project area.
- Implementation of any specific conditions applied to the Project by regulatory authorities.

Proposed mitigation measures to be taken to manage potential terrestrial flora and fauna impact triggers include, but are not limited to those outlined in Table 2.

Table 2: Terrestrial Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
A weed outbreak occurs on-site	■ Advise Crown's Environmental Advisor. ■ 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 an appropriate weed management procedure. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger for Action	Mitigation Measure
Condition of any vegetation remaining within the Project area or in close proximity to the Project area declines in comparison to baseline conditions.	■ Advise Crown's Environmental Advisor. ■ Increase vegetation-monitoring frequency to weekly 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 or as required. ■ 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, disease infestation. ■ Undertake rehabilitation activities in affected area (e.g. revegetation with local provenance species). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
An incidence of death or injury to fauna (such as the death of fauna inhabiting the retained lakes) occurs within the Project area due to Project operations.	■ Advise Crown's Environmental Advisor and DEC. ■ Collect or capture dead/injured fauna and treat or preserve specimen based on DEC advice. ■ Crown to advise relevant regulatory agencies if required. ■ Investigate mitigation measures in consultation with the DEC, if required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Individuals or populations of species of conservation significance are at significant risk from operations	■ Advise Crown's Environmental Advisor and DEC. ■ Investigate relocation of populations and species in consultation with the DEC. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

7.2.4 Proposed Monitoring Procedures

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 their deterioration. Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two-year period, a review will determine if monitoring is to continue occur and at what frequency.

7.3 Aquatic Flora and Fauna

7.3.1 Management Objectives

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

- Minimise and manage the impacts to aquatic fauna and flora located within the lakes remaining within the Project area.

- 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.

7.3.2 Potential Environmental Impacts

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

- Indirect aquatic flora and fauna habitat conservation risks including habitat disturbance associated with a large commercial entertainment venue operating adjacent a river habitat including habitat disturbance.
- Indirect aquatic flora and fauna habitat contamination risks associated with a large commercial entertainment venue operating adjacent a river habitat. Contamination risks could include increased risk of pollution due to incidents such as poor waste management, stormwater discharge, increased respiratory impacts due to high traffic volumes and increased greenhouse gas emissions contributed by the operation of new buildings and associated vehicle emissions.
- Indirect aquatic flora and fauna habitat contamination risks due to the alteration in hydrology and hydrogeology of underlying aquifer(s), 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 Operations noise associated with a large commercial entertainment venue.
- Indirect effects from light pollution affecting circadian rhythms and migratory activity patterns.
- Introduction of aquatic flora and fauna pests.

7.3.3 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to terrestrial and aquatic flora and fauna during operations are to:

- Maintain the upkeep of rehabilitated aquatic fauna habitat within the Project area.
- Maintain vegetation around the remaining lakes established during the rehabilitation phase to offset habitat loss and predator protection.
- Manage contamination to land, groundwater and surface water, spills and contamination risks potentially impacting remaining habitat areas (both terrestrial and aquatic), by implementing waste management measures and the Contaminated Site Management Plan (Golder, 2013d). These include a spill clean-up and remediation procedure. Maintenance and upkeep of rehabilitated terrestrial flora and vegetation within the Project area.
- Maintain the upkeep of rehabilitated terrestrial flora and vegetation within the Project area.
- Implement any specific conditions applied to the Project by regulatory authorities.

Proposed mitigation measures to be taken for the management of aquatic flora and fauna triggers include, but are not limited to those outlined in Table 3.

Table 3: Aquatic Flora and Fauna Mitigation Measures

Trigger for Action	Mitigation Measure
Sediment plume or discharge is visually evident within retained lakes or the Swan River.	■ Advise Crown's Environmental Advisor, DEC and SRT. ■ Investigate cause of sediment increase if sediment plume occurs within the retained lakes. ■ Check sediment traps, bunds and diversion drainage, and rectify potential cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Condition of aquatic vegetation remaining within the Project area or in close proximity of the Project area declines in comparison to baseline conditions.	■ Advise Crown's Environmental Advisor. ■ 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 the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
An incidence of Fishkill occurs within the Swan River or retained lakes.	■ Advise Crown's Environmental Advisor, DEC and SRT. ■ Identify the source of contamination if Fishkill occurs in retained lakes. ■ Investigate mitigation measures in consultation with the DEC and SRT. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Erosion of the riparian environment of the retained lakes or the Swan River is visually worse than background levels.	■ Advise Crown's Environmental Advisor 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 above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

7.3.4 Proposed Monitoring Procedures

To determine if any long term impacts have occurred to the immediate Swan River foreshore and the retained lakes, follow-up vegetation and bank condition monitoring along the Swan River adjacent to the Project area and around the remaining lakes will be undertaken. Focus will also be directed to aquatic fauna habitat, specifically avian fauna habitat.

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 their deterioration. Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two-year period, a review will determine if monitoring is to continue occur and to at what frequency.

7.4 Surface Water

7.4.1 Management Objectives

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

- Emissions are not to 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 Operations Phase.
- Maximise the efficient use of water for the Project and allow the continued use of water resources.

7.4.2 Proposed 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, 2000).
- 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, 2000).

Appendix A 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 rigger 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.

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 South of the Project Area

Water Quality Indicator	Trigger Value
Chl a*	3
Total Phosphorus (TP)*	30
Free Reactive Phosphorus (FRP)*	5
Total Nitrogen*	750
Nitrogen oxides (NO_x)*	45
Ammonia (NH_4)*	40
Dissolved oxygen (DO) (% saturation) *	90–110
pH* (pH units)	7.5–8.5
Turbidity (NTU) $^{\Omega}$	≤10% increase above reference site, or no visible reduction in colour or light penetration of the receiving environment.
Salinity (as TDS) $^{\Omega}$	≤10% increase above reference site.
Temperature	≤10% increase above reference site.
Other contaminants$^{\Omega}$	≤10% increase above reference site , or exceed levels for which there is evidence of lethal or sub-lethal toxic effects or undesirable physiological responses in humans, plants, birds, animals, fish or other aquatic life.

*90% Aquatic Ecosystem Protection trigger values (ANZECC/ARMCANZ, 2000) $^{\Omega}$Swan River acceptable water quality (SRT, 2000).

Note:

- All values are in mg/L unless otherwise stated.
- Values in Table 4 are based on the South-west Australia estuaries for slightly disturbed ecosystems (ANZECC, 2000).

Table 5 provides the guideline trigger levels for the constructed lakes within the Project area.

Table 5: Trigger Values for Reporting Chemical Stressors in the Constructed Lakes within the Project Area

Water Quality Indicator	Trigger Value
Chl a*	30
Total Phosphorus (TP)*	60
Free Reactive Phosphorus (FRP)*	30
Total Nitrogen*	1500
Nitrogen oxides (NO_x)*	100
Ammonia (NH_4)*	40
Dissolved oxygen (DO) (% saturation) *	90–120
pH* (pH units)	7.0–8.5
Turbidity (NTU)	10-100
Salinity (as TDS)	300-1500
Temperature	≤10% increase above seasonal baseline conditions.
Other contaminants	80% ANZECC/ARMCANZ (2000) Aquatic Ecosystem Protection Guidelines

*90% Aquatic Ecosystem Protection trigger values (ANZECC/ARMCANZ, 2000) $^{\Omega}$Swan River acceptable water quality (SRT, 2000).

Note:

- All values are in mg/L unless otherwise stated.
- Values in Table 5 are based on the South-west Australia estuaries for slightly disturbed ecosystems (ANZECC, 2000).

Trigger levels such as those in Table 4 and Table 5, 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 is provided as Appendix A.

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

The protection level for the artificial lakes within the Project area is set at 80%. This is due to the lakes constructed nature and their low intrinsic aquatic ecosystem values.

7.4.3 Potential Environmental Impacts

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

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

7.4.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken to minimise impacts to surface water during operations are:

- Continue to monitor ground and surface water for two years into the Operations Phase of the Project to determine any adverse impacts to water quality and implement contingency measures where required.
- Manage waste by providing sufficient waste disposal bins, recycling bins and other waste collection points within and surrounding the Crower Towers Development.

Maintain and manage the extensive stormwater and urban water collection and management system for the Project using the remaining lakes as catchment and treatment points. Associated infrastructure will be designed to minimise the risk of contamination to land, groundwater and surface water due to spills and unmanaged surface water flows.

- Implementation of any specific conditions applied to the Project by regulatory agencies.

Proposed mitigation measures to be taken for the management of potential surface water impact triggers include, but are not limited to those outlined in Table 6.

Table 6: Surface Water Mitigation Measures

Trigger	Mitigation Measures
Contaminated surface water is discharged to the surrounding environment	■ Advise Crown's Environmental Advisor and DEC. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Surface water quality is in exceedance of trigger values	■ Advise Crown's Environmental Advisor. ■ Identify source of water quality change. ■ If the change is due to activity that can be modified, remove the cause as appropriate. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Sediment plume or discharge is visually evident downstream of a disturbed area or within the remaining lakes.	■ Advise Crown's Environmental Advisor and DEC and/or SRT. ■ Investigate cause of sediment increase. ■ Check sediment traps, bunds and diversion drainage, and rectify potential cause as appropriate. ■ Undertake remediation/rehabilitation within the affected area, if practicable as per DEC/SRT advice. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Storm water system is blocked and/or overflowing	■ Advise Crown management. ■ Identify location and source of blockage. ■ Remove blockage. ■ Clean-up spilt or pooling stormwater as required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

7.4.5 Proposed Monitoring Procedures

Surface water monitoring will be undertaken during the first two years of the Operations Phase of the Project to assess that the ongoing quality of surface water in the remaining lakes and the surrounding ecosystem is not detrimentally affected.

Surface water monitoring will determine water quality and any potential impacts to the Swan River or other surface water bodies (such as the remaining lakes). Surface water monitoring will at least include the parameters listed in Table 7 and be conducted with reference to the applicable trigger levels in Appendix A where practicable. Additional analytes may be included pending the outcomes of the DSI (Golder, 2013c).

Monitoring locations will be established in each of the constructed lakes and in the Swan River. Sampling methodology, including quality control and quality assurance procedures, will be undertaken as described in Golder (2012b).

Table 7: 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 & SO_4	Weekly	Weekly
Total metals (Fe and Al)	Weekly	Weekly
Total suspended solids (TSS)	Weekly	Weekly
Organochlorine and organophosphate pesticides	Fortnightly	Fortnightly
Polyaromatic hydrocarbons (including naphthalene)	Fortnightly	Fortnightly

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

Surface water monitoring will be reviewed based on DSI (Golder, 2013c) and baseline results and each round of monitoring data. Laboratory 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 and mitigation measures outlined in this OEMP and the Contaminated Site Management Plan (Golder, 2013d).

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

Monitoring to be undertaken by Crown will include at a minimum:

- Monthly water quality sampling of the parameters and units outlined in Table 7 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 7 for any retained lakes 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 this document and OEMP and the Contaminated Site Management Plan (Golder, 2013d).
- Monthly inspections of the stormwater capture system to clear debris and 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 retained lakes within the Project area to identify and remove any waste from the lakes.
- Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two-year period, a review (undertaken by Crown in liaison with relevant regulatory authorities if required) will determine if monitoring is to continue to occur and at what frequency.

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

7.5 Groundwater

7.5.1 Management Objectives

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

- Require 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 Operations Phase.
- Maximise the efficient use of water for the Project.

7.5.2 Proposed 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, 2000).
- 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, 2000).
- Drinking Water Aesthetic Values (DEC, 2010).
- Drinking Water Health Values (DEC, 2010).
- Unpublished trigger values provided by the Swan River Trust (2012).

The values of the guidance trigger levels as per the guidance material listed above are listed in Appendix B.

Trigger levels such as those in Appendix B, 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.

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 water is proposed to be discharged into the Swan River, the Swan River Trust guidelines for disposal of dewater into the Swan River are outlined in Table 8. Construction Phase works are not anticipated to increase the existing natural groundwater flow into the Swan River.

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

Item	Trigger Value	Source
Total nitrogen	>1.0 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total phosphorus	>0.1 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
Total iron (Fe+ and Fe3+)	>1.0 mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Dissolved aluminium	>150 ug/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Total aluminium	>1.0 mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
TTA (Acidity)	>40 mg/L	Treatment and management of soils and water in acid sulfate soil landscapes (DEC, 2009)
Odours and colours	No objectionable odours or visible colour changes in the receiving water	Swan River Trust policy SRT/DE6 Dewatering
Floatable matter	No visible floating oil, grease, scum, litter or other objectionable material	Swan River Trust policy SRT/DE6 Dewatering
Settleable matter	No deposits which adversely affect the recreation and ecosystem values of the receiving waters	Swan River Trust policy SRT/DE6 Dewatering
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
Temperature	Not to vary more than 2°C from the background level (in the receiving environment)	Swan River Trust policy SRT/DE6 Dewatering
Salinity	Not to alter the background level in the receiving environment by more than 10%	Swan River Trust policy SRT/DE6 Dewatering
Dissolved Oxygen	>4 mg/L	Healthy Rivers Action Plan (SRT, 2008) long-term targets
pH	Should not fall outside the range of 6-8.5	ANZECC Guidelines for freshwater
All other toxicants	As per ANZECC Guidelines for freshwater or marine water ecosystems. Minimum 95% protection level to be used.	ANZECC Guidelines

7.5.3 Potential Environmental Impacts

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

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

7.5.4 Proposed Management and Mitigation Measures

Proposed management measures to be taken 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 waste management measures and the Contaminated Site Management Plan (Golder, 2013d).
- Maintain and manage the extensive stormwater and urban water collection and management system for the Project using the remaining lakes as catchment and treatment points. Associated infrastructure will be designed to prevent contamination to land, groundwater and surface water due to spills and unmanaged surface water flows.
- Implementation of any specific conditions applied to the Project by regulatory agencies.

Proposed mitigation measures to be taken for the management of potential groundwater impact triggers include, but are not limited to those outlined in Table 9.

Table 9: Groundwater Mitigation Measures

Trigger	Mitigation Measures
Measured decline in groundwater levels is at significant variance to the modelled change.	■ Advise Crown's Environmental Advisor. ■ 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 (if this is deemed the cause). ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Contaminated groundwater is discharged to the surrounding environment	■ Advise Crown's Environmental Advisor and DEC. ■ 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

Trigger	Mitigation Measures
Groundwater quality is in exceedance of trigger values	■ Advise Crown's Environmental Advisor. ■ 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 the Dewatering Management Plan (Golder, 2013f) 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 rate of groundwater extraction. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Survey of adjacent structures shows settlement or abnormalities.	■ Advise Crown's Environmental Advisor. ■ A geotechnical specialist should be employed to review the data and propose appropriate measures. ■ Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities if required. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Identified deteriorating groundwater quality	■ Advise Crown's Environmental Advisor. ■ 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 the Dewatering Management Plan (2013f) 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. ■ If the above points do not resolve the issue, Crown is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

7.5.5 Proposed Monitoring Procedures

Groundwater monitoring (using monitoring wells) will be conducted within the first two years of operation of the Project by a suitably qualified specialist to monitor changes to the groundwater quality and pressures (heads, levels) to determine any potential impacts to the Swan River and aquifer system. Groundwater will be monitored in accordance with following regulations, where appropriate:

- Department of Agriculture and Food *Guidelines for Groundwater Monitoring* (2008)
- 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, 2000)
- 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
- DEC Contaminated Sites Management Series Guidelines.

The following sections outline likely monitoring requirements based on the guidelines from DOW (2006) and DEC (2011).

7.5.5.1 Groundwater

A groundwater monitoring well network will need to be established post Construction Phase works as many monitoring wells may have been destroyed. Groundwater monitoring will be reviewed based on DSI (Golder, 2013c) results and 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 and mitigation measures outlined in this OEMP and within the DMP.

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

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

The proposed analytes to test for are presented in Table 10. Field pH, electrical conductivity, dissolved oxygen, redox potential, TTA and temperature should be measured in the field when collecting the water samples.

Table 10: Proposed Analytes for Laboratory Suite for Groundwater

Miscellaneous Parameters	Total Titratable Acidity, Total Actual Acidity, Total Alkalinity, pH, TDS, turbidity, ORP, EC.
Major Ions	Cations (Ca, Mg, Na, K), Anions (Cl, SO_4, HCO_3)
Dissolved Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Total Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Nutrients	Ammonia as N, Total Nitrogen, reactive Phosphorous, Total Phosphorus
Additional contaminants of concern	*Polycyclic Aromatic Hydrocarbons (including naphthalene) and Organo Chlorine and Organo Phosphate Pesticides.**

Note: * required analytes may be dependent on the location of dewatering

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.

7.5.5.2 Dewatering Discharge

At this stage it is not anticipated that dewatering be required during the Operations Phase of the Project.

If dewatering is required, then dewatering management and discharge monitoring should be undertaken as detailed within the DMP (Golder, 2013f).

7.5.5.3 Monitoring in Accordance with ASS Guidelines

ASS monitoring should be undertaken as detailed within the Contaminated Sites Management Plan (Golder, 2013d).

7.5.5.4 Settling Effects

The DMP (Golder, 2013f) must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. Proximity to nearby infrastructure including the Crown Perth complex and residential buildings to the north and east 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 be determined at an interval during the dewatering period. Survey data should be recorded and reviewed and the reasons for any changes or movements identified.

Proposed monitoring procedures to be undertaken for the management of groundwater during operations are:

- Quarterly monitoring of groundwater bores for first two years of the Operations Phase to allow continued monitoring of water quality trends (at a minimum the parameters outlined in Table 10 and groundwater pressures. This will assess any adverse effects of the Operations Phase to groundwater quality trends.
- Monthly inspections of stormwater capture infrastructure to manage and clear blockages to prevent overflows. Inspections should be carried out more regularly should inclement weather be forecast.
- Monitoring will be undertaken monthly during the first two years of the Operations Phase and following this two year period, a review (undertaken by Crown in liaison with relevant regulatory authorities if required) will determine if monitoring is to continue to occur and at what frequency.

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

7.6 Landfill Gas

7.6.1 Management Objectives

The Project's environmental objectives with regard to the management of landfill gas impacts during the Operations Phase are to:

- Minimise and manage the release of landfill gas throughout the Operations Phase.

7.6.2 Proposed Limits and Targets

The DSI investigation (Golder, 2013b) undertaken at the site included the collection of ground gases from monitoring wells across the site (see the Contaminated Site Management Plan (Golder, 2013d)).
The investigation identified 16 out of 20 locations with concentrations of combustible gas above the trigger value of 25% Lower Explosive Limit (%LEL). Ten wells also contained combustible gas concentrations exceeding 100% LEL or the equivalent of 5% gas as methane. A summary of the exceedances of the trigger values is included in Table 11. No other chemical were measured in concentrations above relevant guideline values.

Table 11: Summary of Well Locations with Concentrations Greater than Trigger Value

Trigger	Location
Wells containing combustible gas concentrations >25% LEL	ASS002, ASS004, ASS005, ASS007, ASS008, SB003, SB008, SB009, SB011, SB012, SB013, SB018, SB026, SB028, SB029 and SB030
Wells containing combustible gas concentrations >100% LEL or 5% gas	ASS004, ASS005, ASS007, ASS008, SB008, SB009, SB011, SB013, SB026, SB028, SB029 and SB030

7.6.3 Potential Environmental Impacts

With respect to outdoor air quality, once groundcover is established on-site ongoing air monitoring is not required during the Operational Phase of the Project.

With respect to the design and operation of the building and considering indoor air quality, the findings from the DSI (Golder 2013c) indicated that some risk mitigation measures should be considered for the operation of the Project. Due to the explosion and asphyxiation risk caused by landfill gas accumulation, Golder considers that due to the potential for enclosed spaces in the building structures that gas management and mitigation measures be adopted.

7.6.4 Proposed Management and Mitigation Measures

Based on CIRIA C665, a *Characteristic Situation 2 or 3* requires two levels of protection. CIRIA specifies management and mitigation measures which may be included in the design and construction of the Project such as:

- Reinforced concrete case *in situ* floor slab (suspended, non-suspended or raft) with at least 1200 g DPM2.
- Beam and block or pre-cast concrete slab and minimum 2000 g DPM/reinforced gas membrane.
- Possibly underfloor venting or pressurisation in combination with the above two points depending on use.
- All joints and penetrations sealed.

7.6.5 Proposed Monitoring Procedures

An indoor air monitoring program should be developed and implemented during the Operational Phase to assess whether the mitigation measures are effective.

7.7 Dewatering Management

If a situation arises in which dewatering is required, such as extraction of groundwater for irrigation, management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures can be located in the Dewatering Management Plan (Golder, 2013f) attached as Appendix B.

7.8 Contaminated Site Management

If localised contaminated sites are discovered, management objectives, limits and targets, potential environmental impacts, management and mitigation measures and monitoring procedures can be located in the Contaminated Site Management Plan (Golder, 2013d) attached as Appendix C.

8.0 REHABILITATION MANAGEMENT PLAN

8.1 Overview

Rehabilitation of the environment from impacts caused by the Project will be a joint effort between Lead Contractor(s) and Crown, with each phase having a number of requirements to address. Crown will monitor the rehabilitation undertaken by the Lead Contractor and undertake maintenance where required.

Rehabilitation will be required within the landscaped areas and the retained lakes and other undeveloped areas. A Rehabilitation Management Plan will be prepared by the Construction Phase Lead Contractor. The role of the Lead Contractor(s) in preparing the site for rehabilitation is outlined in the Project EMP (Golder, 2013b) and will be included in the contract documents for the Construction Phase works.

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 Construction Phase 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. Any plant species used will be local to the region, where practicable (i.e. there will be areas that are lawn-scaped).

8.2 Construction Phase

The Lead Contractor for the Construction Phase 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 relevant regulatory agencies and will be approved by Crown prior to being implemented.

Protection of designated preservation areas (such as the remaining lakes) will be undertaken as part of the rehabilitation procedures throughout the Construction Phase.

The Lead Contactor(s) along with Crown's Environmental Advisor 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.

8.3 Operations Phase

Crown will be required to implement the rehabilitation monitoring and maintenance components of the Rehabilitation Management Plan developed by the Lead Contractor. This will involve monitoring the status of the landscaping and rehabilitation as well as undertaking measures should rehabilitation be unsuccessful.

9.0 ENVIRONMENTAL REPORTING REQUIREMENTS

9.1 Project Compliance

Annual compliance reports will be completed by Crown's Environmental Advisor for the first two years during the Operations Phase covering as a minimum:

- Environmental activities.
- Environmental monitoring results.
- Compliance auditing and tracking.
- Rehabilitation progress.
- Public complaints.
- Any exceedances and corrective actions.
- Environmental incidents.
- Non-conformances.

These reports will be provided to the Environmental Auditor for assessment.

9.2 Compliance Tracking

A corrective actions and compliance tracking program will be developed by Crown to manage and track Project compliance with the commitments in the Project EMP (Golder, 2013b), Environmental Sub-management Plans and OEMP. The tracking document will be a standalone document and will be provided to Crown's Environmental Advisor as part of the monthly compliance reports.

9.3 Management of Non-compliance

Non-compliance will be managed by Crown under the implementation of the Project EMP (Golder, 2013b), Environmental Sub-management Plans and OEMP. Procedures for managing non-compliance including the recording, reporting and implementation of mitigation measures or corrective action and responsible persons will be detailed in the OEMP.

9.4 Records of Environmental Activities

Environmental records for the Operations Phase will be maintained to demonstrate compliance with the Project EMP (Golder, 2013b) as per Crown's Environmental Records policy (Crown Perth, 2012a); Environmental Sub-management Plans and the OEMP 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 kept on-site by Crown.

10.0 AUDITING

10.1 Audits and Inspections

A qualified (e.g. RABQSA) Environmental Auditor (Lead or Principal Auditor level) will be engaged by Crown to conduct quarterly environmental audits during the first two years of the Operations Phase of the Project. The objective of the monthly environmental audits is to assess Crown's compliance with the Project EMP, Environmental Sub-management Plans and OEMP. The results of the quarterly environmental audits will be recorded and any non-conformances identified against the Project EMP, Environmental Sub-management Plans and OEMP, along with proposed corrective actions, will be reported to Crown's Environmental Advisor. Crown's Environmental Advisor will then take corrective action. Depending on the results of the quarterly audits, audits may be able to be reduced to bi-annually.

11.0 EMERGENCY RESPONSE PROCEDURE

Crown has in place an Emergency Response Standard Operating Procedure (ERSOP) (Crown Perth, 2012b) for their existing operations. The content of the ERSOP (Crown Perth, 2012b) will be the basis for the development of a similar ERSOP for the Crown Towers Project. The ERSOP (Crown Perth, 2012b) outlines emergency, incident response and evacuation procedures and situations where works should be promptly ceased. The ERSOP to be developed for the Crown Towers project will also require an emergency contact number to be established which can be telephoned 24 hours a day, seven days per week.
The ERSOP for the Crown Towers project should details the following items, as a minimum, where applicable:

- On-site location of Material Safety Data Sheets (MSDS).
- On-site location of spill kits.
- Location of hazardous material storage areas and safe storage procedures.
- 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 should result in stopping of works/operations.

12.0 ENVIRONMENTAL INCIDENTS MANAGEMENT PROCEDURE

An environmental incident is any of the following:

- A breach or non-conformance of statutory requirements or procedures which have been prescribed in the Project EMP (Golder, 2013b) or OEMP.
- A failure to meet targets or key performance indicators which have been outlined in the individual management plans.
- A breach or non-conformance of relevant licence conditions.

Environmental incidents are to be managed in accordance with the contingency procedures outlined in the individual Emergency Response Procedure. However, the following general procedure (illustrated in Figure 5) is to be followed in the event of an environmental incident:

1) A Crown representative and Environmental Advisor shall be notified immediately upon the occurrence of an environmental incident.

2) Subject to the nature and extent of the non-conformance, Crown's Environmental Advisor shall issue a work order to halt and/or rectify the environmental impact/harm caused as a result of the environmental incident.

3) Within 24 hours of the non-conformance having been reported to Crown's Environmental Advisor, written notification of the time, date and nature of the environmental incident, plus the corrective action if required, shall be forwarded to Crown Senior Management, and relevant regulatory agencies where required.

4) Crown's Senior Management in conjunction with Crown's Environmental Advisor shall assess the environmental incident report and the nature of further corrective action to be taken, and shall state the timeframe within which the corrective action is to be implemented.

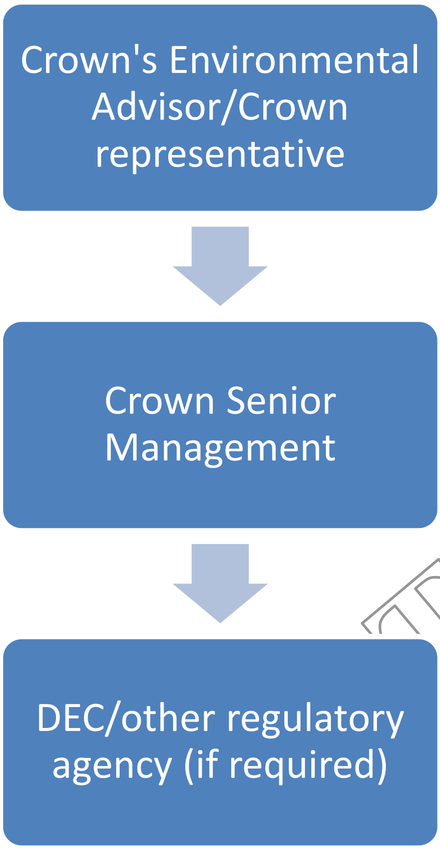

Figure 5: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Operations Phase

It should be stressed that at any point during the operation of the Project any personnel have the right to halt work if human health is at risk.

Environmental incidents and complaints are to be recorded in an Environmental Complaint and Incident Register to be kept by Crown and to be made available to the DEC officers and any other authorised parties to view upon request.

Crown and/or Crown's Environmental Advisor (if directed by Crown) 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 and mitigation measures in the OEMP and/or the Emergency Response Procedure.

13.0 PUBLIC COMPLAINT MANAGEMENT

All complaints received by Crown from the public will be recorded in the Environmental Complaint and Incident Register which will record the following information:

- **Contact details**: Name, address and phone number of party raising concern.
- **Nature of concern**: Details of issue/incident.
- **Action taken or required**: Details of action proposed or undertaken to address the concern, including time and date.
- **Response to action**: Was the party raising the concern satisfied with the outcome. If not, what else needs to be done, or is it outside the scope of the operation of the Crown Towers.

- **Prevention of reoccurrence**: If the concern relates directly to an Operations problem, what action has been taken to prevent the problem from reoccurring.

All complaints shall be referred to Crown for the purpose of investigation.

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.

14.0 TRAINING

Crown shall implement appropriate training and inductions to each person employed to work at the Crown Towers during the Operations Phase. The induction should include the content of Crown's existing Training, Awareness and Competence program (Crown Perth, 2012a) and as a minimum:

- All aspects of the Emergency Response Procedure.
- All aspects of the Environmental Incidents Management Procedure.
- 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.

15.0 REVIEW

The Project EMP (Golder, 2013b), the Environmental Sub-management Plans and the 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 operations to assess if the OEMP is 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 or mitigation measures, or monitoring procedures.
- Where unpredicted adverse environmental impact necessitates a change in environmental management or mitigation 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.

16.0 REFERENCES

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

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

Crown Perth (2012a). Crown Perth Environmental Management System Manual. Perth, WA.

Crown Perth (2012b). Crown Perth Emergency Response Standard Operation Procedure. Perth, WA.

Golder (2012a) Preliminary Site Investigation Report, Proposed Perth Major Stadium. April, 2012. Golder Document Reference Number 127643077-R-005. Golder Associates Pty Ltd. Perth, WA.

Golder (2012b) Sampling and Analysis Plan and Data Quality Objectives, November 2012. Golder document reference number 127642102-008-R-Rev0. Golder Associates Pty Ltd. Perth, WA.

Golder (2013a) Crown Towers Operations Environmental Management Framework. January 2013. Golder Document Reference Number 127643111-R-015. Golder Associates Pty Ltd. Perth WA.

Golder (2013b) Crown Towers Environmental Management Plan. January 2013. Golder Document Reference Number 127643111-R-011. Golder Associates Pty Ltd. Perth WA.

Golder (2013c) Crown Towers Detailed Site Investigation. (Yet to be published). Golder Document Reference Number 127643111-R-0XX. Golder Associates Pty Ltd. Perth WA.

Golder (2013d) Crown Towers Contaminated Site Management Plan. January 2013. Golder Document Reference Number 127643111-R-022. Golder Associates Pty Ltd. Perth WA.

Golder (2013e) Crown Towers Construction Environmental Management Framework. January 2013. Golder Document Reference Number 127643111-R-013. Golder Associates Pty Ltd. Perth WA.

Golder (2013f) Crown Towers Dewatering Management Plan. January 2013. Golder Document Reference Number 127643111-R-012. Golder Associates Pty Ltd. Perth WA.

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Report Signature Page

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APPENDIX A

Guideline Trigger Levels for Surface Water Monitoring

Table 12: Guideline Trigger Levels for Surface Water Monitoring

Chem Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Field Parameters	Oxidation Reduction Potential	mV	-				
	Temperature	0C	-				
	pH		-	**6.5-8.5**	**8-8.4**		**6-9.0**
	Conductivity	ms/cm	-				
	Dissolved oxygen	mg/L	-				
Sample Quality Parameters	pH (Lab)	pH Units	0.1	**6.5-8.5**	**8-8.4**		**6-9.0**
	Sodium (Filtered)	mg/L	0.5				
	Potassium (Filtered)	mg/L	0.1				
	Calcium (Filtered)	mg/L	0.2				
	Magnesium (Filtered)	mg/L	0.1				
	Chloride	mg/L	1			**2500**	
	Sulfate (as SO4)	mg/L	1			**5000**	
	Sulfate (as SO3)	mg/L	1				
	Bicarbonate Alkalinity as (HCO3)	mg/L	5				
	Carbonate Alkalinity (as CO3)	mg/L	1				
	Total Alkalinity (as CaCO3)	mg/L	5				
	Hardness (as CaCO3) (Filtered)	mg/L	5				
	Sum of Ions	mg/L	10				
	TFSS	mg/L	10				
	Anion-Cation Balance	%	-100				

Chem Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Heavy Metals	Arsenic	mg/L	0.001			**0.07**	**0.1**
	Arsenic (Filtered)	mg/L	0.001			**0.07**	**0.1**
	Boron	mg/L	0.005	**0.37**		**40**	**0.5**
	Boron (Filtered)	mg/L	0.005	**0.37**		**40**	**0.5**
	Cadmium	mg/L	0.0001	**0.0002**	**0.0007**	**0.02**	**0.01**
	Cadmium (Filtered)	mg/L	0.0001	**0.0002**	**0.0007**	**0.02**	**0.01**
	Chromium	mg/L	0.001		**0.027**(4)		**0.1**
	Chromium (Filtered)	mg/L	0.001		**0.027**(4)		**0.1**
	Copper	mg/L	0.001	**0.0014**	**0.0013**	**20**	**0.2**
	Copper (Filtered)	mg/L	0.001	**0.0014**	**0.0013**	**20**	**0.2**
	Lead	mg/L	0.001	**0.0034**	**0.0044**	**0.1**	**2**
	Lead (Filtered)	mg/L	0.001	**0.0034**	**0.0044**	**0.1**	**2**
	Manganese	mg/L	0.001	**1.9**		**5**	**0.2**
	Manganese (Filtered)	mg/L	0.001	**1.9**		**5**	**0.2**
	Mercury (filtered)	mg/L	0.00005	**0.00006**	**0.0001**	**0.01**	**0.002**
	Mercury	mg/L	0.0001	**0.00006**	**0.0001**	**0.01**	**0.002**
	Molybdenum	mg/L	0.001			**0.5**	**0.01**
	Molybdenum (Filtered)	mg/L	0.001			**0.5**	**0.01**
	Nickel	mg/L	0.001	**0.011**	**0.007**	**0.2**	**0.2**
	Nickel (Filtered)	mg/L	0.001	**0.011**	**0.007**	**0.2**	**0.2**
	Selenium	mg/L	0.002	**0.005**		**0.1**	**0.02**
	Selenium (Filtered)	mg/L	0.002	**0.005**		**0.1**	**0.02**
	Tin	mg/L	0.001				
	Tin (Filtered)	mg/L	0.001				
	Zinc	mg/L	0.001	**0.008**	**0.015**	**30**	**2**
	Zinc (Filtered)	mg/L	0.001	**0.008**	**0.015**	**30**	**2**

Chem Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Organochlorine Pesticides	a-BHC	mg/L	0.00005				
	Aldrin	mg/L	0.00001				
	Aldrin & Dieldrin (Sum of total)	mg/L				**0.003**	
	b-BHC	mg/L	0.00005				
	cis-Chlordane	mg/L	0.000002				
	gamma-Chlordane	mg/L	0.000002				
	d-BHC	mg/L	0.00005				
	DDD (1)	mg/L	0.00001				
	DDE (2)	mg/L	0.00001				
	DDT (3)	mg/L	0.000002	**0.000006**		**0.2**	
	DDT+DDE+DDD (Sum of total)	mg/L					
	Dieldrin	mg/L	0.000002				
	Endosulfan I	mg/L	0.000005				
	Endosulfan II	mg/L	0.000005				
	Endosulfan sulfate	mg/L	0.000005				
	Endrin	mg/L	0.000004	**0.00001**	**0.000004**		
	Endrin ketone	mg/L	0.00005				
	g-BHC	mg/L	0.00005			**0.2**	
	Heptachlor	mg/L	0.00001	**0.00001**			
	Heptachlor & heptachlor epoxide (Sum of total)	mg/l				**0.003**	
	Heptachlor epoxide	mg/L	0.00002				
	Methoxychlor	mg/L	0.0001				
	Hexachlorobenzene	mg/L	0.00001				

Chem Group	Chem Name	Output Unit	EQL	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005				
	Bromophos-ethyl	mg/L	0.00005				
	Chlorpyriphos	mg/L	0.000009	**0.00001**	**0.000009**	**0.01**	
	Diazinon	mg/L	0.00001	**0.00001**		**0.001**	
	Dichlorvos	mg/L	0.0005				
	Ethion	mg/L	0.00005				
	Fenitrothion	mg/L	0.0002	**0.0002**		**0.01**	
	Malathion	mg/L	0.00005	**0.00005**			
	Methidathion	mg/L	0.00005				
	Parathion	mg/L	0.000004	**0.000004**		**0.01**	
PCBs	PCB 101	mg/L	0.0001				
	PCB 138	mg/L	0.0001				
	PCB 153	mg/L	0.0001				
	PCB 28	mg/L	0.0001				
	PCB 52	mg/L	0.0001				
	PCB 118	mg/L	0.0001				
	PCB 180	mg/L	0.0001				
Total Recoverable Hydrocarbons	TRH C_{10}-C_{14} Fraction	mg/L	0.05				
	TRH C_{15}-C_{28} Fraction	mg/L	0.2				
	TRH C_{29}-C_{36} Fraction	mg/L	0.2				
	TRH >C_{10}-C_{16} F2	mg/L	0.06				
	TRH >C_{16}-C_{34} F3	mg/L	0.5				
	TRH >C_{34}-C_{40} F4	mg/L	0.5				

APPENDIX B

Guideline Trigger Levels for Groundwater Monitoring

Table B1: Guideline Trigger Levels for Groundwater Monitoring

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Sample Quality Parameters	pH (Lab)	pH units	0.01	***6.0-8.5***		6.5-8.5	***8.0-8.4***		6.5-8.5		6-8.5
	Total Dissolved Solids @180°C	mg/L	10								
	Sodium (Filtered)	mg/L	0.5								
	Potassium (Filtered)	mg/L	0.1								
	Calcium (Filtered)	mg/L	0.2								
	Magnesium (Filtered)	mg/L	0.1								
	Chloride	mg/L	1					2500	250		
	Sulfate (as SO4)	mg/L	1					5000	250	500	
	Sulfide	mg/L	0.1								
	Bicarbonate Alkalinity as (HCO3)	mg/L	5								
	Carbonate Alkalinity (as CO3)	mg/L	1								
	Total Alkalinity (as CaCO3)	mg/L	1								
	Hardness (as CaCO3) (Filtered)	mg/L	5						200		
	Nitrate (as NO3-)	mg/L	0.05			0.7		500		50	
	Nitrite (as NO2-)	mg/L	0.05					30		3	
	Nitrogen (Total Oxidised)	mg/L	0.005								
	Ammonia	mg/L	0.005			0.9	***0.91***	5	0.5		
	Total Kjeldahl Nitrogen (as N)	mg/L	0.05								
	Nitrogen (Inorganic)	mg/L	0.05								
	Nitrogen (Total)	mg/L	0.05	***>1.0***							5
	Cyanide (total)	mg/L	0.004			0.007	***0.004***	0.8		0.08	
	Reactive Phosphorus (as P)	mg/L	0.002								
	Phosphorus	mg/L	0.01	***>0.1***		0.2					0.05

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Ionic Balance	%	-100								
	Sum of Ions (calc.)	mg/L	10								
	Thiocyanate	mg/L	0.1								
	Methane	mg/L	0.005								
Microbiological	Coliform	cfu/100ml	1								
	E. coli	cfu/100 ml	1								10(1)
Heavy Metals	Arsenic (Filtered)	mg/L	0.001					0.07		0.007	0.1
	Boron (Filtered)	mg/L	0.005			0.37		40		4	0.5
	Cadmium (Filtered)	mg/L	0.0001			0.0002	***0.0055***	0.02		0.002	0.01
	Chromium (Filtered)	mg/L	0.001								0.1
	Copper (Filtered)	mg/L	0.001			0.0014	***0.0013***	20	1	2	0.2
	Lead (Filtered)	mg/L	0.001			0.0034	***0.0044***	0.1		0.01	2
	Manganese (Filtered)	mg/L	0.001			1.9		5	0.1	0.5	0.2
	Mercury	mg/L	0.00005			0.00006	***0.0001***	0.01		0.001	0.002
	Molybdenum (Filtered)	mg/L	0.001					0.5		0.05	0.01
	Nickel (Filtered)	mg/L	0.001			0.011	***0.07***	0.2		0.02	0.2
	Selenium (Filtered)	mg/L	0.002			0.005		0.1		0.01	0.02
	Tin (Filtered)	mg/L	0.001								
	Zinc (Filtered)	mg/L	0.001			0.008	***0.015***	30	3		2
MAH	1,2,4-trimethylbenzene	mg/L	0.0005								
	1,3,5-Trimethylbenzene	mg/L	0.0005								
	Benzene	mg/L	0.0005			0.95	***0.5***	0.01		0.001	
	Ethylbenzene	mg/L	0.0005					0.003	0.003	0.3	
	Isopropylbenzene	mg/L	0.0005								
	n-Butylbenzene	mg/L	0.0005								
	n-Propylbenzene	mg/L	0.0005								
	p-Isopropyltoluene	mg/L	0.0005								

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	sec-Butylbenzene	mg/L	0.0005								
	Styrene	mg/L	0.0005					0.004	0.004	0.03	
	tert-Butylbenzene	mg/L	0.0005								
	Toluene	mg/L	0.0005					0.025	0.025	0.8	
	Xylenes (m & p)	mg/L	0.001			0.2 (2)		0.02	0.02	0.6	
	Xylene (o)	mg/L	0.0005			0.35		0.02	0.02	0.6	
Organochlorine Pesticides	a-BHC	mg/L	0.00001								
	Aldrin	mg/L	0.00001								
	Aldrin & Dieldrin (Sum of total)	mg/L						0.003	0.0003	0.00001	
	b-BHC	mg/L	0.00001								
	Chlordane (Sum of total)	mg/L	0.00001			0.00003		0.01	0.001	0.00001	
	cis-Chlordane	mg/L	0.000002								
	gamma-Chlordane	mg/L	0.000002								
	trans-Chlordane	mg/L	0.00001								
	d-BHC	mg/L	0.00001								
	DDD	mg/L	0.00001								
	DDE	mg/L	0.00001								
	DDT	mg/L	0.000002			0.00001		0.2	0.02	0.00006	
	DDT+DDE+DDD (Sum of total)	mg/L	0.00001								
	Dieldrin	mg/L	0.000002								
	Endosulfan I	mg/L	0.000005								
	Endosulfan II	mg/L	0.000005								
	Endosulfan sulfate	mg/L	0.000005								
	Endrin	mg/L	0.000004			0.00001	***0.000004***				
	Endrin ketone	mg/L	0.00001								
	g-BHC	mg/L	0.00001			0.0002		0.2	0.02	0.00005	

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Heptachlor	mg/L	0.000005			0.00001					
	Heptachlor & heptachlor epoxide (Sum of total)	mg/l						0.003	0.0003	0.00005	
	Heptachlor epoxide	mg/L	0.00001								
	Methoxychlor	mg/L	0.00001								
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005			0.00002					
	Bromophos-ethyl	mg/L	0.00005								
	Chlorpyriphos	mg/L	0.000009			0.00001	***0.000009***	0.01	0.01		
	Diazinon	mg/L	0.00001			0.00001		0.001	0.003	0.001	
	Dichlorvos	mg/L	0.0001								
	Ethion	mg/L	0.00005								
	Fenitrothion	mg/L	0.0002			0.0002		0.01	0.01		
	Malathion	mg/L	0.00005			0.00005					
	Methidathion	mg/L	0.00005								
	Parathion	mg/L	0.000004			0.000004		0.01	0.01		
Pesticides - Others	Carbaryl	mg/L	0.0005								
Herbicides	Carbofuran	mg/L	0.0005			0.00006		0.005	0.01	0.005	
	Atrazine	mg/L	0.0005			0.013		0.0001	0.04	0.0001	
	Cyanazine	mg/L	0.0005								
	Hexazinone	mg/L	0.001								
	Metribuzin	mg/L	0.0005								
	Prometryn	mg/L	0.0005								
	Propazine	mg/L	0.0005								
	Simazine	mg/L	0.0005			0.0032		0.0005	0.02	0.0005	
	Terbutryn	mg/L	0.0005								
	Terbutylazine	mg/L	0.0005								

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Polychlorinated Biphenyls	PCB 101	mg/L	0.0001								
	PCB 138	mg/L	0.0001								
	PCB 153	mg/L	0.0001								
	PCB 28	mg/L	0.0001								
	PCB 52	mg/L	0.0001								
	PCB 118	mg/L	0.0001								
	PCB 180	mg/L	0.0001								
PAH	Acenaphthene	mg/L	0.00001								
	Acenaphthylene	mg/L	0.00001								
	Anthracene	mg/L	0.00001								
	Benz(a)anthracene	mg/L	0.00001								
	Benzo(a)pyrene	mg/L	0.00001					0.0001		0.00001	
	Benzo(b)&(k)fluoranthene	mg/L	0.00002								
	Benzo(g,h,i)perylene	mg/L	0.00001								
	Chrysene	mg/L	0.00001								
	Dibenz(a,h)anthracene	mg/L	0.00001								
	Fluoranthene	mg/L	0.00001								
	Fluorene	mg/L	0.00001								
	Indeno(1,2,3-c,d)pyrene	mg/L	0.00001								
	Naphthalene	mg/L	0.00002			0.016	***0.05***				
	Phenanthrene	mg/L	0.00001								
	Pyrene	mg/L	0.00001								
PAH - Others	1-Methylnaphthalene	mg/L	0.00001								
	2-Methylnaphthalene	mg/L	0.00001								
Halogenated Benzenes	1,2,3-Trichlorobenzene	mg/L	0.0005			0.003		0.005	0.005	0.003	
	1,2,4-Trichlorobenzene	mg/L	0.0005			0.085	***0.02***	0.005	0.005	0.003	
	1,2-Dichlorobenzene	mg/L	0.0005			0.16		0.001	0.001	1.5	

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	1,3-Dichlorobenzene	mg/L	0.0005			0.26		0.02	0.02		
	1,4-Dichlorobenzene	mg/L	0.0003			0.06		0.003	0.003	0.04	
	2-Chlorotoluene	mg/L	0.0005								
	4-Chlorotoluene	mg/L	0.0005								
	Bromobenzene	mg/L	0.0005								
	Chlorobenzene	mg/L	0.0005					0.01	0.01	0.3	
	Hexachlorobenzene	mg/L	0.00001								
Phenolics	2,4-Dimethylphenol	mg/L	0.0001								
	2,4-Dinitrophenol	mg/L	0.0001								
	2-Methylphenol	mg/L	0.0001								
	2-Nitrophenol	mg/L	0.00005								
	3- & 4-Methylphenol	mg/L	0.0002								
	3,4-Dimethylphenol	mg/L	0.0002								
	4-Nitrophenol	mg/L	0.00005								
	Phenol	mg/L	0.0001			0.32	***0.4***				
Phenolics-Halogenated	2,3,4,6-Tetrachlorophenol	mg/L	0.00001			0.01					
	2,3,5,6-Tetrachlorophenol	mg/L	0.00001								
	2,4,5-Trichlorophenol	mg/L	0.00001								
	2,4,6-Trichlorophenol	mg/L	0.00001			0.003		0.2	0.002	0.02	
	2,4-Dichlorophenol	mg/L	0.00001			0.12		2	0.0003	0.2	
	2,6-Dichlorophenol	mg/L	0.00001								
	2,3,4,6 & 2,3,5,6-Tetrachlorophenol	mg/L	0.00002								
	2-Chlorophenol	mg/L	0.0001			0.34		3	0.0001	0.3	
	Pentachlorophenol	mg/L	0.00001			0.0036	***0.011***				

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Solvents	Methyl Ethyl Ketone	mg/L	0.01								
	2-Hexanone	mg/L	0.005								
	4-Methyl-2-pentanone	mg/L	0.005								
	Acetone	mg/L	0.01								
	Acrylonitrile	mg/L	0.0005								
	Methyl-t-butyl ether	mg/L	0.0005					0.012	0.012		
	Vinyl acetate	mg/L	0.01								
Total Recoverable Hydrocarbons	TRH C_6-C_9 Fraction	mg/L	0.02								
	TRH C_{10}-C_{14}	mg/L	0.05								
	TRH C_{15}-C_{28}	mg/L	0.1								
	TRH C_{29}-C_{36}	mg/L	0.05								
	TRH C_6-C_{10} minus BTEX (F1)	mg/L	0.02								
	TRH >C_{10}-C_{16} F2	mg/L	0.06								
	TRH >C_{16}-C_{34} F3	mg/L	0.5								
	TRH >C_{34}-C_{40} F4	mg/L	0.5								
Total Petroleum Hydrocarbons	TPH >C_{16}-C_{28} Aliphatic	ug/L	250								
	TPH >C_{16}-C_{28} Aromatic	ug/L	250								
	TPH >C_{16}-C_{35} Aliphatic (Sum)	ug/L	500								
	TPH >C_{28}-C_{35} Aliphatic	ug/L	250								
	TPH >C_{28}-C_{35} Aromatic	ug/L	250								
	TPH >C_9-C_{16} Aliphatic	ug/L	150								
	TPH >C_9-C_{16} Aromatic	ug/L	150								
	Aliphatic Hydrocarbons>C_{35} - C_{40}	mg/L	0.5								
	TPH C_{16}-C_{35} Aromatic	mg/L	0.5								

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Volatile Organic Compounds	1,1,1,2-Tetrachloroethane	mg/L	0.0005								
	1,1,2,2-Tetrachloroethane	mg/L	0.0005								
	1,1,1-Trichloroethane	mg/L	0.0005								
	1,1,2-Trichloroethane	mg/L	0.0005			6.5	***1.9***				
	1,2,3-Trichloropropane	mg/L	0.0005								
	1,2-Dibromo-3-chloropropane	mg/L	0.0005								
	1,2-Dibromoethane	mg/L	0.0005								
	1,1-Dichloroethane	mg/L	0.0005								
	1,2-Dichloroethane	mg/L	0.0005					0.03		0.003	
	1,1-Dichloroethene	mg/L	0.0005					0.3		0.03	
	cis-1,2-Dichloroethene	mg/L	0.0005								
	trans-1,2-dichloroethene	mg/L	0.0005								
	1,2-Dichloropropane	mg/L	0.0005								
	1,3-Dichloropropane	mg/L	0.0005								
	2,2-Dichloropropane	mg/L	0.0005								
	1,1-Dichloropropene	mg/L	0.0005								
	cis-1,3-Dichloropropene	mg/L	0.0005								
	trans-1,3-dichloropropene	mg/L	0.0005								
	cis-1,4-Dichloro-2-butene	mg/L	0.001								
	trans-1,4-Dichloro-2-butene	mg/L	0.001								
	Allyl chloride	mg/L	0.0005								
	Bromochloromethane	mg/L	0.0005								
	Bromodichloromethane	mg/L	0.0005								
	Bromoform	ug/L	0.5								
	Bromomethane	mg/L	0.01								
	Carbon disulfide	mg/L	0.0005								
	Carbon tetrachloride	mg/L	0.0005					0.03		0.003	

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values	Estuarine	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Chlorodibromomethane	mg/L	0.0005								
	Chloroethane	mg/L	0.005								
	Chloroform	mg/L	0.0005								
	Chloromethane	mg/L	0.005								
	Dibromomethane	ug/L	0.5								
	Dichlorodifluoromethane	mg/L	0.005								
	Dichloromethane	mg/L	0.005					0.04		0.004	
	Hexachlorobutadiene	mg/L	0.001					0.007		0.0007	
	Iodomethane	mg/L	0.005								
	Trichloroethene	mg/L	0.0005								
	Tetrachloroethene	mg/L	0.0005					0.5		0.05	
	Trichlorofluoromethane	mg/L	0.001								
	Vinyl chloride	mg/L	0.0003					0.003		0.0003	

APPENDIX C

Crown Towers Dewatering Management Plan

APPENDIX D

Crown Towers Contaminated Site Management Plan

APPENDIX E

Glossary and Definitions

Project Glossary and Definitions

Term	Definition
µg/m^3	Micrograms per cubic metre
AHD	Australian Height Datum
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.
DEC	Department of Environment and Conservation
DOW	Department of Water
DSI	Detailed Site Investigation
EMFs	Environmental Management Frameworks
EMPs	Environmental Management Plans
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
Golder	Golder Associates
Lead Contractor	Contractor engaged to undertake Construction Phase works
OEMF	Operations Environmental Management Framework
OEMP	Operations Environmental Management Plan
OEPA	Office of the Environmental Protection Authority
OHS	Occupational Health and Safety
Operations Phase	The phase of the Project during which operations will be undertaken
ppm	Parts per million
Project	The Crown Towers Project
Project EMP	Crown Towers Environmental Management Plan
PSI	Preliminary Site Investigation
RL	Reduced Levels
SCD	Sandy Channel Deposit
SRA	Swan River Alluvium
SRT	Swan River Trust
TSP	Total Suspended Particulates

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Golder Associates

APPENDIX C

Contaminated Site Management Plan

February 2013

CROWN PERTH

Contaminated Site Management Plan

Submitted to:
James Noel
Crown Perth
Great Eastern Highway
BURSWOOD WA 6979

REPORT

Report Number. 127643111-022-R-RevC

Distribution:

1 Electronic Copy - Crown Perth
1 Electronic Copy - Golder Associates Pty Ltd

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1.0 INTRODUCTION

1.1 Overview

Crown Perth (Crown Perth) has engaged Golder Associates Pty Ltd (Golder) to prepare a Contaminated Sites Management Plan (CSMP) for the construction of the new Crown Towers Project (the Project) on the Burswood Peninsula in Perth, Western Australia. This CSMP has been prepared as part of an Environmental Management Strategy to assist Crown in establishing and maintaining best practice controls to manage potential environmental and social impacts during the Project.

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 is intended to be a working draft and will be revised once the Detailed Site Investigation (DSI) is finalised and the Lead Contractor has been engaged.

For planning purposes the Project is to be delivered in two phases:

- **Construction Phase:** the construction of the Crown Towers, Podium and associated infrastructure, which will include the use of deep piles to provide building support for the main structures.
- **Operations Phase:** the operation of the Crown Towers. The transition from the Construction Phase to the Operations Phase will occur once the all Construction Phase work has been completed and the Lead Contractor has left site, handing the development infrastructure over to Crown. Ongoing environmental monitoring of the site and management of site facilities will continue during the Operations Phase.

Delivery of the Project has potential for environmental and social impacts (primarily surrounding the works proposed for the Construction Phase) and will therefore be referred to the Office of the Environmental Protection Authority (OEPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (EP Act).

1.2 Scope

The scope of this CSMP relates to the Construction Phase and Operations Phase of the Project including:

- Construction of the:
  - Crown Towers' six-star, 25-level, 500-room hotel development.
  - Podium structure, linking the hotel to adjoining buildings and properties (approximately 25 000 m^2 footprint).
  - Associated services buildings (for generators, bins, refuse, hoist and loading bay under croft).
  - Porte cocheré.
  - Pedestrian access ways.
  - Undercover parking facilities.
- New and refurbishment of existing external works (including new landscaping and swimming pools, approximately 11 000 m^2)
- Refurbishment of existing function room and associated public spaces
- Rehabilitation and landscaping (approximately 33 000 m^2 footprint)
- Stormwater catchment lake(s) infill and expansion.

1.3 Contaminated Site Management Plan Objectives

The Project area is classified by the Department of Environment and Conservation (DEC) 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 further 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, 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 Crown Perth 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 Crown Perth and its contractors are to follow to minimise impact on sensitive receptors and the environment during the Operations Phase of the Project.

1.4 Project Location and History

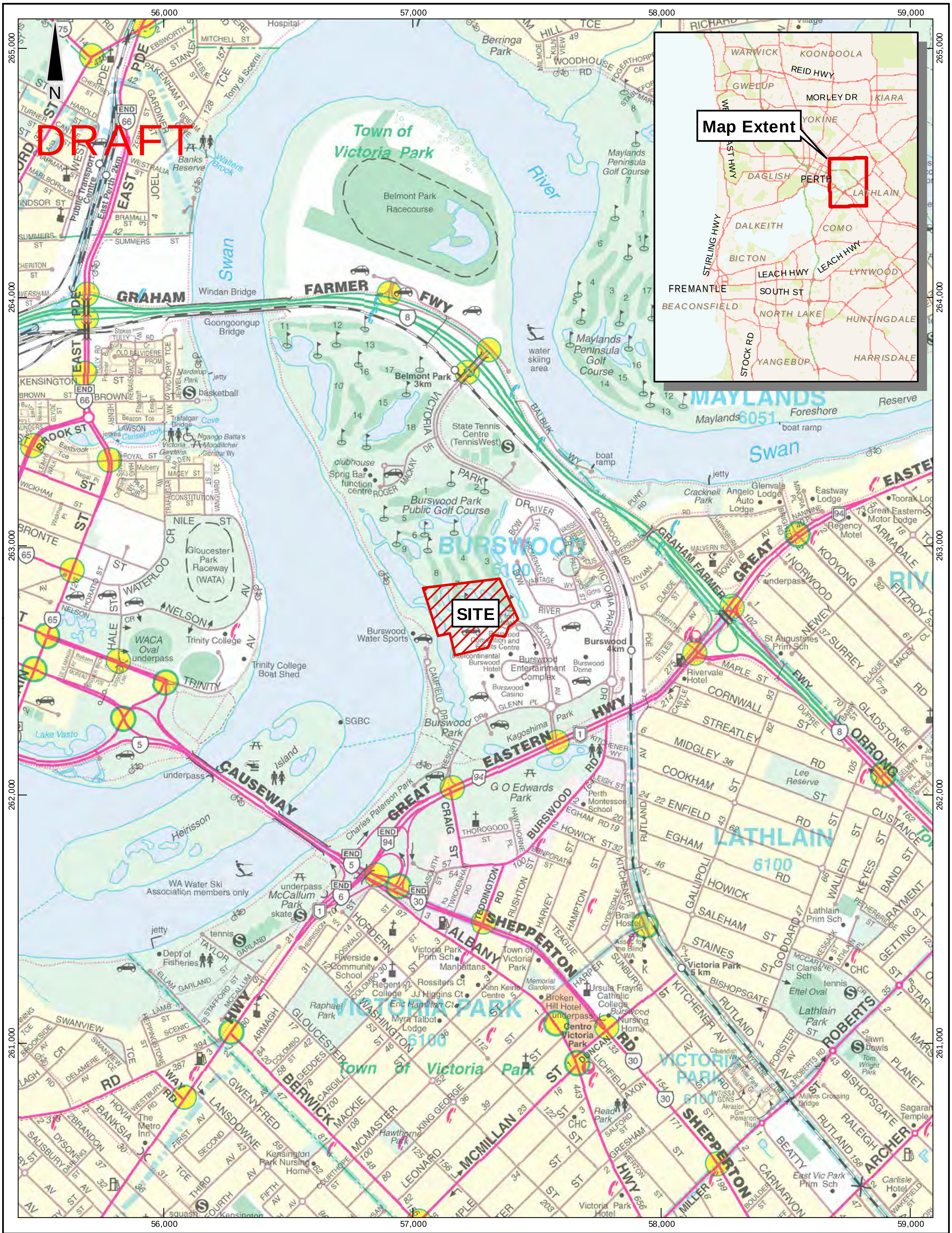
The Crown Perth complex is located at 201 Great Eastern Highway on the Burswood Peninsula in the City of Perth, Western Australia. The Project will be located within the southern nine holes of the Burswood Park Golf Course located on the Burswood Peninsula, as shown in Figure 1.

The Burswood Peninsula extends over an area of approximately 280 ha and is located approximately 2.9 km east of the Perth CBD. A variety of land uses are located within the Burswood Peninsula including the Burswood Park Golf Course, the State Tennis Centre, the Crown Perth Complex, the Dome, the Burswood Peninsula residential development, the Belmont Racecourse and assorted parklands and car parks. The Burswood Peninsula is accessed by road from the Graham Farmer Freeway, Victoria Park Drive and the Great Eastern Highway, with Belmont and Burswood train stations also servicing the area.

The Project area includes the southern end of the Burswood Park Golf Course, which is currently under the control and management of the Burswood Park Board, and the Crown Perth Complex. The Project area is surrounded by land zoned for parks and recreation, residential, and public purposes - special uses (Crown Perth Complex). The Swan River, which is in close proximity but not directly adjacent the Project area is managed by the Swan River Trust (SRT), a state government agency that protects, manages and enhances the Swan Canning Riverpark.

The Project area is shown in Figure 2 (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 Burswood Park Golf Course to the north; the Mirvac residential development to the east; the Crown Perth complex to the south; and the Burswood Water Sports Centre and the Swan River to the west.

The Project area has had an extensive history of potentially contaminating land use activities. Therefore, an environmental DSI was conducted in accordance with the Department of Environment and Conservation (DEC) Contaminated Sites Management Series Guidelines and the implications of the DSI findings are discussed throughout this document. It is anticipated that the DSI report, once reviewed by the Contaminated Sites Auditor engaged for the Project, will be available towards the end of February 2013.



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DATE	07 Feb 2013
COMPILED	MS
APPROVED	DRAFT

0 200 400 600 800 1,000
Metres

SCALE (at A4) 1:20,000

NOTES
Coordinate System: Perth Coastal Grid (PCG94)

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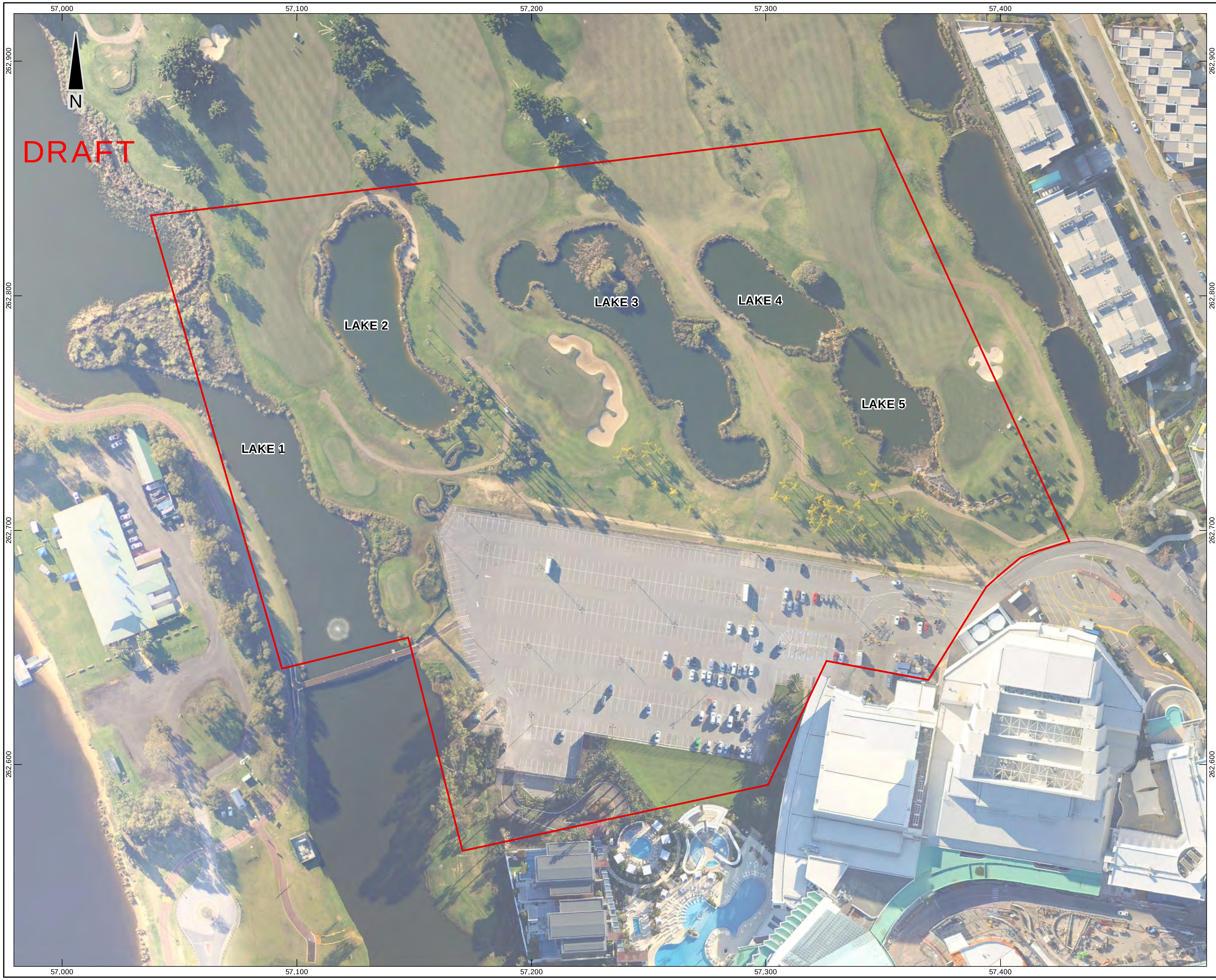
Base Data/Roads sourced from Street Pro Data 2009.

Crown Towers Perth
Contaminated Site Management Plan

SITE LOCATION

FIGURE 1

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\022 R\127643111-022-R-F001-RevC.mxd



LEGEND

Site boundary

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

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Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 20 40 60
Metres

SCALE (at A3) 1:1,500

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COMPILED	MS
APPROVED	DRAFT

Crown Towers Perth
Contaminated Site Management Plan

PROJECT LAYOUT

FIGURE 2

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\022 R\127643111-022-R-F002-RevC.mxd

2.0 PROJECT SCOPE

The delivery of the Construction Phase (including any preconstruction works) of the Project, and the delivery of the Operations Phase of the Project is described in the following sections.

2.1 Construction Phase

2.1.1 Preconstruction Works

Preconstruction works are necessary to prepare the site for construction and in particular, to manage the underlying ground conditions. The main components of the preconstruction works for this Project are site preparation and earthworks. Information in the following sections is based on the *Preliminary Geotechnical Advice* (Golder, 2013a).

2.1.1.1 Site Preparation

The site preparation works have been identified as those that do not require significant ground disturbance:

- 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, if required.

2.1.1.2 Earthworks

Isolated excavation works may be required for the construction/installation of:

- Trenches for provision of services such as sewage and electricity.
- Swimming pools.
- Piles for the main structures.
- Base of the elevator shaft.
- All excavation works will not extend below the clean fill layer where practicable.

Other earthworks include:

- Importation and placement of clean fill materials and undertaking general earthworks including shaping and contouring existing landscape to specific levels.
- Removing the existing car park.
- Clearing existing trees and vegetation.
- The new development needs 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 site.
- In relation to the lakes:
  - Partially infill Lake 1.
  - Enlarge and replace clay liner in Lake 2 for use in on-site stormwater retention.
  - Infill a portion and reshape and replace clay liner in Lakes 3 and 4.
  - Completely infill Lake 5.

2.1.2 Construction Works

2.1.2.1 Overview

The construction works will commence following completion of the preconstruction works. The development loads associated with the Crown Towers 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.

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 palaeochannel which traverses the site.

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

- Low rise structures (such as Pools and associated deck and landscaped area).
- High rise structures (such as the Crown Towers hotel building).

2.1.2.2 Piling

Potential piling solutions for more heavily loaded areas are:

- Driven precast concrete piles of larger cross-section, such as 450 mm square or 550 mm octagonal sections.
- Driven steel tubular piles of typically about 600 mm to 750 mm diameter.
- Bored piles of typically about 900 mm to 1200 mm diameter.
- Continuous flight auger piles of typically about 750 mm to 900 mm diameter.

Pile lengths of between about 30 m and 35 m would be anticipated at the tower location should 600 mm diameter driven steel tubular piles be constructed. Steel tubular piles are expected to be able to be driven a greater distance into the Kings Park Formation (KPF) than precast concrete piles.

Detailed consideration and regular maintenance is likely to be required at the interface between the piled area and the non-piled areas.

2.2 Operations Phase

The Operations Phase of the Project involves the transition of the Towers, Podium and other infrastructure from construction to operation and being opened to the public. The Operations Phase will include ongoing environmental management by Crown Perth. Crown Perth will also be responsible for the maintenance of the facilities and infrastructure and the monitoring of the site which is anticipated to be ongoing for at least a period of two years as detailed in Section 0 and within the OEMP.

The potential environmental impacts, proposed management and mitigation measures and monitoring procedures associated with the operations, particularly noise, are detailed in the respective Crown Perth Environmental Management Plans (EMPs).

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 OEPA. Crown Perth is referring the Project to the OEPA under Section 38 of the EPA Act. 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) - Licences 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.

  It is expected that only isolated dewatering will be required during Project works and it is the responsibility of the Lead Contractor for the Construction Phase to obtain a 5C licence to take water from an underground source, if required. Nonetheless, Crown Perth has undertaken consultation with DOW regarding the Project. 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 DEC database indicates that "*landfill material has been identified beneath the site including impacts to soil, groundwater and sediment*". Jason Clay of AECOM Pty Ltd is the Contaminated Site Auditor and therefore all environmental matters (including the individual management plans) related to the project must be reviewed by him from a contaminated sites perspective prior to implementation.

- ***Occupational Health, Safety and Welfare Act, 1984*** - Construction of the Project as well as any plants designed to remediate contaminated material on-site must be in accordance with the *Occupation Health, Safety and Welfare Act 1984*. This Act 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. The registration of a plant design is required under part 4 of the regulations.

  A more detailed list of legislation and standards potentially applicable to the Project is outlined in Crown Perth's EMP (Golder, 2013b).

3.1 Guidance Literature

The CSMP has been prepared following guidance included in the DEC 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 Crown Perth 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 3. The position of this document within the structure is highlighted in red text.

This CSMP has been prepared by Golder on behalf of Crown Perth and reviewed by the Contaminated Site Auditor and will be provided to the Lead Contractor(s) to implement to ensure specific environmental management of the Project. The CSMP will be prepared to the satisfaction of the relevant regulating agencies and may be submitted with any licence or permit applications required. Final approval of any amendments to contract specific CSMPs (where amended by the Lead Contractor(s) with input from the Contaminated Site Auditor) will be required by Crown Perth's Environmental Advisor before any form of work begins on-site. 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 Crown Perth's EMP (Golder, 2013b).

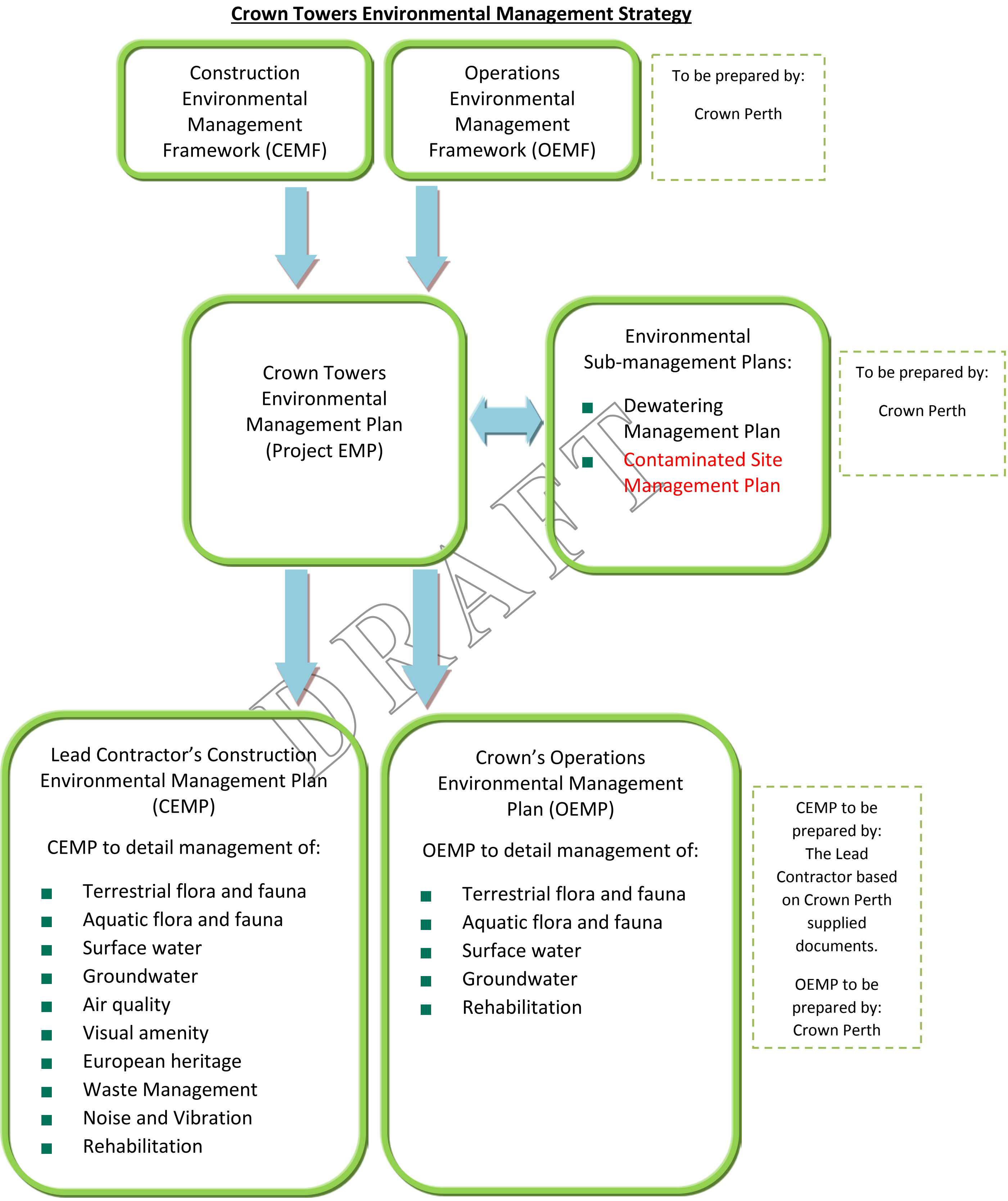


Figure 3: Environmental Management Strategy Structure

5.0 ROLES AND RESPONSIBILITIES

Roles and responsibilities for all personnel involved in the Project are outlined in Crown Perth's EMP (Golder, 2013b), including the:

- Crown Perth's General Project Management Team
- Crown Perth's Environmental Advisor
- Lead Contractor General Project Management Team
- Lead Contractor's Construction Manager
- Lead Contractor's Environmental Representative.

Jason Clay from AECOM Pty Ltd has been appointed as the Contaminated Sites Auditor 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 reported to the Contaminated Sites Auditor within 24 hours of occurrence. 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, etc) must be made available to the Contaminated Sites Auditor at his request.

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 Environmental Representative 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 Crown Perth's Environmental Advisor(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.
- 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 Crown Perth's Environmental Advisor 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 refer to Crown Perth's EMP (Golder, 2013b).

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 the Construction Manager for approval by Crown Perth's Environmental Advisor and the Contaminated Sites Auditor (if required).

A copy of the MTS records should be retained on-site and be provided on request by the Lead Contractor(s) at any time. A MTS shall be in place for the incoming materials, excavated soil and dewatered 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.

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

- Details of area excavated or dewatered, including location, estimated 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 or receipts from the landfill facility.
- Reference to analytical results, including quality control results and waste classification category if available.

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 50 m east of the Project.
- Swan River which is approximately 50 m to 90 m to the west of the Project area.
- Flora and fauna contained within the landscaped Burswood Park Golf Course.
- Groundwater system.

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.
- Importation of fill material to 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.
- 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.

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 Crown Perth's EMP (Golder, 2013b). 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.
- Reiteration of specific environmental management procedures which have already been communicated to site personnel.

Regular meetings between the Lead Contractor's Environmental Representative and Crown Perth's Environmental Advisor 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 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. All materials likely to be disturbed during Construction Phase works at the site are considered ASS. Management procedures are outlined in Section 10.1.6 below, and are presented in full detail as Appendix A.

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 golf course portion of the site largely consists of undulating grass fairways, greens, sand bunkers and "rough" areas containing grass and trees as well as four shallow man-made lakes (Lakes 2 through 5). The western portion of the site consists of a portion of Lake 1. The southern portion of the site consists of a large parking lot used by the nearby Crown Perth Complex. None of these lakes are connected via permanent water ways to the Swan River.

The ground surface level over this part of the peninsula is largely low lying and is subject to inundation during flooding of the Swan River. During elevated periods of rain the groundwater levels on the golf course may also rise above ground surface resulting in boggy conditions. The current ground surface elevation at the golf course generally ranges from RL 2 m Australian Height Datum (AHD) near Lake 1 and gently undulates to the east with an overall increase to about RL 4 m AHD. A topographical high point is located on the south-east corner of the golf course with an RL 7.4 m AHD at a recently reconstructed bunker area. In comparison the parking lot on the southern portion of the site is generally flat with a topographical range of approximately RL 2.4 m AHD to 3.1 m AHD. The topography of the site has changed dramatically over the years due to the importation of various types of fill material which has generally increased the topographically elevation due to the placement of the fill material.

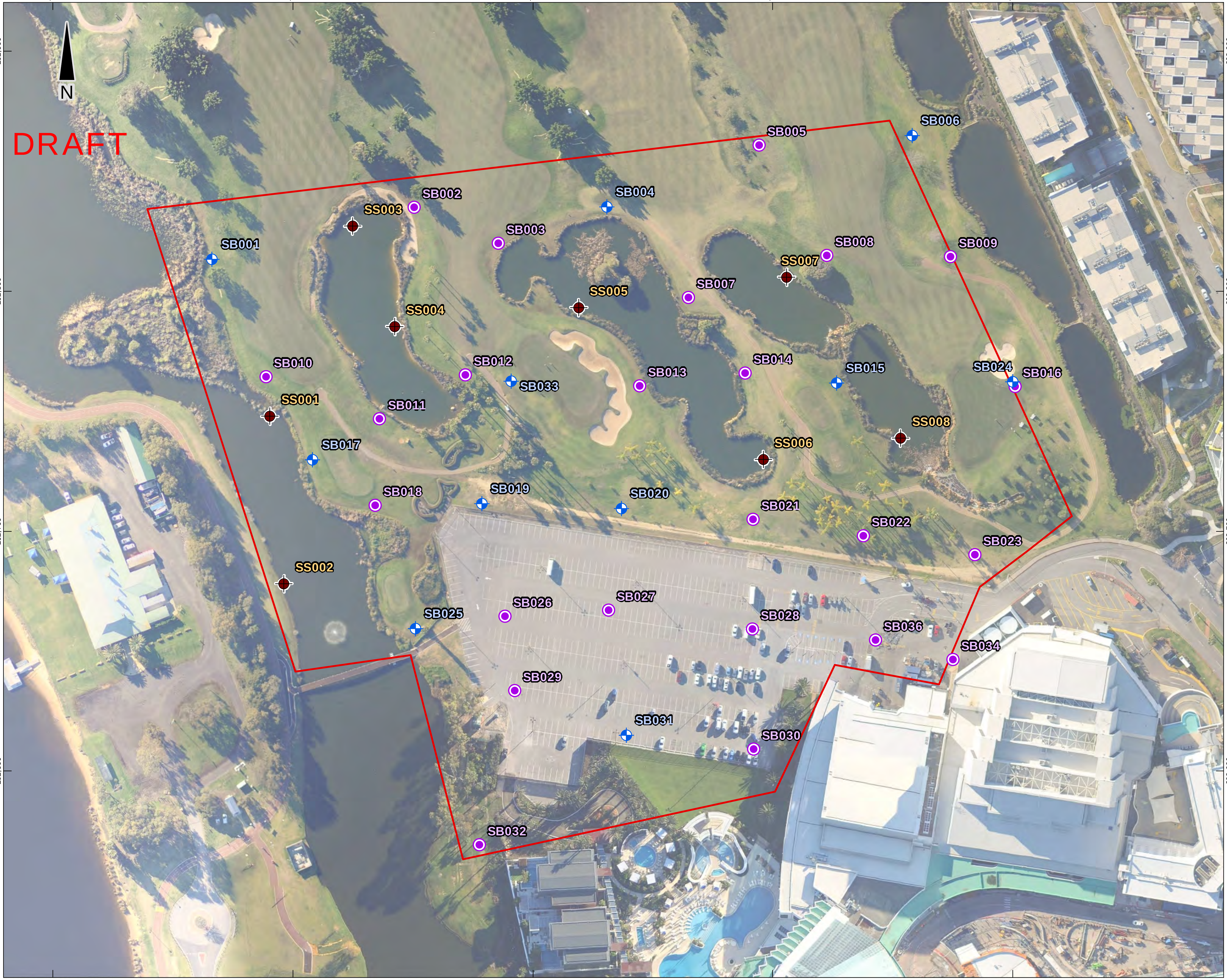
In chronological order from youngest to oldest, the four principal geological units have been assigned as follows:

- 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 detail on the composition of the above units is described in the Preliminary Geotechnical Advice (Golder, 2013a).

10.1.2 Contaminated Soils

A DSI was undertaken by Golder (2013c) and included the collection of samples of lake sediment and soil from bores across the site and 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.



LEGEND

- Soil bore converted to a groundwater monitoring well
- Soil bore converted to a landfill gas monitoring well
- Sediment sample
- Site boundary

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT

Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 20 40 60
Metres

SCALE (at A3) 1:1,500

Golder Associates

CLIENT	Crown Perth
DOCUMENT	127643111-022-R-RevC
DATE	07 Feb 2013
COMPILED	MS
APPROVED	DRAFT

Crown Towers Perth
Contaminated Site Management Plan

DSI SOIL & SEDIMENT INVESTIGATION LOCATIONS

FIGURE 4

A summary of the exceedances of DEC Ecological Investigation Levels (EIL) in soil samples collected during the DSI has been included as Table 1. A summary of the exceedances of the DEC Health Investigation Levels (HIL D) has been provided in Table 2. Asbestos was not noted during the investigation; however, due to the type of waste material and the confirmed presence of asbestos in waste fill at locations outside of the site boundaries there is the potential for asbestos in fragment form and fibre form to be present on-site.

Table 1: Locations of EIL Exceedances

Contaminant of Concern	Location and Depth (m bgl)
Arsenic	SB006 (2.2 to 2.6), SB017 (2.5 to 3)
Cadmium	SB011 (3.5 to 4), SB012 (5 to 5.5), SB015 (2.8 to 4.5), SB030 (3 to 3.3), SB036 (3 to 3.2)
Copper	SB003 (2.5 to 3), SB014 (3 to 4.5), SB034 (3.5 to 4.3)
Lead	SB005 (5.8 to 6), SB012 (3 to 4.5)
Tin	SB002 (4 to 4.5), SB004 (2.6 to 3), SB006 (2.2 to 2.6), SSB007 (3 to 4.5), SB014 (3 to 4.5), SB020 (3.2 to 3.6), SB030 (3 to 3.3), SB034 (3.5 to 4.3), SB036 (3 to 3.2)
Zinc	SB003 (2.5 to 3), SB004 (2.6 to 3), SB005 (5.8 to 6), SB007 (3 to 4.5), SB009 (5.8 to 6), SB011 (3.6 to 4), SB012 (4.6 to 5), SB012 (5 to 5.5) SB012 (5.6 to 5.9), SB014 (3 to 4.5), SB015 (2.8 to 4.5), SB018 (5 to 5.5), SB020 (3.2 to 3.6), SB020 (4 to 4.5), SB021 (4.2 to 4.5), SB022 (4.3 to 5), SB024 (4.5 to 6) SB025 (3.2 to 4), SB030 (3 to 3.3), SB022 (3 to 3.2), SB034 (3.5 to 4.3), SB036 (4.6 to 4.9)
Polychlorinated biphenyls	SB003 (2.5 to 3), SB005 (5.8 to 6), SB007 (3 to 4.5), SB014 (3 to 4.5)
Benzo(a)pyrene	SB002 (1.8 to 2.2), SB009 (3.5 to 4.5), SB011 (3.5 to 4), SB022 (3.5 to 4), SB029 (4 to 4.5)
Fluoranthene	SB009 (3.5 to 4.5), SB011 (3.5 to 4)
Pyrene	SB009 (3.5 to 4.5), SB011 (3.5 to 4)
Dieldrin	SB012 (2.5 to 3)
Sum of (DDT, DDE and DDD)	SB017 (3.2 to 4)

Table 2: Location of HIL D Exceedances

Contaminant of Concern	Location and Depth (m bgl)
Lead	SB009 (3.5 to 4.5)
Benzo(a)pyrene	SB011 (3.5 to 4)

Sediment samples were compared to both the ISQG low and high guidelines. Only exceedances of the ISQG low guidelines were noted and a summary is included in Table 3.

Table 3: Location of ISQG Low Exceedances

Contaminant of Concern	Location
Cadmium	SS001
Nickel	SS001
Lead	SS009

10.1.3 Acid Sulfate Soils

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 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 5 illustrates the risk for ASS in the Project area.

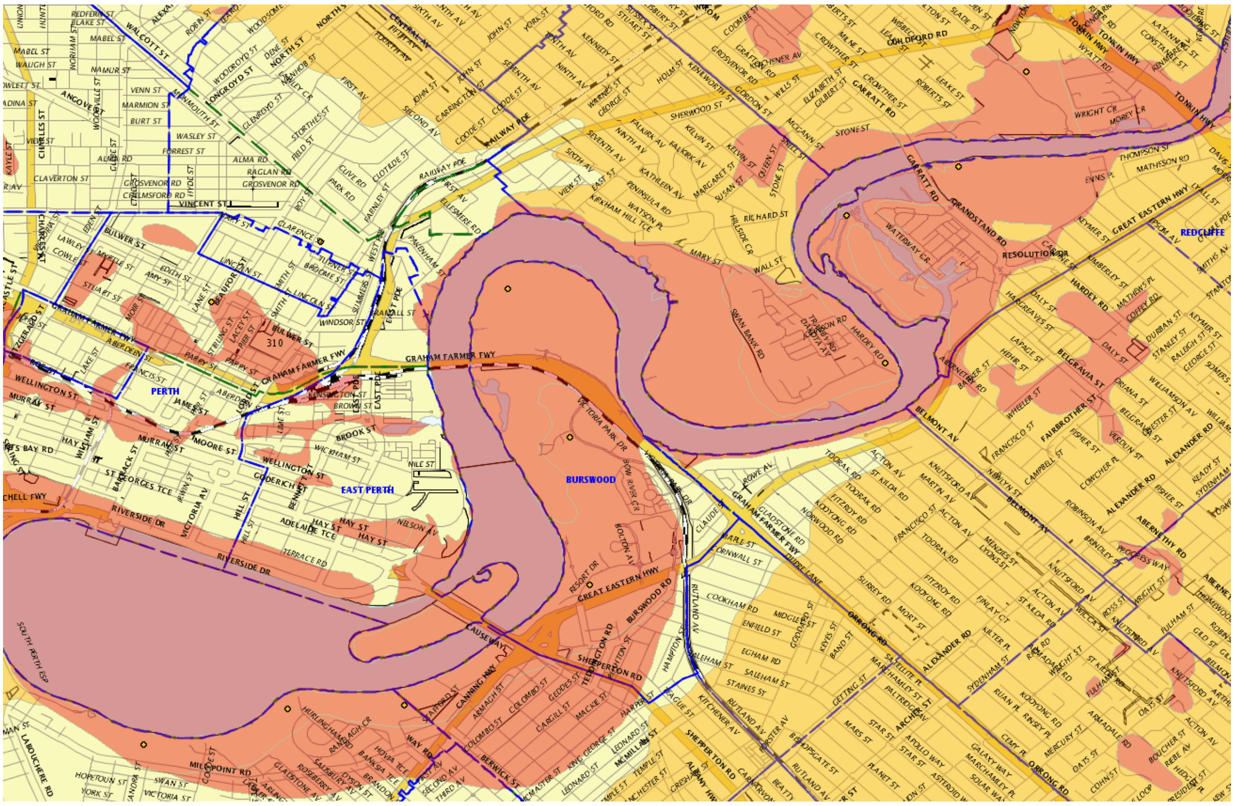


Figure 5: Risk for ASS in the Project Area

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. Consequently, the information derived from the maps cannot be relied upon to confirm whether ASS management will be required for a specific location, even though these maps provide a broad-scale indication of ASS risk.

Investigations including the recently completed DSI (Golder, 2013c) have confirmed that ASS are present in areas of the Burswood Peninsula. The high risk natural materials detailed in the DEC 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 Swan River Alluvium also potentially contains 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 as part of the DSI (Golder, 2013c). Acidic 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 greater than 0.5 m below ground level (m bgl) are considered to be ASS and if disturbed during construction activities should be managed according to the procedures presented as Appendix A. It is advised the top 0.5 m of material excavated at the site can be placed elsewhere on-site without active management, provided it remains within 0.5 m of ground surface and is found to be uncontaminated.

ASS at site will be managed by the Lead Contractor(s) according to this CSMP.

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 piles.
- Excavation of obstructions in fill material for installation of 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 via dust generation.

10.1.5 Construction Phase Management Objectives, Targets and Key Performance Indicators

Table 4: 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 not to remain on-site for longer than 3 days (72 hours) after the receipt of laboratory analytical results	Site inspection and MTS detailing stockpiles
Prevent adverse impacts to sensitive receptors as a result of excavation or stockpiling of contaminated soil.	No runoff from stockpiled material	All stockpiled material to be in bunded areas (Procedure B 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
		Management of water as per Procedure D (Appendix A)

10.1.6 Management Measures

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

All excavated soils within the groundwater zone will need to be stockpiled in order to facilitate draining of water from the soil prior to removal to a landfill. These stockpiles should not remain on-site for more than three days after the receipt of analytical results. When not in use and if feasible, stockpiles should remain covered to minimise dust generation. All efforts should be made to minimise the amount and duration of stockpiled soil on-site.

Provided that the top 0.5 m of material excavated at the site is above the water table and not contaminated it can be placed elsewhere on-site without active management, provided it remains within 0.5 m of the ground surface.

A decision tree 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 are not treated on-site due to the potential for asbestos fibres to be mobilised during mixing of aglime. As a result, excavated materials which are either ASS or deemed contaminated are to be transported to a suitably licensed 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 contaminant exceedances exist, this classification may need to be reviewed. Tip dockets are to be collected and included in the final closure report. All excavated materials are to be included on the MTS as outlined in Section 6.0.

Management measures related to address these issues are presented as 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 any 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 5. 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 Construction Phase of the Project can be prevented.

The management of leachate from the processes of dewatering and soil draining is detailed in Procedure D of Appendix A and should also be used to ensure compliance with the necessary requirements.

Table 5: Monitoring Required to Achieve Soil Management Targets and Key Performance Indicators

<table>
<tr><th>Objective</th><th>Parameters</th><th>Frequency</th><th>Location</th><th>Responsibility</th></tr>
<tr><td rowspan="3">Ensure proper disposal of excavated material while minimising impact of stockpiled soil on receptors</td><td rowspan="2">Landfill disposal suite[1]</td><td>Within three days of material being excavated</td><td>Stockpile</td><td>Lead Contractor’s Environmental Representative</td></tr>
<tr><td>Number of samples based on volume excavated[2]</td><td>Stockpile</td><td>Lead Contractor’s Environmental Representative</td></tr>
<tr><td colspan="2">Daily observations throughout stockpile period[3]</td><td>Stockpile</td><td>Lead Contractor’s Environmental Representative</td></tr>
<tr><td>Ensure that groundwater and the Swan River are not impacted by stockpiled soils</td><td colspan="4">Covered as part of the Water Management Plan, Section 10.2</td></tr>
<tr><td>Air quality (dust, vapours, odours) is not impacted</td><td colspan="4">Covered as part of the Air Management Plan, Section 10.3</td></tr>
</table>

[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 6. The Lead Contractor has responsibility for the implementation of contingency actions and is to notify Crown Perth of any triggered events.

Table 6: Contingency Actions for the Soil Management Plan

Trigger	Potential Actions
Runoff occurring from stockpiles	1) Stop runoff from occurring by increasing bund height (outlined in Procedure B of Appendix A) 2) Have stockpiles removed to a licensed off-site disposal location 3) Confirm water quality of runoff based on laboratory analysis 4) Monitor receiving environment for negative impacts.
Stockpile remains on-site for longer than three days after the receipt of analytical results	1) Have stockpiles removed to a licensed off-site disposal location.
Groundwater acidity increases near excavation activities[1]	1) Stop excavation activities 2) Confirm status of groundwater by undertaking laboratory analysis 3) Monitor downgradient locations for increased acidity 4) Advise Crown Perth and Crown Perth's Environmental Advisor 5) If increases in acidity are noted at downgradient locations then implement relevant mitigation measures as per the Contractor's CEMP 6) If the above points do not resolve the issues, or if otherwise required, Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Groundwater acidity increase near stockpiles[2] above trigger levels in Table 10	1) Have stockpiles removed to a licensed off-site disposal location 2) Prior to re-use of bunded area, check lining for defects.
Monitoring results indicate elevated dust levels associated with excavation of potentially contaminated material	1) Stop work if workers or receptors are being exposed to elevated dust levels 2) Implement additional dust suppression measures as per the Contractor's CEMP 3) Advise Crown Perth and Crown Perth's Environmental Advisor 4) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Monitoring results indicate elevated dust levels associated with on-site stockpiled contaminated material	1) Stop work if workers or receptors are being exposed to elevated dust levels. 2) Implement additional dust suppression measures as per the Contractor's CEMP 3) Have stockpiles removed to a licensed off-site disposal location.
Monitoring results indicate elevated vapour concentrations	1) Ensure health and safety measures for on-site workers are suitable. 2) Stop ground disturbance activity 3) Advise Crown Perth and Crown Perth's Environmental Advisor 4) Implement additional suppression such as water sprays as per the Contractor's CEMP 5) Stop site activities until wind conditions are favourable to minimise risk to sensitive receptors (Additional information in Section 10.3) 6) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

[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.

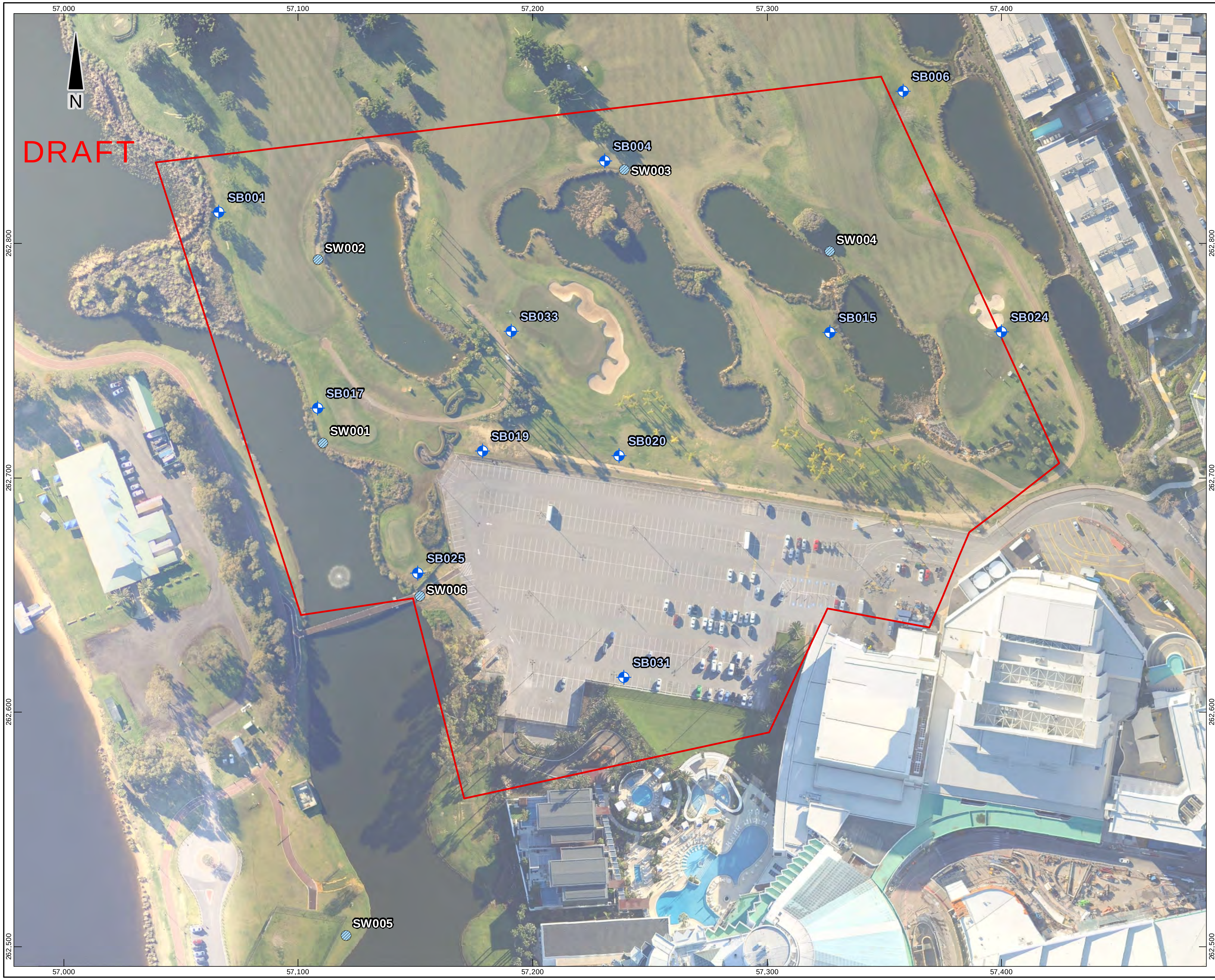
10.2 Water Management Plan

Environmental impacts to groundwater and surface water during the Construction Phase will be managed in accordance with the Dewatering Management Plan (DMP) (Golder, 2013d) and Crown Perth's EMP (Golder, 2013b).

10.2.1 Current Understanding

The DSI was undertaken by Golder (2013c) and included collection of surface water samples from the five on-site lakes and groundwater samples from various groundwater bores on-site screened in the fill material, SCD and SRA formations. These locations are presented in Figure 6. Groundwater results from the DSI were compared to the following guidelines:

- DEC Freshwater
- DEC Marine Water
- ANZECC Estuaries in South West Australia
- DEC Domestic Non-Potable
- DEC Long-Term Irrigation Water
- Swan River Trust Trigger Values.



LEGEND

Soil bore converted to a groundwater monitoring well

Surface water sample

Site boundary

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

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Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 20 40 60
Metres

SCALE (at A3) 1:1,500

Golder Associates

CLIENT	Crown Perth
DOCUMENT	127643111-022-R-RevC
DATE	07 Feb 2013
COMPILED	MS
APPROVED	DRAFT

Crown Towers Perth
Contaminated Site Management Plan

DSI GROUNDWATER & SURFACE WATER INVESTIGATION LOCATIONS

FIGURE 6

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\022 R\127643111-022-R-F006-RevC.mxd

A summary of the locations of groundwater exceedances per contaminant of concern is presented in Table 7. It should be noted that exceedances were also noted for pesticides; however, they were below the LOR and therefore have not been included in this table. As pesticides, PAHs and PCBs were detected in soil at concentrations above guidelines, it is recommended that they be considered as potential contaminants of concern in groundwater.

Table 7: Location of Groundwater Exceedances

Contaminants of Concern	Location
Boron	SB025, BH04, BH09
Molybdenum	BH04
Nickel	BH04
Ethylbenzene	SB004
Total Nitrogen	SB001, SB004, SB006, SB015, SB017, SB019,SB020, SB024, SB025, SB031, SB033, BH04, BH09, BH02_2003
Ammonia (as N)	SB001, SB004, SB006, SB015, SB017, SB019, SB020, SB024, SB025, SB031, SB033, BH04, BH09, BH02_2003
Total Cyanide	SB001, SB004, SB017, SB019, SB020, SB025, SB031
Phosphorus	SB001, SB004, SB006, SB015, SB017, SB019, SB020, SB024, SB025, SB031, SB033, BH04, BH09, BH002_2003

Surface water samples from the DSI were compared to:

- DEC Freshwater
- DEC Marine Water
- DEC Domestic Non-Potable
- DEC Long-Term Irrigation Water Protection.

A summary of the locations of surface water exceedances per contaminant of concern is presented in Table 8. It should be noted that the only exceedances were noted in Lake 1 which is currently only proposed to be partially in-filled and does not required draining.

Table 8: Location of Surface Water Exceedances

Contaminant of Concern	Location
Copper	SW005, SW006

The following sections outline the water management plan for the purpose of the CSMP.

10.2.2 Potential Environmental Disturbance and Impacts

Due to the known presence of contaminated 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 the air through volatilisation from water.
- Potential mobilisation of impacted groundwater 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 9.

Table 9: 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 abstracted groundwater	No release of contaminated dewatering effluent to the surrounding environment	Monitoring results as outlined in the DMP (Golder 2013d) and summarised in Table 10
		Site inspection and validation
	Low impact of volatiles from dewatering effluent into the air	Air monitoring results, refer to Crown Perth's EMP (Golder, 2013b)/Lead Contractor's CEMP
Prevent adverse impacts to sensitive receptors as a result of contaminated surface water generated from on-site activities	No release of contaminated surface water to the surrounding environment	Monitoring results as outlined in Crown Perth's 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

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).

The management of water relating to dewatering and excavation of ASS material from below the groundwater table should be done in accordance with Procedure D (Appendix A).

Groundwater management measures are outlined in Crown Perth's EMP (Golder 2013b).

10.2.5 Monitoring Procedures

This section outlines monitoring procedures to be undertaken by the Lead Contractor(s). As mentioned in the above section Procedure D - Dewatering Management and Monitoring of Water Quality should be used to assist with appropriate management of effluent at the site.

10.2.5.1 Dewatering Discharge

Field monitoring of groundwater discharge pre-treatment is to include the following:

- Flow meters should 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 should be measured in the field once per day, pre and post any treatment (if required) during the dewatering operations.

- Metals, nutrients, polychlorinated biphenyls (PCBs), BTEX (benzene, toluene, ethylbenzene, xylenes), PAHs and organochlorine pesticides which were identified as contaminants of concern based on results of the soil and water data from the DSI (Golder, 2013c).

If groundwater is found to be contaminated then treatment on-site or disposal off-site is required and should be undertaken as discussed in the DMP (Golder, 2013d). Water requiring discharge on-site via infiltration or overland discharge must be below the trigger values outlined in Table 10.

Table 10: 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	>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 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)
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)

The DMP indicates that weekly or fortnightly sampling for laboratory analysis of the dewatering discharge is required and must not exceed the trigger values. Proposed analytes are listed in Table 11.

Table 11: Required Analytes for Laboratory Suite for Dewatering Discharge Post-treatment

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	PCBs, BTEX, PAHs and organochlorine pesticides

* Only needed when discharging to the stormwater system

10.2.5.2 Groundwater

During dewatering activities monitoring of groundwater in the surrounding area should be undertaken as outlined in the DMP (Golder, 2013d). This includes groundwater monitoring prior, during and after dewatering activities. A monitoring network of groundwater wells will be established throughout the site and two to four groundwater wells should be installed along the downgradient boundary of the development site. 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 lakes and the Swan River. The final monitoring network will be dependent on the nature and extent of dewatering; the current groundwater monitoring well locations are illustrated in Figure 6. A minimum requirement will be that monitoring wells SB01, SB017 and SB025 as these wells are located downgradient of the main development area. 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.

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, 2013d).

Field monitoring should commence one week prior to start of the construction phase and continue throughout the on-site construction activities until one week after completion.

If the dewatering ceases due to unforeseen events for a period of less than 14 days, measurement of groundwater levels 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.

Table 12: 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, reactive phosphorous, total phosphorous
Contaminants of Concern	PCBs, BTEX, PAHs and organochlorine pesticides

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 Surface Water

All lakes within the Project area will be affected by the proposed Project with:

- Lake 1 being partially in-filled
- Lake 2 being enlarged and the clay liner replaced for use in on-site stormwater retention
- Lakes 3 and 4 being partially in-filled and reshaped with clay liners replaced
- Lake 5 being completely in-filled.

The relevant lakes will be drained prior to being in-filled in preparation for Construction Phase works. The DSI investigation (Golder, 2013c) found that groundwater within the Lakes 2 through 5 were not contaminated. Water from these lakes is suitable for use as irrigation prior to the required in-filling work. Surface water from Lake 1 was found to have elevated copper concentrations and is not recommended to be used for irrigation.

Further information regarding water management is detailed in the DMP (Golder, 2013d) for the site.

10.2.6 Contingencies

Potential contingency actions for managing key performance targets which are not achieved are outlined in Table 13. The Lead Contractor has responsibility for the implementation of contingency actions and is to notify Crown Perth and the Contaminated Sites Auditor immediately after becoming aware of any triggered events. Reference should also be made to the Procedures provided as Appendix A for more specific information relating to on-site management.

Table 13: Contingency Actions for Water Management Plan

Trigger	Potential Actions
Water from stockpiles impacts on sensitive receptors negatively.	1) Advise Crown Perth and Crown Perth's Environmental Advisor 2) Confirm that risk assessment is still valid 3) Mitigate spill area and alter stockpile bund design accordingly to prevent from reoccurring 4) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities such as DEC and SRT within a timely matter.
Monitoring indicates elevated vapours from dewatering effluent impacting on sensitive receptors negatively	1) Ensure that health and safety measures for on-site workers are suitable. 2) Advise Crown Perth and Crown Perth's Environmental Advisor 3) Stop construction activities or move upwind until wind conditions are favourable to minimise risk to sensitive receptors 4) Evaluate vapour risk to nearest downwind sensitive receptor 5) Seek alternative on-site water storage methodology or have water removed off-site
Contaminated surface water discharged to the surrounding environment	1) Advise Crown Perth, Crown Perth's Environmental Advisor and DEC. 2) Confirm that risk assessment is still valid 3) Stop pathway of contaminated water to the surrounding environment 4) Stop the source of contamination 5) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely matter.
Groundwater quality in exceedance of trigger values (Table 10)	1) Advise Crown Perth and Crown Perth's Environmental Advisor 2) A groundwater specialist is to review groundwater monitoring results. 3) Increase monitoring frequency (i.e. weekly laboratory analysis or inclusion of additional analytes to be tested). 4) 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. 5) Identify source of water quality change. 6) Actions outlined in the DMP to be strictly followed. 7) 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. 8) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Groundwater quality monitored in the groundwater wells east of Lake 1 is identified as being in exceedance of trigger values (Table 10)	1) Advise Crown Perth and Crown Perth's Environmental Advisor 2) Assess validity of risk assessment. 3) If ecological risk is considered unacceptable, consider options such as interception of groundwater via trench and pumping for preventing groundwater from entering Lake 1. 4) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.

10.3 Air Management Plan

General air quality management measures, monitoring procedures and mitigation measures for the Construction Phase of the Project are contained within Crown Perth's EMP (Golder, 2013b).

10.3.1 Current Understanding

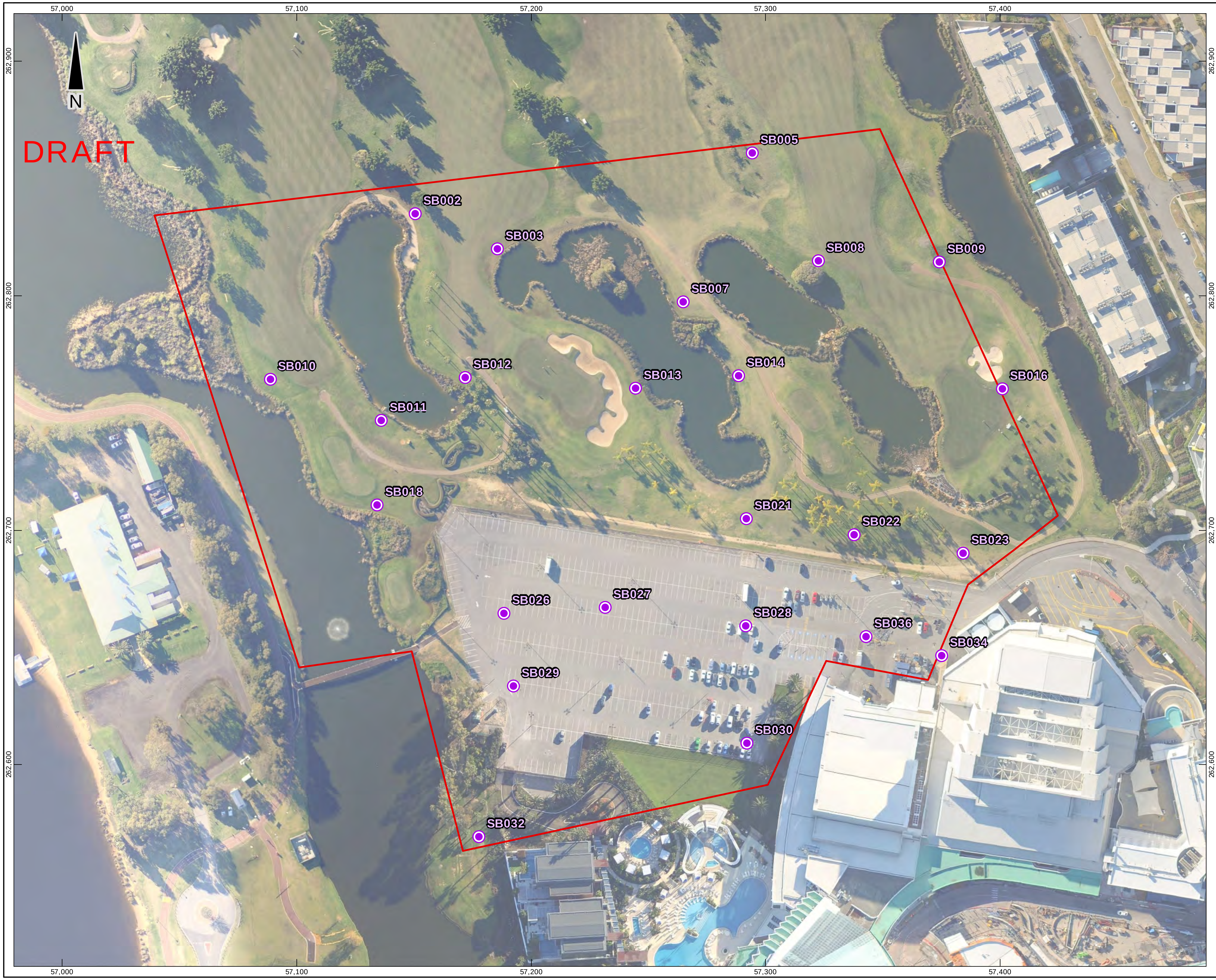
The DSI investigation (Golder, 2013c) undertaken at the site included the collection of ground gases from monitoring wells across the site and are presented in Figure 7. The investigation identified 16 out of 20 locations with concentrations of combustible gas above the trigger value of 25% Lower Explosive Limit (%LEL). Ten wells also contained combustible gas concentrations exceeding 100% LEL or the equivalent of 5% gas as methane. A summary of the exceedances of the trigger values is included in Table 14. No other chemical were measured in concentrations above relevant guideline values.

Table 14: Summary of Well Locations with Concentrations Greater Than Trigger Value

Trigger	Location
Wells containing combustible gas concentrations >25% LEL	ASS002, ASS004, ASS005, ASS007, ASS008, SB003, SB008, SB009, SB011, SB012, SB013, SB018, SB026, SB028, SB029 and SB030
Wells containing combustible gas concentrations >100% LEL or 5% gas	ASS004, ASS005, ASS007, ASS008, SB008, SB009, SB011, SB013, SB026, SB028, SB029 and SB030

There is also the potential for soil and groundwater contamination issues to impact on air quality during the Construction Phase of the Project. These issues include:

- Generation of dust from potentially contamination soil which may include asbestos.
- Odours and/or vapours from disturbed contaminated soil or groundwater.
- Ground gas generation from *in situ* landfilled material.



LEGEND

Soil bore converted to a landfill gas monitoring well

Site boundary

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

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Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 20 40 60
Metres

SCALE (at A3) 1:1,500

Golder Associates

CLIENT Crown Perth
DOCUMENT 127643111-022-R-RevC
DATE 07 Feb 2013
COMPILED MS
APPROVED DRAFT

Crown Towers Perth
Contaminated Site Management Plan

DSI LANDFILL GAS INVESTIGATION LOCATIONS

FIGURE 7

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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 15.

Table 15: 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 Construction Phase 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 Crown Perth's EMP (Golder, 2013b)
		Environmental Complaint and Incident Register
Minimise the effect of dust on the surrounding land users	No dust complaints from surrounding land users	Environmental Complaint and Incident Register
Minimise the potential generation of dust from ground material containing asbestos	Minimise airborne asbestos	Monitoring results as per Crown Perth's EMP (Golder, 2013b)
Minimise the impact of ground gases on sensitive receptors	Minimise exposure of sensitive receptor to ground gas	Monitoring results as per Crown Perth's EMP (Golder, 2013b)

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. It is Golder's recommendation that a minimum of two water carts be operating continuously on days likely to generate airborne dust, based on seasonal data, weather monitoring results and types of activities being undertaken. This will ensure that if one water cart is inoperable another is available for dust suppression. 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 Crown Perth's EMP (Golder, 2013b). This programme should be implemented by a suitably qualified professional.
- Procurement of 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, 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, ensuring that odours are kept away from residents and other users of the surrounding area.
- Implementation of an education programme 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.
- Implementation of a ground gas recovery system (combustion by flare/electricity generation equipment or another system use) if ground gas is identified on-site to reduce overall air and greenhouse gas emissions from landfills, reduce odour and manage subsurface migration.
- Should odours occur, works will be undertaken during suitable weather conditions, ensuring that odours are kept away from residents and other users of the surrounding area.

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 Crown Perth's EMP (Golder, 2013b) 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.

10.3.6 Contingencies

Potential contingency actions for managing key performance targets which are not achieved are outlined in Table 16. The Lead Contractor has responsibility for the implementation of contingency actions and is to notify Crown Perth and Crown Perth's Environmental Advisor immediately after becoming aware of any triggered events.

Table 16: 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 ■ 5% Lower Explosive Limit (LEL) of methane	1) Check that source of emissions is from the open hole or excavation 2) Evaluate the concentrations against the Short Term Exposure Limit (STEL) 3) Stop work 4) Advise Crown Perth and Crown Perth's Environmental Advisor 5) Implement appropriate emergency evacuation procedures 6) Implement the appropriate emergency incident response procedures 7) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Permanent ground gas level in excess of 500 ppm	1) Confirm elevated concentrations of ground gas 2) Stop work 3) Advise Crown Perth and Crown Perth's Environmental Advisor 4) Implement appropriate emergency evacuation procedures 5) Implement the appropriate emergency incident response procedures 6) If the above points do not resolve the issues Crown Perth is to report the impacts as well as mitigation measures applied to the relevant regulatory authorities within a timely manner.
Visible dust generated from potentially contaminated material	1) Increase dust mitigation measures as outlined in Crown Perth's EMP (Golder, 2013b) 2) Stop work 3) Advise Crown Perth and Crown Perth's Environmental Advisor 4) Wait until wind conditions improve

Trigger	Potential Actions
Airborne concentrations of asbestos above recommend concentration	1) Stop work 2) Advise Crown Perth and Crown Perth's Environmental Advisor 3) Identify source of airborne asbestos 4) Increase dust mitigation measures as outlined in Crown Perth's EMP (Golder 2013b) and in line with the Contractors CEMP. 5) Wait until wind conditions improve 6) Remove source to an off-site locations 7) If the above points do not resolve the issues Crown Perth 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 Crown Perth 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.

After completion of site works, the Lead Contractor(s) must include the following information outlined in Table 17 in a closure report to Crown Perth.

Table 17: 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

Factor	Information to be Included in Closure Report
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 OPERATIONS PHASE

Crown Perth currently has an Environmental Management System Manual for the adjacent Crown Perth Complex (formerly Burswood Entertainment Complex) (Crown Perth 2012). This document outlines the Environmental Management System (EMS) for the development and includes any ongoing environmental monitoring, including that associated with potential contamination. It is anticipated that the Crown Towers development would be managed under a similar system. This section of the CSMP contains separate management plans for soil, water and air which should be implemented during the Operations Phase of the Project to manage contamination and should therefore be included in any future EMS manual for the Crown Towers. Each respective management plan outlines the following:

- Potential environmental disturbance and impacts.
- Proposed management objectives, targets and key performance indicators.
- Proposed management measures.
- Proposed monitoring procedures.
- Proposed contingencies.

11.1 Soil Management Plan

Intrusive work should not occur on-site without the approval from Crown Perth Management. 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 Crown Perth for known contaminants of interest on a biannual basis.

11.2.2 Surface Water

The proposed design of the Crown Towers Project includes the partial or complete in-fill of all five lakes on-site. Rehabilitation of the partially in-filled lakes will be required and biannual monitoring (summer and winter) to ensure no ongoing contamination issues exist will be required. After two years and based on the results from the monitoring, the frequency and ongoing monitoring may be reviewed.

11.3 Air Management Plan

With respect to outdoor air quality, once groundcover is established on-site ongoing air monitoring is not required during the Operations Phase of the Project.

With respect to the design and operation of the building for the purpose of indoor air quality, the finding from the DSI investigation (Golder 2013c) indicated that some risk mitigation measures should be considered for the construction of the Project. In addition, Golder considers that due to the potential for enclosed spaces in the structures that gas mitigation measures be adopted.

Based on CIRIA C665, a *Characteristic Situation 2 or 3* requires one to two levels of protection in addition to sealing of all joints and penetrations. The details of ground gas protection will need to be developed by the Construction Contractor in line with the principles outlined in CIRIA C665 and in agreement with the Auditor.

Once construction has been completed an indoor air monitoring programme should be development and implemented to ensure that the mitigation measured are effective.

11.4 Reporting

Until the site is reclassified by the DEC a brief letter/report (separate to an annual reports listed in Crown Perth's EMP (Golder, 2013b)) should be submitted on a yearly basis to DEC by Crown Perth. 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 audits and inspections by Crown Perth's Environmental Advisor or delegate as outlined in Crown Perth's EMP (Golder, 2013b). 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 Crown Perth's EMP (Golder, 2013b)).
- 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 ENVIRONMENTAL INCIDENTS REPORTING SYSTEM

An environmental incident is any of the following:

- A breach or non-conformance of statutory requirements or procedures which have been prescribed in Crown Perth's EMP and the CEMP.

- A failure to meet targets or key performance indicators which have been outlined in the individual management plans.
- A breach or non-conformance of relevant licence conditions.

Environmental incidents are to be managed in accordance individual Emergency Response Procedures prepared by the Lead Contractor(s) (see Crown Perth's EMP (Golder, 2013b)). However, the following general procedure (illustrated in Figure 8) is to be followed in the event of an environmental incident during the Construction Phase:

1) The Lead Contractor(s)' Construction Manager and Environmental Representative shall be notified immediately upon the occurrence of an environmental incident and they shall immediately notify Crown Perth and Crown Perth's Environmental Advisor.
2) Subject to the nature and extent of the environmental incident, the Lead Contractor(s)' Construction Manager or Environmental Representative in conjunction with Crown Perth's Environmental Advisor shall issue a work order to halt and/or rectify the environmental impact/harm caused as a result of the environmental incident.
3) Within 24 hours of the environmental incident having been reported to the Lead Contractor(s)' Construction Manager and/or Environmental Representative, written notification of the time, date and nature of the environmental incident, plus the corrective action if required, shall be forwarded to Crown Perth and Crown Perth's Environmental Advisor, who will inform regulatory agencies where required.
4) The Lead Contractor(s)' Construction Manager in conjunction with Crown Perth's Environmental Advisor shall assess the environmental incident report and shall assess the nature of further corrective action to be taken and shall state 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 by Crown Perth and Crown Perth's Environmental Advisor.

Figure 8: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting

The following general procedure (illustrated in Figure 9) is to be followed in the event of an environmental incident during the Operations Phase:

1) A Crown Perth representative and Environmental Advisor shall be notified immediately upon the occurrence of an environmental incident.

2) Subject to the nature and extent of the non-conformance, Crown Perth’s Environmental Advisor shall issue a work order to halt and/or rectify the environmental impact/harm caused as a result of the environmental incident.

3) Within 24 hours of the non-conformance having been reported to Crown Perth’s Environmental Advisor, written notification of the time, date and nature of the environmental incident, plus the corrective action if required, shall be forwarded to Crown Perth Senior Management, and relevant regulatory agencies where required.

4) Crown Perth’s Senior Management in conjunction with Crown Perth’s Environmental Advisor shall assess the environmental incident report and the nature of further corrective action to be taken, and shall state the timeframe within which the corrective action is to be implemented.

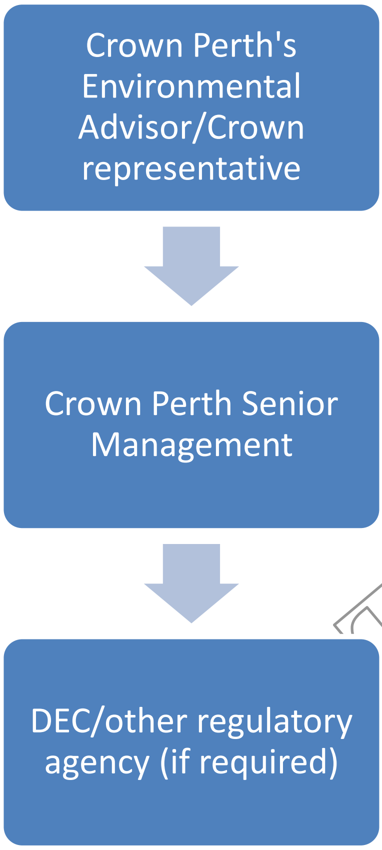

Figure 9: Organisational Structure of the Environmental Management Responsibilities for Environmental Incident Reporting for the Operations Phase

It should be stressed that at any point during the development of the site any site personnel have the right to halt work if human health is at risk.

Environmental incidents and complaints are to be recorded in an Environmental Complaint and Incident Register to be kept by the Lead Contractor(s) and Crown Perth's Environmental Advisor and are to be made available to Crown Perth upon request. The register must also be made available to the DEC officers and any other authorised parties to view upon request.

Crown Perth and/or the Lead Contractor(s) if directed by Crown Perth, 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 and mitigation measures in the CEMP/OEMP and/or the Emergency Response Procedure.

14.0 PUBLIC COMPLAINT MANAGEMENT

All complaints received by Crown Perth from the public, in relation to impacted sensitive receptors or the environment will be recorded in the Environmental Complaint and Incident Register which will record the following information:

- **Contact details**: Name, address and phone number of party raising concern.
- **Nature of concern**: Details of issue/incident.
- **Action taken or required**: Details of action proposed or undertaken to address the concern, including time and date.

- **Response to action**: Was the party raising the concern satisfied with the outcome. If not, what else needs to be done, or is it outside the scope of the operation of the Crown Towers.
- **Prevention of reoccurrence**: If the concern relates directly to an Operations problem, what action has been taken to prevent the problem from reoccurring.

All complaints shall be referred to Crown Perth for the purpose of investigation.

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.

15.0 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 Crown Perth's EMP (Golder, 2013b), 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 Operations Phase site personnel should be made aware by Crown Perth that the site is a contaminated site under the *Contaminated Sites Act 2003*. Personnel are to be made aware by the Crown Perth that groundwater abstraction and intrusive work is not to be undertaken without management's approval.

Results from the DSI investigation indicate that mitigation measures will be required for ongoing ground gas management is likely to be required at the site. Therefore indoor air monitoring will need to be undertaken by a suitably qualified practitioner.

16.0 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 Operations Phase Operations Manager will be responsible for issuing documentation to site personnel and maintaining an inventory of documentation distribution. The Operations Phase Operations Manager will also be responsible for ensuring all document holders receive any updates to the documents.

17.0 REFERENCES

CIRIA C665 (2007). Assessing Risks Posed By Hazardous Ground Gases to Buildings.

Crown Perth (2012). *Crown Perth Environmental Management System Manual.*

Golder (2013a). Preliminary Geotechnical Advice, Crown Towers Perth, Burswood. Golder document reference 127642138-004-L-Rev0. Golder Associates Pty Ltd. Perth, WA.

Golder (2013b). Crown Towers Environmental Management Plan (Project EMP). January 2013. Golder Document Reference Number 127643111-R-011. Golder Associates Pty Ltd. Perth WA.

Golder (2013c). Crown Perth Towers Detailed Site Investigation 127642102-011-R-RevA. In Progress.

Golder (2013d). Dewatering Management Plan Crown Perth (127643111-012-RevA). January 2013.

Swan River Trust (May 2012). Disposal of Dewatering Effluent in the Swan Canning Catchment, Draft Discussion Paper.

Report Signature Page

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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

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

All materials encountered below 0.5 m from ground surface should be removed immediately to an approved treatment and disposal facility, or stockpiled appropriately on site according to the information provided in Procedure B (Appendix A).

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, 1994
- 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

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 DEC 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 DEC approved treatment and disposal facility

Provided that the top 0.5 m of material excavated at the site is not contaminated and does not contain ASS material it can be placed elsewhere on site without active management, provided it remains within 0.5 m of the ground surface.

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

As all excavated material will be considered to be ASS then the minimum classification of the material excavated from site is Class II. 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.

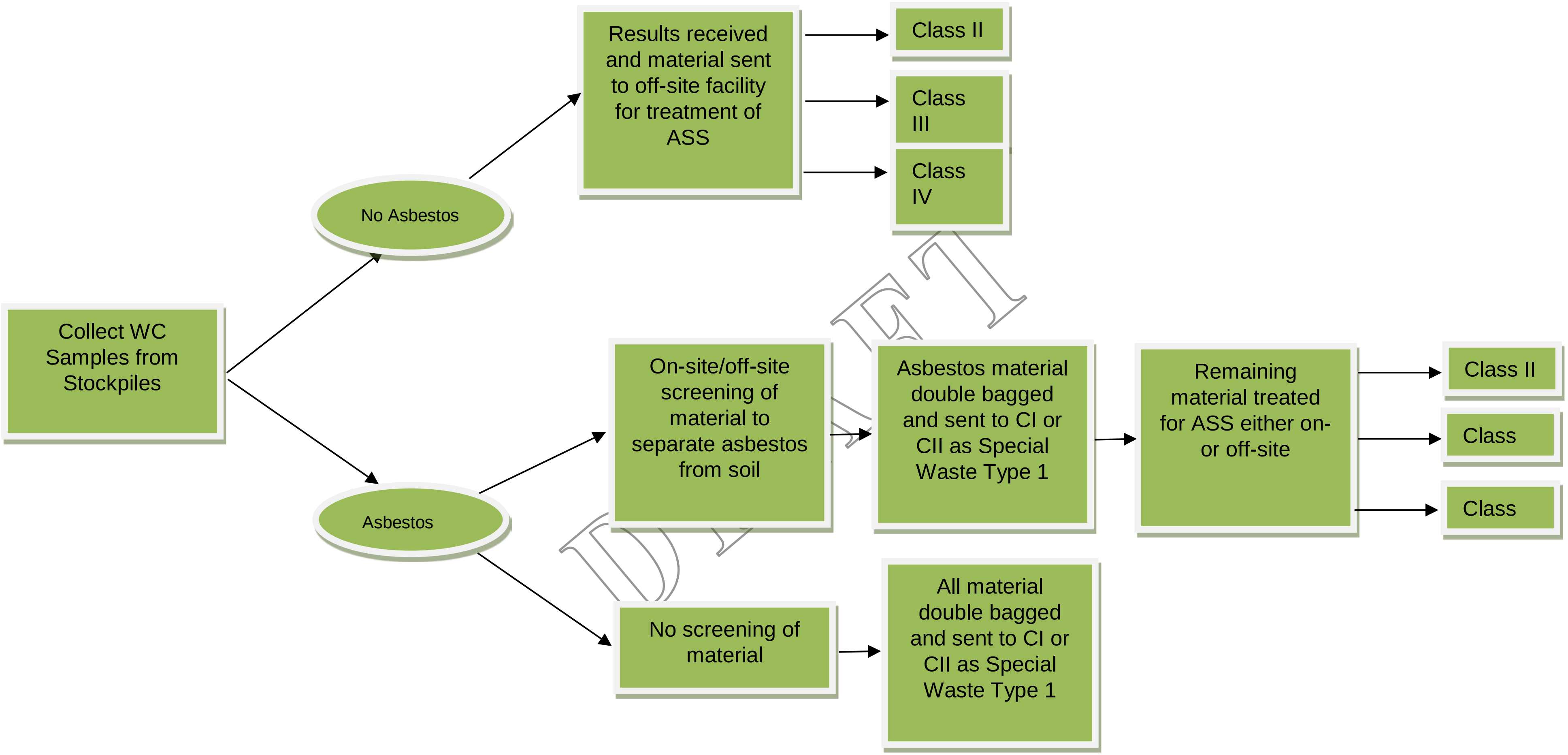

Figure 1: Process for Management and Treatment of Excavated Material

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 discharge as outlined in the site Dewatering Management Plan[1] (Golder 2012e).

All monitoring of water quality shall be carried out by a suitably qualified and trained 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 DEC approved treatment and disposal facility	■ All contaminated material and ASS removed to a DEC 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 shall provide details on the bund construction, including but not limited to survey data to confirm the appropriate thickness of materials has been used (e.g. survey pre-placement and post-placement of guard layer)

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.

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[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	11
FILL: Waste	153
CLAY/Silty CLAY/Sandy CLAY/SAND	197

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 (sand), 1.05 t/m^3 (clay)	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 lot 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 Table 2.
- 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 3 and Table 4 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, 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.

The table below 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. If proposed to be discharged on-site then water must meet criteria outlined in Table 3 and Table 4.

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 3. 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

Item	Performance Indicator
Water quality	■ No uncontrolled releases of water from the stockpile areas. Discharge water quality within performance indicators in Table 3 and Table 4. ■ 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 3 and 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 CP's Environmental Advisor.

The Lead Contractor's Construction Manager shall inform the Superintendent of non-compliance with Table 3 and Table 4 upon detection. The Superintendent shall inform DEC of such non-compliances as soon as practicable and instigate an assessment of the impact.

Table 3: 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	>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 background level (in the receiving environment) or cause a visible reduction in light penetration of receiving waters
Temperature	Not to vary more than 2ºC from the background level (in the receiving environment)
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 4: Dewatering Discharge 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

	Trigger	Action	Monitoring
3	**Total titratable acidity in range 40 mg/L to 100 mg/L** pH > 6	Discharge 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)
4	**Total titratable acidity in range 40 mg/L to 100 mg/L** pH in range 4 to 6	Discharge 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**	Discharge 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) DEC 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.

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APPENDIX D

Dewatering Management Plan

February 2013

CROWN PERTH

Dewatering Management Plan

Submitted to:
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REPORT

Report Number. 127643111-012-R-RevC

Distribution:

1 Electronic Copy - Crown Perth
1 Electronic Copy - Golder Associates Pty Ltd

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1.0 INTRODUCTION

1.1 Overview

Crown Perth (Crown) has engaged Golder Associates Pty Ltd (Golder) to prepare a Dewatering Management Plan (DMP) for the construction of the new Crown Towers Project (the Project) on the Burswood Peninsula in Perth, Western Australia (Figure 1). This DMP has been prepared as part of an Environmental Management Strategy to assist Crown in establishing and maintaining best practice controls to manage potential environmental and social impacts during the Project.

For information on the Environmental Management Strategy refer to the Project EMP (Golder, 2013a) and Construction Environmental Management Framework (CEMF), in Golder (2013b).

The dewatering requirements have not yet been fully identified, and this document is therefore not considered to be the final DMP. 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 DMP that matches each specific dewatering scheme for submission to the Department of Water (DoW) to accompany their application for a Licence to Take Water (5C Licence).

This document has been prepared using information available at the time of preparation. This document should be updated as additional information becomes available on construction elements requiring dewatering and dewatering designs are developed.

For planning purposes the Project is to be delivered in two phases:

- **Construction Phase:** the construction of the Crown Towers, Podium and associated infrastructure, which will include the use of deep piles to provide support for the main structures.
- **Operations Phase:** the operation of the Crown Towers. The transition from the Construction Phase to the Operations Phase will occur once the all Construction Phase work has been completed and the Lead Contractor has left site, handing the development infrastructure over to Crown. Ongoing environmental monitoring of the site and management of site facilities will continue during the Operations Phase.

Delivery of the Project has potential for environmental and social impacts (primarily surrounding the works proposed for the Construction Phase) and will therefore be referred to the Office of the Environmental Protection Authority (OEPA) in accordance with Section 38 of the *Environmental Protection Act 1986* (EP ACT).

Golder understands dewatering will likely be required for installation of services during the construction works.

1.2 Scope

The scope of this DMP relates to the Construction Phase of the Project including:

- Construction of the:
  - Crown Towers' six-star, 25-level, 500-room hotel development.
  - Podium structure, linking the hotel to adjoining buildings and properties (approximately 25 000 m^2 footprint).
  - Associated services buildings (for generators, bins, refuse, hoist and loading bay under croft).
  - Porte cocheré.
  - Pedestrian access ways.

- New and refurbishment of existing external works (including new landscaping and swimming pools, (approximately 11 000 m^2).
- Refurbishment of existing function rooms and associated public spaces.
- Rehabilitation and landscaping (approximately 33 000 m^2 footprint).
- Stormwater catchment lake(s) infill and expansion.

1.3 Dewatering Management Plan Objectives

The objective of this document is to provide a management plan that can be implemented during dewatering to manage and minimize potential effects on the environment. As noted earlier, this plan is not the final, detailed version that will emerge as dewatering designs are developed closer to the start of construction.

The DMP will serve as a supporting document to obtain necessary approvals.

1.4 Project Location and History

The Crown Perth complex is located at 201 Great Eastern Highway on the Burswood Peninsula in the City of Perth, Western Australia. The Project will be located within the southern nine holes of the Burswood Park Golf Course located on the Burswood Peninsula, as shown in Figure 1.

The Burswood Peninsula extends over an area of approximately 280 ha and is located approximately 2.9 km east of the Perth CBD. A variety of land uses are located within the Burswood Peninsula including the Burswood Park Golf Course, the State Tennis Centre, the Crown Perth complex, the Dome, the Burswood Peninsula residential development, the Belmont Racecourse and assorted parklands and car parks. The Burswood Peninsula is accessed by road from the Graham Farmer Freeway, Victoria Park Drive and the Great Eastern Highway, with Belmont and Burswood train stations also servicing the area.

The Project area includes the southern end of the Burswood Park Golf Course, which is currently under the control and management of the Burswood Park Board, and the Crown Perth complex. The Project area is surrounded by land zoned for parks and recreation, residential, and public purposes - special uses (Crown Perth complex). The Swan River, which is in close proximity but not directly adjacent to the Project area is managed by the Swan River Trust (SRT), a state government agency that protects, manages and enhances the Swan Canning Riverpark.

The Project area is shown in Figure 2 (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 Burswood Park Golf Course to the north; the Mirvac residential development to the east; the Crown Perth complex to the south; and the Burswood Water Sports Centre and the Swan River to the west.

The Project area has had an extensive history of potentially contaminating land use activities. Therefore, an environmental Detailed Site Investigation (DSI) was conducted in accordance with the Department of Environment and Conservation (DEC) Contaminated Sites Management Series Guidelines and the implications of the DSI findings are discussed throughout this document. It is anticipated that the DSI report, once reviewed by the Contaminated Sites Auditor engaged for the Project, will be available towards the end of February 2013.

2.0 PROJECT SCOPE

The delivery of the Construction Phase (including any pre-construction works) of the Project is described in the following section.

2.1 Construction Phase

2.1.1 Pre-construction Works

Pre-construction works are necessary to prepare the site for construction and in particular, to manage the underlying ground conditions. The main components of the pre-construction works for this Project are site preparation and earthworks. Information in the following sections is based on the *Preliminary Geotechnical Advice and Desk Study* (Golder, 2012a).

2.1.1.1 Site Preparation

The site preparation works have been identified as those that do not require significant ground disturbance:

- 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, if required.

2.1.1.2 Earthworks

Isolated excavation works may be required for the construction/installation of:

- Trenches for provision of services such as sewage and electricity.
- Swimming pools.
- Piles for the main structures.
- Base of the elevator shaft.
- All excavation works will not extend below the clean fill layer where practicable.

Other earthworks include:

- Importation and placement of clean fill materials and undertaking general earthworks including shaping and contouring existing landscape to specific levels.
- Removing the existing car park.
- Clearing existing trees and vegetation.
- The new development needs 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 site.
- In relation to the lakes:
  - Partially infill Lake 1.
  - Enlarge and replace clay liner in Lake 2 for use in on-site stormwater detention.
  - Infill a portion and reshape and replace clay liner in Lakes 3 and 4.
  - Completely infill Lake 5.

2.1.2 Construction Works

2.1.2.1 Overview

The construction works will commence following completion of the pre-construction works. The development loads associated with the Crown Towers 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.

Some areas of the site will require ground improvement in order to meet specific long-term ground movement requirements. 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 palaeochannel which traverses the site.

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

- Low rise structures (such as Pools and associated deck and landscaped area).
- High rise structures (such as the Crown Towers hotel building).

2.1.2.2 Piling

Potential piling solutions for more heavily loaded areas are:

- Driven precast concrete piles of larger cross-section, such as 450 mm square or 550 mm octagonal sections.
- Driven steel tubular piles of typically about 600 mm to 750 mm diameter.
- Bored piles of typically about 900 mm to 1200 mm diameter.
- Continuous flight auger piles of typically about 750 mm to 900 mm diameter.

Pile lengths of between about 30 m and 35 m would be anticipated at the tower location should 600 mm diameter driven steel tubular piles be constructed. Steel tubular piles are expected to be able to be driven a greater distance into the Kings Park Formation (KPF) than precast concrete piles.

Detailed consideration and regular maintenance is likely to be required at the interface between the piled area and the non-piled areas.

3.0 APPLICABLE LEGISLATION

Relevant legislation applicable to the dewatering activities for the Project is the *Rights in Water and Irrigation Act 1914* (RIWI Act). Under the 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.

A full list of legislation applicable and standards to the Project is outlined in the Project EMP (Golder, 2013a).

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.
- 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 SITE CONDITIONS

4.1 Site Description

4.1.1 Surface Features

Burswood Peninsula is the land 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 low-lying. The Project is proposed to be located within an area currently occupied by a portion of the southern nine holes of the Burswood Park Golf Course and an existing Crown Perth complex car park, as shown in Figure 2.

The Burswood Park Golf Course portion of the site largely consists of undulating grass fairways, greens, sand bunkers and “rough” areas containing grass and trees as well as five shallow artificial lakes. The western portion of the site consists of a portion of Lake 1. None of these lakes are connected via permanent water ways to the Swan River.

The ground surface level over this part of the peninsula is undulating, with some low lying portions of the Burswood Park Golf Course prone to inundation during periods of high rainfall or high river levels.

The current ground surface elevation at the Burswood Park Golf Course generally ranges from 2 m Australian Height Datum (m AHD) near Lake 1 and gently undulates to the east with an overall increase to about 4 m AHD. A topographical high point is located on the south-east corner of the Burswood Park Golf Course at 7.4 m AHD at a recently reconstructed bunker area. In comparison the car park on the southern portion of the site is generally flat with a topographical range of approximately 2.4 m AHD to 3.1 m AHD. The topography of the site has changed dramatically over the years due to the importation of various types of fill material, the placement of which has generally increased the ground elevation.

4.2 Geology and Subsurface Conditions

A generalised subsurface ground profile encountered during the geotechnical investigation (Golder Associates 2012) is provided below:

- Unit 1 - FILL: Generally granular, but containing varying amounts of landfill materials comprising bricks and brick fragments, plastics and plastic sheeting, timber, rubber tyres, concrete and steel, generally about 3 m to 5 m thick and encountered to levels of between about RL 0.4 and RL 2.5 m AHD; overlying
- Unit 2 - Swan River Alluvium (SRA): Silty CLAY (CH) to Clayey SILT (MH) high plasticity normally consolidated which is very soft to soft but becoming firm with depth. The base of the unit varies significantly across the development site and ranges in level between about RL -4.8 and RL -23.5 m AHD; overlying
- Unit 3A - Guildford Formation: Silty CLAY to Sandy CLAY (CL-CH) medium to high plasticity with fine to coarse grained quartz sand and gravels. Very stiff to stiff becoming soft at the base, not encountered at all locations, extending to a level of between about RL -13.5 and RL -25.6 m AHD; overlying

- Unit 3B - Guildford Formation: SAND (SP)/Gravelly SAND (SP)/Clayey SAND (SC)/Silty SAND (SM): fine to coarse grained sand with trace gravels and well cemented lenses and nodules, generally medium dense to very dense (except BH10 as discussed below), extending to a level of between about RL -22.3 and RL -33.0 m AHD; overlying
- Unit 4A - Mullaloo Sandstone: Silty Clayey SAND (SC-SM): fine to coarse sand with about 15-25% medium plasticity fines, predominantly medium dense with lenses of dense and very dense material, loose in parts (BH05), possesses soil properties, extending to a level of between about RL -30.8 and RL -45.9 m AHD; overlying
- Unit 4B - Mullaloo Sandstone: SAND (SP): very dense, fine to coarse quartz sand, appears to possess soil properties, extending to the maximum depth investigated at RL -49.7 m AHD.

A plan showing the location of the environmental monitoring wells is attached as Figure 2.

Cross sections showing the different subsurface units across the project site are provided as Figure 3 and Figure 4. The alignment of the sections is shown on Figure 2.

4.3 Surface Water

The closest surface water features are the Swan River and the five artificial lakes within the Project area.

4.3.1 Swan River

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

4.3.2 Artificial Lakes

There are five artificial lakes within the Project area (Figure 2). Lake 1 receives stormwater runoff from the Crown Perth complex. Lakes 2 to 5 are reportedly clay-lined and topped up with bore water to maintain constant levels and to provide water for irrigation.

A section of Lake 3 (estimated total area of 4 000 m^2), a section of Lake 4 (estimated total area of 1 500 m^2) and Lake 5 (estimated total area of 1 300 m^2), are proposed to be filled-in during pre-construction works for the Project, because they are located directly below the Project footprint. The southern end of Lake 1 has an estimated total area of 14 000 m^2 (within the Project boundary) and is proposed to be partially in-filled. Lake 2 has an estimated total area of 2 500 m^2 and will be retained and expanded. Lake 2 may be indirectly impacted by pre-construction and development works and is proposed to be used as a water storage and treatment body throughout the construction phase and into operations.

4.4 Hydrogeology

Figure 3 and Figure 4 show the subsurface lithologies across the development, based on the geotechnical investigation. Based on Golder's current understanding of the development, the fill layer is the main unit of interest for construction dewatering, although the underlying units are outlined briefly in this section. It is important to note that the presented geological cross-sections (Figure 3 and Figure 4) do 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 fill layer contains landfill materials and is highly variable over the site. The hydraulic conductivity of the fill layer is expected to vary considerably from place to place.

The three principal geological units underlying the proposed construction are the Fill, SRA, and Guildford Formation. The fill, SRA and Guildford Formation in the Burswood area are all included in the superficial aquifer that extends across the Perth area as outlined in Davidson (1995).

Across the Burswood Peninsula there are variations in both the thickness and presence of the three superficial units. At the site the Guildford Formation and fill are separated by approximately 5 to 25 m of

SRA, silt and clay, which act as a local confining unit for the Guildford Formation aquifer. However, in areas immediately east of the site, the SRA is absent and the fill is in direct contact with the Guildford Formation.

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

Below the superficial aquifer are the King's Park and Leederville Formations, both of which are aquifers. At the development site, the Kings Park Formation is represented by an uncemented, very dense sand layer called the Mullaloo Sandstone, probably a poor aquifer, and the underlying Leederville Formation forms a major aquifer in the Perth region. These aquifers are expected not to be affected by dewatering of the shallow, landfill material for the Project construction.

4.4.1 Groundwater Levels

Measured groundwater levels within the fill (Unit 1), as recorded on 12 December 2012, range from about RL 2.8 m AHD to about RL 1.6 m AHD.

Groundwater levels are influenced by rainfall, irrigation and Swan River level, resulting in localised changes in level and flow direction. Natural seasonal fluctuation of groundwater levels is likely to be in the order of 0.5 to 1.0 m but this fluctuation range may currently be dampened by irrigation practices and proximity to the Swan River.

4.4.2 Recharge

Currently the Burswood Park Golf Course uses an irrigation system for the greens and surrounding grounds that results in additional recharge and groundwater mounding over those areas. Although the lakes are clay lined there is potentially some leakage, possibly causing localised recharge and groundwater mounding.

4.4.3 Groundwater Movement

Davidson (1995) and the Perth Groundwater Atlas (2004) indicates that groundwater flow in the vicinity of Burswood is in a north-westerly direction towards the Swan River over the peninsula, while at the Project area flow is likely to be west to south-west 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 carpark and buildings to the south and eastern extents of the Project area.

The tidal fluctuations of the Swan River may change the directions of nearby groundwater movement. On a rising tide a localised reversal of the flow direction may occur but this is not likely to extend to within the Project area.

4.4.4 Hydraulic Properties

Hydraulic properties for the shallow fill layer were obtained based on hydraulic testing (slug tests) undertaken for the Project. Hydraulic conductivity values ranged from 1 to 14 m/d with a geometric mean of approximately 3 m/d. Due to the heterogeneity in the fill layer it may be required to undertake additional hydraulic testing at the specific dewatering location to obtain more accurate dewatering rate estimations.

Based on literature and professional experience with similar materials both on the Burswood Peninsula and in the greater Perth Metropolitan area, the hydraulic conductivity for the SRA at the Project Area is judged to be in the probable range of 0.001 m/d to 0.01 m/d.

The Guildford Formation has a variable hydraulic conductivity, since it is an interbedded sequence, mostly of sand and clay. Hydraulic conductivity can range from less than 1 m/d in the sandy clay to almost 100 m/d in zones of clean, sandy gravel. Golder's experience indicates that an average hydraulic conductivity is likely to be around 10 m/d.

4.5 Groundwater Quality

Groundwater quality sampling has been completed as part of environmental investigations for the Project, with details of the sampling and test results presented in Golder Associates (2013c). Results from these investigations should be consulted during the preparation of the specific DMP. The location of monitoring wells is shown in Figure 2.

Laboratory test results for groundwater sampling in November and December 2012 are presented as Appendix A from 14 wells. Of these wells 12 are screened in the fill layer, one is screened in the SRA and one is in the Guildford Formation. Results indicate:

- Field measured pH is generally neutral to slightly basic.
- Total Dissolved Solids (TDS) values range from 878 mg/L to 7210 mg/L in the Fill layer. A higher TDS of 8590 mg/L was reported in the well screened in the SRA.
- Total cyanide was reported above the ANZECC 2000 guideline value at six locations.
- Some metal concentrations were marginally above ANZECC 2000 and SRT guidelines with concentrations of nickel, aluminium, copper, and iron exceeding at least one guideline value for at least one sample at the site.
- Ammonia concentrations exceeded the ANZECC 2000 guideline value in all reported results except one, with maximum values significantly higher than the guideline values. Total phosphorus and total nitrogen levels were reported above the SRT guideline at some locations.
- The chloride:sulfate ratio exceeded the DEC Groundwater Acidification guidelines in both wells sampled.
- Total Petroleum Hydrocarbons (TPH C_{10}-C_{36}) were observed in one sample above the ANZECC 2000 guideline, and was reported above the laboratory detection limit at six other locations.

4.6 Acid Sulfate Soils

Investigations including the DSI (Golder Associates 2013c) have confirmed that ASS are present in areas of the Burswood Peninsula. The high risk natural materials detailed in the DEC risk maps at this site are correlated to shallow expressions of the SRA. The SRA is known to be sulfidic across the metropolitan area in locations close to the Swan River. The underlying Guilford Formation is also potentially ASS (PASS) but will not be dewatered.

The fill within the landfill areas has also been identified as ASS. Acidic conditions may have been generated due to the putrescible nature of some of the waste which is conducive to sulfide generation and subsequent oxidation upon dewatering. All materials that are disturbed during construction activities should be managed according to the procedures present in the CSMP (Golder Associates 2013d).

5.0 SITE DEWATERING

At this stage construction details are not known, however dewatering may be required during the Construction Phase of the Project as outlined in the following sections.

5.1 Dewatering Requirements

Dewatering may be required for service installation or modification, in particular the stormwater system and the sewer system. Dewatering may also be required for a lift pit and swimming pools.

It is also possible that if excavation is required to remove obstructions in the fill, dewatering may be required; however, Golder understands that generally the site will be raised (i.e. clean fill will be brought onto the site) rather than cutting down to establish site level and the need for excavation will therefore be minimised.

5.2 Dewatering Method

The dewatering methodology would depend on the dewatering requirements of individual Construction Phase tasks and would therefore have to be assessed for each specific task. However, it is likely that the following dewatering methods, or a combination thereof, could be used:

- Dewatering spears - likely to be used for localised and/or elongated dewatering. Pre-drilling for installation of dewatering spears could be required due to obstructions in the uncontrolled fill.
- In-pit sump pumps - for localised dewatering inside pits. It is likely to be the dewatering method for removing obstructions in the fill.

The dewatering method would have to be specified in each specific DMP.

5.3 Dewatering Schedule

At this stage dewatering schedule requirements are not known.

5.4 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 on an individual basis. The outcomes will be used by the regulators for issuing necessary regulatory approvals. It is proposed to provide likely and "worst case" volumes and apply for the upper bound of estimated volumes to minimise the risk for exceeding the licensed dewatering allocation.

To aid with the dewatering estimation Golder has made preliminary estimates of dewatering rates and volumes for the installation of sewer and connection to existing sewer, which is likely to be the largest dewatering operation. Rates presented are based on analytical calculations for assumed excavation depths and duration. The actual rates will vary depending on the location, extent, depth, and dewatering period.

These analytical calculations are based on the following assumptions:

- Dewatering and excavation is in the fill unit only.
- Saturated thickness (in fill) is 4.5 m.
- Groundwater is 0.5 m below ground level.
- Hydraulic conductivity is 1 to 10 m/d.
- Specific yield is 0.1 to 0.2.

Example 1: Connection to existing sewer

Assuming a 5 m deep excavation over a 10 m by 10 m square, with target drawdown reached after two days, the initial rate is calculated as less than 10 L/s, with longer term rates less than 5 L/s. Assuming the excavation remains open for two weeks after reaching target drawdown this gives a dewatering volume of approximately 8000 m^3.

Example 2: 20 m long trench section

Assuming a 5 m deep trench section of 20m long by 5 m wide, with target drawdown reached after two days, the initial rate is calculated as less than 10 L/s, with longer term rates of less than 3 L/s. Assuming the excavation remains open for four days after reaching target drawdown this gives a dewatering volume of approximately 3000 m^3 per 20 m length.

6.0 AFFECT OF DEWATERING

6.1 Area of Influence

When details are available for the dewatering requirements, the extent of groundwater drawdown from the dewatering location should be estimated 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 DMP must address the area of influence in the context of ASS.

6.2 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 dewatering operations.

Groundwater management measures and management of ASS are outlined in the Contaminated Site Management Plan (Golder Associates 2013d) and the Project EMP (Golder Associates 2013a) and reference to these documents will be made in the specific DMP.

6.3 Surface Water

Given the large volume of the Swan River, the environmental stress on the River resulting from the abstraction of groundwater within the Project area is considered to be negligible. The artificial lakes 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. In addition, some of these lakes will be removed during the Construction Phase.

6.4 Flora and Fauna

The DMP will need to include an assessment as to whether or not the magnitude, extent and period of dewatering is expected to impact on ecology and flora and fauna habitat due to the physical act of lowering the groundwater level. However, given that the majority of the Project area is going to be cleared during the Construction Phase, impact to vegetation within the extent of dewatering drawdown is unlikely.

6.5 Settlement of Structures

The DMP must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. Proximity to nearby infrastructure including the current Crown Perth complex and the residential buildings to the north and east will need to be assessed on a case by case basis.

6.6 Local Bore Users

A search of the DoW borehole database (WIN) was carried out to identify any registered bores within close proximity of the Project area. The Burswood Park Board operates a borefield reportedly comprising seven production bores, two from the Leederville Aquifer and five from the Kings Park Formation. Golder understands not all of these bores are being utilised. The Belmont Park racecourse also has a licensed bore screened in the Leederville Aquifer for irrigation of turf. Given the limited and shallow potential dewatering in the Superficial Aquifer and the identified bores are abstracting water from deeper aquifers, it is unlikely that these bores will be affected by the dewatering operations

7.0 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 for some locations reported concentrations of cyanide, TPH, some metals and nutrients exceed the DEC and SRT guidelines (refer to Section 4.5). Depending on the disposal method, the discharge may therefore require some treatment prior to disposal to ensure that it does not have an adverse effect on the receiving environment.

The currently identified disposal options, dependent on the dewatering rate/volume and dewatering discharge quality, and in order of preference, are:

- Re-infiltration.
- Discharge into sewer.
- Discharge into stormwater system, which drains into the Swan River.

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

7.1.1 Re-infiltration

Re-infiltration on-site may be a feasible dewatering discharge disposal option, if a 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. The effect of the infiltration on the groundwater table and flow direction would also need to be assessed, to ensure it does not affect any potential groundwater quality "hot spots", identified during the environmental investigation.

Re-infiltration to groundwater would typically be achieved using a standard on-site "treatment system" endorsed by the EPA and DEC 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 location. The specific DMP would need to address groundwater quality in the immediate vicinity of the excavation and the requirement for further treatment

7.1.2 Sewer

Disposal to the sewer may 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".
- Disposal volume is normally restricted by the sewer capacity, which would need to be discussed with the Water Corporation and would depend on the expected discharge rates and volumes.
- This option would likely require limited on-site treatment, such as pH adjustment and removal of Total Suspended Solids (TSS).
- This option would require less dewatering discharge monitoring during the dewatering operation.

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

7.1.3 Stormwater System

Disposal to the stormwater system may be 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 DEC 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, DEC 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 location of dewatering.
- 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.

Discharge to the stormwater system may also be considered as a contingency measure, i.e. as a backup to other selected disposal option, e.g. should dewatering rates be higher than expected. This contingency would also need prior approval however.

8.0 MONITORING

Monitoring of the groundwater (using monitoring wells) and dewatering discharge is the responsibility of the Lead Contractor(s) during dewatering. The monitoring should 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 specific DMP. The following sections outline likely monitoring requirements based on the guidelines from DoW (2006) and DEC (2011).

8.1 Groundwater

A groundwater monitoring well network has been established as part of the geotechnical and environmental investigation (refer to Figure 2). This network should be used as part of the monitoring of any dewatering operation. 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 DMP.

8.1.1 Field Water Quality Parameter Monitoring

Groundwater level, pH, electrical conductivity (EC), total titratable acidity (TTA) and total alkalinity should 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 after 14 days, but should re-commence one week prior to continuation of dewatering.

8.1.2 Laboratory Analysis

Groundwater samples should be collected from the monitoring wells for laboratory analysis prior to commencement and then every 14 days during the dewatering operation depending on the dewatering duration. The frequency of monitoring may be increased in the specific DMP depending on the proximity of dewatering operations to groundwater impacted by contaminants. 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 water samples taken during the ongoing environmental investigation will be used as background water quality.

The proposed analytes are presented in Table 1. Field pH, electrical conductivity, dissolved oxygen, redox potential, TTA and temperature should be measured in the field when collecting the water samples.

Table 1: Proposed Analytes for Laboratory Suite for Groundwater

Miscellaneous Parameters	Total Acidity, Total Alkalinity, pH, TDS, turbidity
Major Ions	Cations (Ca, Mg, Na, K), Anions (Cl, SO_4, HCO_3)
Dissolved Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Total Metals	Al, As, B, Cd, Cr, Cu , Fe, Hg, Mo, Mn, Ni, Pb, Se, Sn, Zn
Nutrients	Ammonia as N, Total Nitrogen, reactive Phosphorus, Total Phosphorus
Contaminants of Concern	PCBs, BTEX, PAHs and organochlorine pesticides

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.

8.2 Dewatering Discharge

The following section outlines the monitoring requirements for the dewatering discharge. Actual requirements will be dependent on the disposal option and will need to be outlined in the specific DMP.

8.2.1 Dewatering Volume

Flow meters should be installed on all dewatering discharge streams to record and log discharge rates and cumulative volumes and read daily.

8.2.2 Monitoring in Accordance with ASS Guidelines

TTA, pH, electrical conductivity, and total alkalinity should be measured in the field once per day, pre- and post- any treatment (if required) in accordance with Table 2, 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 2: 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), 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, 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, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - field measurement: dissolved oxygen (DO), redox potential (Eh)
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, TTA, total alkalinity **Weekly** - laboratory analysis: total acidity, total alkalinity, pH **Fortnightly** - laboratory analysis * **Fortnightly** - field measurement: DO, Eh

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 Crown. Crown may advise appropriate action which may include ceasing dewatering.	**Twice daily -** field measurement: pH, EC, TTA, total alkalinity **Weekly -** laboratory analysis * **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.

* Required analytes Laboratory Suite is presented in Table 3.

Table 3: Required Analytes for Laboratory Suite for Dewatering Discharge

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
Contaminants of Concern	PCBs, BTEX, PAHs and organochlorine pesticides

* Only needed if when discharging to the stormwater system

Table 2 indicates that weekly or fortnightly sampling for laboratory analysis of the dewatering discharge could be required pre and post-treatment. The required analytes for laboratory analysis are presented in Table 3

8.2.3 Other Monitoring

Monitoring of additional contaminants of concern may be necessary depending on the 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, monitoring would be required in accordance with SRT (2012) guidance (Table 4).

Table 4: Summary of Trigger Value for Discharge (Swan River Trust 2012)

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	>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

Parameter	Trigger Value
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)
Salinity	Not to vary more than 10% from the background level in the receiving environment
Dissolved Oxygen	<80-90% stable saturation
pH	Should remain within the range 6.5 to 8.5 and should aim to remain within 1 pH unit of the receiving environment
Toxins and broader water quality analytes	ANZECC 95% protection trigger values. In the absence of estuarine guidelines, the lowest of either the freshwater or marine guidelines levels should be applied. These values have been summarised in Appendix 2 of Golder Associates 2013a.
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)

It is proposed that photos are taken regularly of the dewatering effluent to document the visual quality of the water.

8.3 Settling Effects

The DMP must address if drawdown is expected to be of sufficient magnitude to cause settlement of surrounding nearby structures. Proximity to nearby infrastructure including the Crown Perth complex and residential buildings to the north and east 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 predetermined intervals during the dewatering period. Survey data should be recorded and reviewed and the reasons for any changes or movements identified.

9.0 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 Crown 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 Crown an initial closure report which collates all the monitoring data and details management measures undertaken at the site.

10.0 CONTINGENCY PLAN

Contingency plans should 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 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.

10.1 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 with respect to the stability of excavations) until proper storage or disposal options have been arranged.

10.2 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 2 strictly followed; (advise Crown via the lead contractor to discuss actions). Additional actions could be to install strategically placed monitoring wells to monitor groundwater quality off-site.

10.3 Dewatering Volume

In the event that discharge rates or dewatering periods are greater than estimated, which would result in exceeding the licensed dewatering volume, Crown is to be advised via the Lead Contractor. The Lead Contractor is then responsible for obtaining approval to increased discharge rates or periods in consultation with the DoW in accordance with their licence.

10.4 Groundwater Level

In the event that the groundwater level monitoring in monitoring wells indicates greater than expected drawdown, 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 Regulatory Agencies may need to be advised (through Crown) of the review and implemented measures.

10.5 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 Regulatory Agencies may need to be advised (through Crown) of the review and implemented measures.

10.6 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 Regulatory Agencies should be advised (through Crown) of the results of the investigation and proposed actions.

Further applicable contingency measures are outlined in the Project EMP.

11.0 SCHEDULE OF CONTRACTUAL RESPONSIBILITIES

As part of the DMP the roles and responsibilities are usually outlined to ensure procedures are followed throughout the dewatering program. Figure 5 shows the overall communication line between the Lead Contractor, Crown and the Regulatory Agency, particularly with reference to reporting environmental incidents (see the Project EMP (Golder, 2013a) for more information).

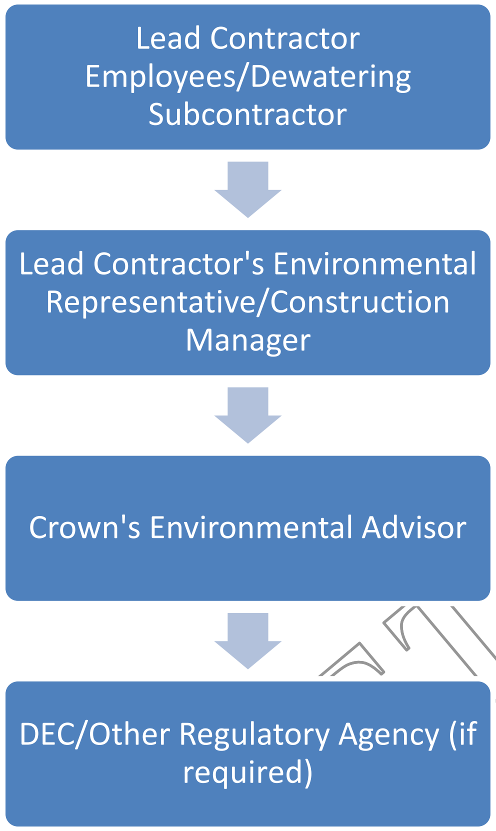

Figure 5: Organisational Structure of Reporting Responsibilities

Table 5 presents an example of the individual responsibilities required for the dewatering program.

Table 5: Proposed Responsibilities

Party	Responsibilities
Crown	Liaison with regulators
Lead Contractor	Excavation and overseeing entire Construction Phase of the Project
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 Closure Reports

12.0 REFERENCES

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Report Signature Page

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Golder Associates

CLIENT	Crown Perth
DOCUMENT	127643111-012-R-RevC
DATE	07 Feb 2013
COMPILED	MS
APPROVED	DRAFT

0 200 400 600 800 1,000
Metres

SCALE (at A4) 1:20,000

NOTES
Coordinate System: Perth Coastal Grid (PCG94)

COPYRIGHT
Base Data/Roads sourced from Street Pro Data 2009.

Crown Towers Perth
Dewatering Management Plan

SITE LOCATION

FIGURE 1

File Location: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\M6100_BURSWOOD\127643111\Projects\012 R\RevC\127643111-012-R-F001-RevC.mxd

LEGEND

Groundwater monitoring well

Estimated project boundary

NOTES

Coordinate System: Perth Coastal Grid (PCG94)

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Aerial imagery sourced from Nearmap 2012.
Site plans provided by Client.

0 20 40 60 80 100
Metres

SCALE (at A3) 1:2,000

Golder Associates

CLIENT Crown Perth
DOCUMENT 127643111-012-R-RevC
DATE 07 Feb 2013
COMPILED MS
APPROVED DRAFT

Crown Towers Perth
Dewatering Management Plan

SITE PLAN AND GROUNDWATER MONITORING WELL LOCATIONS

FIGURE 2

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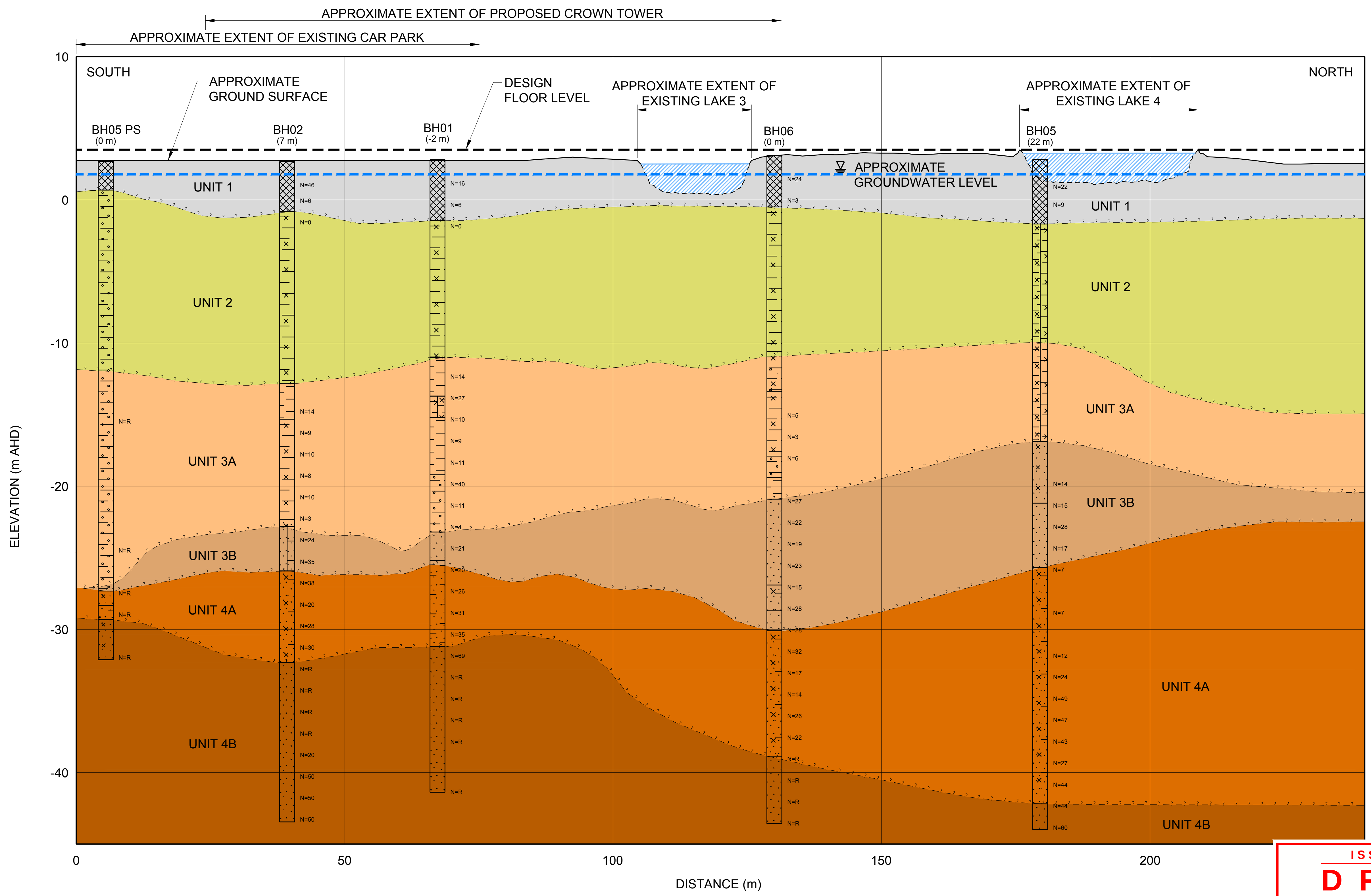

LEGEND

BASELINE OFFSET ###### (0 m)

N=4 SPT N VALUE

R = SPT REFUSAL OR N VALUE GREATER THAN 50 FOR 450mm PENETRATION

FILL	SANDY SILT	GRAVEL SAND	UNIT 1 - FILL
SILTY CLAY	GRAVELLY SAND	CLAYEY GRAVELLY SAND	UNIT 2 - SWAN RIVER ALLUVIUM
CLAY	CLAYEY SILTY SAND	ASPHALT	UNIT 3A - GUILDFORD FORMATION
SANDY CLAY	TOPSOIL	SILTY SAND	UNIT 3B - GUILDFORD FORMATION
SAND	GRAVELLY CLAY	CLAYEY SILT	UNIT 4A - MULLALOO SANDSTONE
CLAYEY SAND	CLAYEY SILT	SANDY SILTY CLAY	UNIT 4B - MULLALOO SANDSTONE

ISSUED FOR
DRAFT
NOT FOR CONSTRUCTION

V 1:300 (0, 6, 12, 18m)

H 1:800 (0, 16, 32, 48m)

NOTES:

1. FIGURE ILLUSTRATES INFERRED SUBSURFACE CONDITIONS FOR THE PURPOSES OF GEOTECHNICAL ANALYSIS ONLY. MATERIAL BOUNDARIES ARE APPROXIMATE AND CONJECTURAL.
2. FOR DETAILED UNIT DESCRIPTIONS REFER TO REPORT 127642138-004-L-F003-RevA

Golder Associates	CLIENT: CROWN PERTH	PROJECT: CROWN PERTH - DEWATERING MANAGEMENT PLAN
www.golder.com GOLDER ASSOCIATES PTY. LTD.	DRAWN BY: JRP/DH; DATE: 30.01.2013; CHECKED BY: ; DATE:	DRAWING TITLE: GEOLOGICAL CROSS SECTION A
	SCALE: AS SHOWN; SHEET SIZE: A3	PROJECT No: 127643111; DOC No: 012; DOC TYPE: R; FIGURE No: F003; REVISION: B; FIGURE 3

Plot Date: 30 January 2013 Time:4:26:31 PM By: Petilla, Julius Path: J:\Env\2012\127643111 - Crown Perth ESIA\CAD\FIGURES - File Name:127643111-012-R-003.dwg
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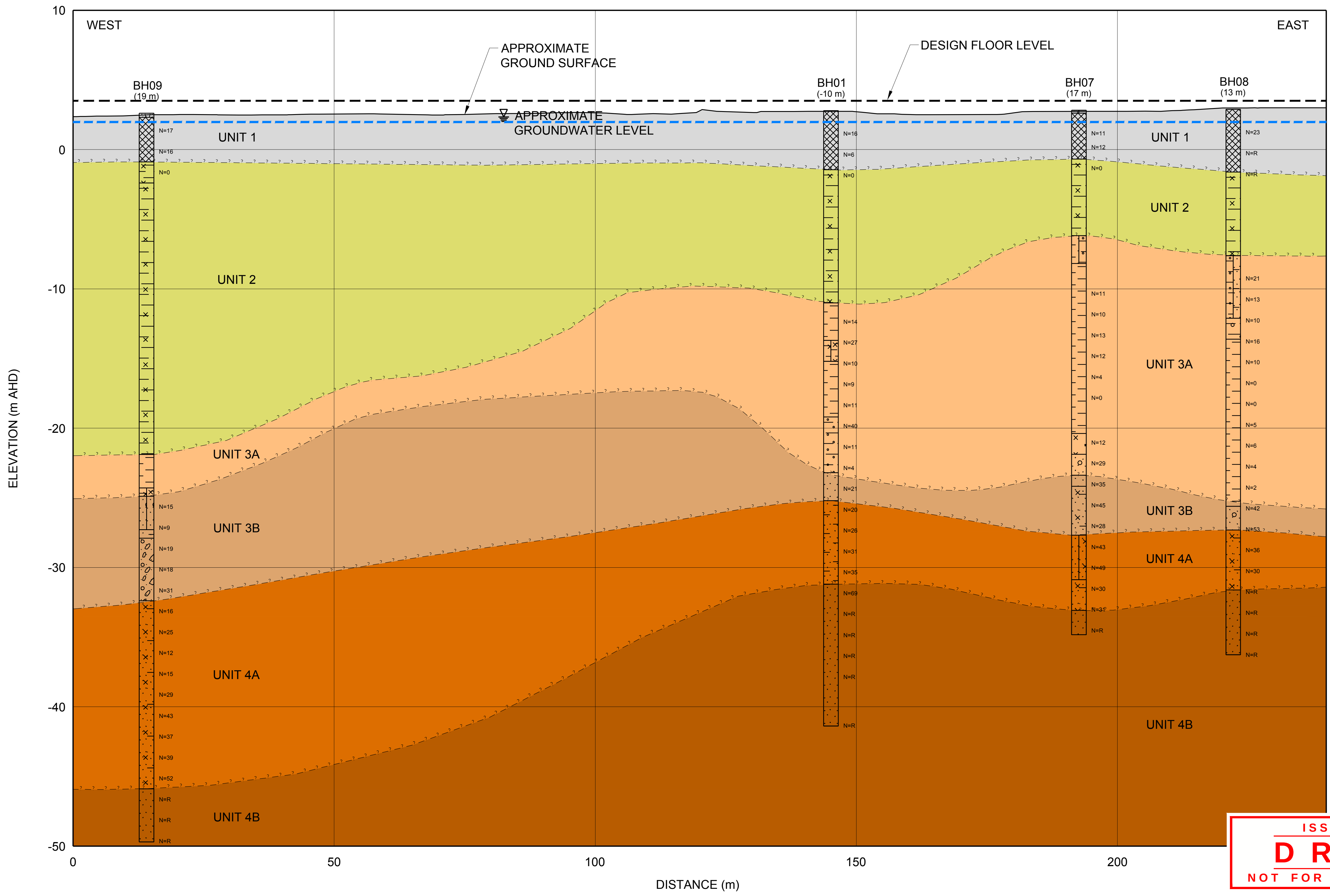

ISSUED FOR DRAFT NOT FOR CONSTRUCTION

V 1:300 (0, 6, 12, 18m)

H 1:800 (0, 16, 32, 48m)

LEGEND

(0 m)

BASELINE OFFSET

N=4 — SPT N VALUE

R = SPT REFUSAL OR N VALUE GREATER THAN 50 FOR 450mm PENETRATION

- FILL
- SILTY CLAY
- CLAY
- SANDY CLAY
- SAND
- CLAYEY SAND
- SANDY SILT
- GRAVELLY SAND
- CLAYEY SILTY SAND
- TOPSOIL
- GRAVELLY CLAY
- CLAYEY SILT
- GRAVEL SAND
- CLAYEY GRAVELLY SAND
- ASPHALT
- SILTY SAND
- CLAYEY SILT
- SANDY SILTY CLAY
- UNIT 1 - FILL
- UNIT 2 - SWAN RIVER ALLUVIUM
- UNIT 3A - GUILDFORD FORMATION
- UNIT 3B - GUILDFORD FORMATION
- UNIT 4A - MULLALOO SANDSTONE
- UNIT 4B - MULLALOO SANDSTONE

NOTES:

1. FIGURE ILLUSTRATES INFERRED SUBSURFACE CONDITIONS FOR THE PURPOSES OF GEOTECHNICAL ANALYSIS ONLY. MATERIAL BOUNDARIES ARE APPROXIMATE AND CONJECTURAL.
2. FOR DETAILED UNIT DESCRIPTIONS REFER TO REPORT 127642138-004-L-F004-RevA

Golder Associates www.golder.com GOLDER ASSOCIATES PTY. LTD.	CLIENT: CROWN PERTH	PROJECT: CROWN PERTH - DEWATERING MANAGEMENT PLAN
	DRAWN BY: JRP/DH; DATE: 16.01.2013	DRAWING TITLE: GEOLOGICAL CROSS SECTION B
	CHECKED BY: ; DATE:	
	SCALE: AS SHOWN; SHEET SIZE: A3	PROJECT No: 127643111; DOC No: 012; DOC TYPE: R; FIGURE No: F004; REVISION: B; FIGURE 4

APPENDIX A

Summarised Groundwater Quality Results

						Sample Location	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
						Sample COC	09885-01	09885-02	Q09858-02	Q09858-03	Q09858-04	Q09858-06	Q09859-01	Q09859-02	Q09859-03	Q09860 - 01	Q09860 - 02	Q09860 - 03	Q6837-01	Q6837-02
						Sampled Date	20/12/2012	20/12/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	14/11/2012	14/11/2012	14/11/2012	13/12/2012	13/12/2012
						Laboratory Ref	EP1210657	EP1210657	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209550	EP1209550	EP1209550	EP1210433	EP1210433
						Stratigraphic Unit	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	SRA	Guildford
Chemical Group	**Parameter**	**Unit**	**Detection limit**	**ANZECC 2000 Marine Water Slightly-Moderately Disturbed Ecosystems**	**Swan River Trust**	**DEC Groundwater Acidification**	**BH02-2003**	**SB035**	**SB017**	**SB019**	**SB020**	**SB001**	**SB033**	**SB004**	**SB015**	**SB031**	**SB024**	**SB006**	**BH04**	**BH09**
Field Parameters	**Groundwater Levels**	**m bgl**	**0.01**				0.98	0.48	0.51	0.42	0.44	0.58	0.51	0.74	1.51	0.71	3.62	1.1	0.85	2.7
	Groundwater Temperature	**C**					24.3	23.2	19.9	23.2	20.6	18.8	21.3	20.6	20.6	26.2	19.7	19.5	24.78	19.71
	pH	**pH Units**					7.17	7.14	6.94	7.07	6.91	7.42	7	7.23	6.95	6.93	7.44	7.22	7.38	7.32
	Electrical Conductivity	**uS/cm**					805	2121	3550	5420	3980	3500	2750	12150	4100	2350	1785	2360	14850	3630
	Color						Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Sample Quality Parameters	pH (Lab)	pH Units	0.01	8.0 - 8.4		≤5	7.73	7.78	7.53	7.58	7.57	7.92	7.72	7.68	7.54	7.63	7.91	7.68	7.74	7.49
	Turbidity (Field Observation)	NTU	0.1	1.0 - 2.0			-	-	-	-	-	-	-	-	-	-	-	-	25.8	23.4
	Total Dissolved Solids @180°C	mg/L	10				878	1200	2410	3630	2480	1990	1680	7210	2260	1390	1080	1430	8590	2160
	Sodium (Filtered)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	2470	480
	Potassium (Filtered)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	144	46
	Calcium (Filtered)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	86	70
	Magnesium (Filtered)	mg/L	1				11	28	58	78	53	46	43	202	73	34	22	32	209	66
	Chloride	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	4640	920
	Sulphate (as SO4) (Filtered)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	162	62
	Bicarbonate Alkalinity (as CaCO3)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	963	305
	Carbonate Alkalinity (as CaCO3)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	<1	<1
	Hydroxide Alkalinity (as CaCO3)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	<1	<1
	Total Alkalinity (as CaCO3)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	963	305
	Nitrate (as N)	mg/L	0.01				<0.01	<0.01	<0.05	<0.05	<0.05	<0.01	<0.01	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrite (as N)	mg/L	0.01				<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrite + Nitrate as N	mg/L	0.01				-	-	<0.05	<0.05	<0.05	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrogen (Total Oxidised)	mg/L	0.01				<0.01	<0.01	<0.05	<0.05	<0.05	<0.01	<0.01	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01
	Ammonia (as N)	mg/L	0.01	0.91			9.07	2.08	8.9	13.1	13.4	1.28	0.18	38.8	3.46	2.41	1.9	3.74	28	8.24
	Total Kjeldahl Nitrogen (as N)	mg/L	0.1				8.4	2.6	10.1	13.4	14.2	2.7	1.4	40.2	3.6	3.4	2.2	4.4	23.5	7.2
	Nitrogen (Total)	mg/L	0.1		1		8.4	2.6	10.1	13.4	14.2	2.7	1.4	40.2	3.6	3.4	2.2	4.4	23.5	7.2
	Cyanide (total)	mg/L	0.004	0.004			<0.004	<0.004	0.008	0.01	0.008	0.007	<0.004	0.01	<0.004	0.006	<0.004	<0.004	<0.004	<0.004
	Reactive Phosphorus (as P)	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.7	0.05
	Phosphorus	mg/L	0.01		0.1		0.61	0.07	0.04	0.08	0.08	0.11	0.08	0.08	0.04	0.09	0.03	0.06	0.67	0.2
	Sulphide	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
	Total Suspended Solids	mg/L	5				-	-	-	-	-	-	-	-	-	-	-	-	11	27
	Total Anions	meq/L	0.01				-	-	-	-	-	-	-	-	-	-	-	-	154	33.3
	Total Cations	meq/L	0.01				-	-	-	-	-	-	-	-	-	-	-	-	132	31.1
	Ionic Balance	%	0.01				-	-	-	-	-	-	-	-	-	-	-	-	7.35	3.54
	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	0.4	0.9
	Chloride:Sulphate Ratio		Calculated			≤2	-	-	-	-	-	-	-	-	-	-	-	-	28.64	14.84
Dissolved Metals	Aluminium (Filtered)	mg/L	0.01			1	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
	Arsenic (Filtered)	mg/L	0.0002				0.0078	0.0013	0.0008	0.0004	0.0006	0.003	0.0015	0.0015	0.0009	0.0078	0.0008	0.0012	0.0195	0.0043
	Boron (Filtered)	mg/L	0.005				0.111	0.148	0.154	0.234	0.28	0.118	0.087	0.3	0.078	0.109	0.058	0.095	2.38	0.473
	Cadmium (Filtered)	mg/L	0.00005	0.0007			<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
	Chromium (Filtered)	mg/L	0.0002	0.0284			0.0004	0.0006	0.0005	0.0005	0.0009	0.0009	0.0007	0.0007	<0.0002	0.0013	0.0004	<0.0002	0.0021	0.0002
	Copper (Filtered)	mg/L	0.0005	0.0013			0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001	<0.0005
	Iron (Filtered)	mg/L	0.05				-	-	-	-	-	-	-	-	-	-	-	-	0.14	2.42
	Lead (Filtered)	mg/L	0.0001	0.0044			<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Manganese (Filtered)	mg/L	0.0005				0.0541	0.207	0.16	0.106	0.116	0.109	0.117	0.198	0.113	0.143	0.0763	0.122	0.0595	0.159
	Mercury (Filtered)	mg/L	0.0001	0.0001			<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Molybdenum (Filtered)	mg/L	0.0001				0.0002	0.001	0.0017	0.0011	0.0018	0.0018	0.0017	0.0025	0.0031	0.0012	0.0003	0.0002	0.0215	0.0085
	Selenium (Filtered)	mg/L	0.01				<0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0003	<0.0002	0.0004	<0.0002	0.0003	<0.0002	<0.0002	0.0016	<0.0002
	Nickel (Filtered)	mg/L	0.0005	0.007			0.0014	0.0027	0.0012	0.0006	0.0056	0.0016	0.0007	0.0006	<0.0005	0.0007	<0.0005	<0.0005	0.0212	0.0007
	Tin (Filtered)	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Zinc (Filtered)	mg/L	0.001	0.015			0.002	0.004	0.002	<0.001	<0.001	0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001
Total Metals	Aluminium	mg/L	0.01		0.15	1	-	-	-	-	-	-	-	-	-	-	-	-	0.25	0.35
	Arsenic	mg/L	0.001				-	-	-	-	-	-	-	-	-	-	-	-	0.014	0.004
	Cadmium	mg/L	0.0001	0.0007			-	-	-	-	-	-	-	-	-	-	-	-	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.0284			-	-	-	-	-	-	-	-	-	-	-	-	0.004	0.002
	Copper	mg/L	0.001	0.0013			-	-	-	-	-	-	-	-	-	-	-	-	0.002	<0.001
	Iron	mg/L	0.05		1		-	-	-	-	-	-	-	-	-	-	-	-	0.7	4.22
	Lead	mg/L	0.001	0.0044			-	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001
	Manganese	mg/L	0.001				-	-	-	-	-	-	-	-	-	-	-	-	0.07	0.161
	Mercury	mg/L	0.0001	0.0001			-	-	-	-	-	-	-	-	-	-	-	-	<0.0001	<0.0001
	Nickel	mg/L	0.001	0.007			-	-	-	-	-	-	-	-	-	-	-	-	0.022	0.001
	Selenium	mg/L	0.01				-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
	Zinc	mg/L	0.005	0.015			-	-	-	-	-	-	-	-	-	-	-	-	0.005	<0.005
Herbicides	2,4,5-Trichlorophenoxy Acetic Acid	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	2,4-D	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	2,4-dichlorophenoxybutanoic acid	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	2,4-Dichlorprop	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	2,6-D	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	2-Methyl-4-chlorophenoxyacetic acid	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	2-Methyl-4-Chlorophenoxy Butanoic Acid	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	4-Chlorophenoxyacetic acid	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Atrazine	mg/L	0.0005				<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Clopyralid	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Golder Associates

Chemical Group	Parameter	Unit	Detection limit	ANZECC 2000 Marine Water Slightly-Moderately Disturbed Ecosystems	Swan River Trust	DEC Groundwater Acidification	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
						Sample Location	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
						Sample COC	09885-01	09885-02	Q09858-02	Q09858-03	Q09858-04	Q09858-06	Q09859-01	Q09859-02	Q09859-03	Q09860 - 01	Q09860 - 02	Q09860 - 03	Q6837-01	Q6837-02
						Sampled Date	20/12/2012	20/12/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	14/11/2012	14/11/2012	14/11/2012	13/12/2012	13/12/2012
						Laboratory Ref	EP1210657	EP1210657	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209550	EP1209550	EP1209550	EP1210433	EP1210433
						Stratigraphic Unit	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	SRA	Guildford
	Dicamba	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Fenoprop	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Fluroxypyr	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Mecoprop	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Picloram	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Simazine	mg/L	0.0005				<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Triclopyr	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MAH	1,2,4-trimethylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,3,5-Trimethylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Benzene	mg/L	0.001	0.5			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Ethylbenzene	mg/L	0.002				<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Isopropylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	n-Butylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	n-Propylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	p-Isopropyltoluene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	sec-Butylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Styrene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	tert-Butylbenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Toluene	mg/L	0.002				<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Xylenes (m & p)	mg/L	0.002				<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Xylene (o)	mg/L	0.002				<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Xylenes (Sum of total)	mg/L	0.002				<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Total BTEX	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Organochlorine Pesticides	a-BHC	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Aldrin	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	b-BHC	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Chlordane (Sum of total)	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	cis-Chlordane	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	trans-Chlordane	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	d-BHC	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	DDD	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	DDE	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	DDT	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	DDT+DDE+DDD (Sum of total)	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Dieldrin	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endosulfan	mg/L	0.00001	0.000005			<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endosulfan I	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endosulfan II	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endosulfan sulphate	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endrin	mg/L	0.00001	0.000004			<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endrin aldehyde	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Endrin ketone	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	g-BHC	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Heptachlor	mg/L	0.000005				<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
	Heptachlor epoxide	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Methoxychlor	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Oxychlordane	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Bromophos-ethyl	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Carbophenothion	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chlorpyriphos	mg/L	0.00005	0.000009			<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
	Chlorpyriphos-methyl	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	cis-Chlorfenvinphos	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Diazinon	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Dichlorvos	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Dimethoate	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Ethion	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Fenamiphos	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Fenthion	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Malathion	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Parathion-methyl	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Monocrotophos	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Parathion	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Pirimphos-ethyl	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Prothiofos	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Pesticides-Others	3-Hydroxy-Carbofuran	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Aldicarb	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Bendiocarb	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Carbaryl	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Carbofuran	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Demeton-s-methyl	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Methomyl	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Oxamyl	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
	Thiodicarb	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Golder Associates

	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
Sample Location	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
Sample COC	09885-01	09885-02	Q09858-02	Q09858-03	Q09858-04	Q09858-06	Q09859-01	Q09859-02	Q09859-03	Q09860 - 01	Q09860 - 02	Q09860 - 03	Q6837-01	Q6837-02
Sampled Date	20/12/2012	20/12/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	14/11/2012	14/11/2012	14/11/2012	13/12/2012	13/12/2012
Laboratory Ref	EP1210657	EP1210657	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209550	EP1209550	EP1209550	EP1210433	EP1210433
Stratigraphic Unit	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	SRA	Guildford

Chemical Group	Parameter	Unit	Detection limit	ANZECC 2000 Marine Water Slightly-Moderately Disturbed Ecosystems	Swan River Trust	DEC Groundwater Acidification	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
PAH	Acenaphthene	mg/L	0.00002				0.00002	0.00003	0.00004	<0.00002	0.00002	0.00002	<0.00002	<0.00002	0.00006	<0.00002	0.00013	0.00015	<0.00002	<0.00002
	Acenaphthylene	mg/L	0.00002				<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Anthracene	mg/L	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
	Benz(a)anthracene	mg/L	0.00002				<0.00002	<0.00002	0.00005	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Benzo(a)pyrene	mg/L	0.000005				0.000006	<0.000005	0.000055	0.000013	0.000007	0.000028	0.000009	<0.000005	0.000036	0.000011	0.000019	<0.000005	<0.000005	<0.000005
	Benzo(b)fluoranthene	mg/L	0.00002				<0.00002	<0.00002	0.00004	<0.00002	<0.00002	0.00003	<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Benzo(g,h,i)perylene	mg/L	0.00002				<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Benzo(k)fluoranthene	mg/L	0.00002				<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Chrysene	mg/L	0.00002				<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Dibenz(a,h)anthracene	mg/L	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
	Fluoranthene	mg/L	0.00002				<0.00002	<0.00002	0.00008	<0.00002	0.00002	0.00003	<0.00002	0.00003	0.00006	0.00002	0.00005	0.00003	<0.00002	<0.00002
	Fluorene	mg/L	0.00002				<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00002	0.00003	<0.00002	0.00006	0.0001	<0.00002	<0.00002
	Indeno(1,2,3-c,d)pyrene	mg/L	0.00002				<0.00002	<0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
	Naphthalene	mg/L	0.00002	0.05			0.00005	0.00004	0.00004	0.00006	<0.00002	<0.00002	<0.00002	0.00017	<0.00002	<0.00002	0.00005	<0.00002	0.00016	0.00022
	Phenanthrene	mg/L	0.00002				0.00003	<0.00002	0.00005	<0.00002	0.00004	<0.00002	<0.00002	0.00006	0.00007	0.00002	0.00005	0.00011	<0.00002	<0.00002
	Pyrene	mg/L	0.00002				<0.00002	<0.00002	0.0001	<0.00002	0.00003	0.00004	0.00002	0.00006	0.00007	0.00002	0.00005	0.00004	<0.00002	<0.00002
	PAH (Sum of Common 16 PAHs)	mg/L	0.000005				0.000106	0.00007	0.000595	0.000073	0.000117	0.000218	0.000029	0.00034	0.000416	0.000071	0.000429	0.00043	0.00016	0.00022
Halogenated Benzenes	1,2,3-Trichlorobenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2,4-Trichlorobenzene	mg/L	0.005	0.02			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2-Dichlorobenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,3-Dichlorobenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,4-Dichlorobenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	2-Chlorotoluene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	4-Chlorotoluene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Bromobenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Chlorobenzene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Hexachlorobenzene	mg/L	0.00001				<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Phenolics	2,4-Dimethylphenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2-Methylphenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2-Nitrophenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	3- & 4- Methylphenol	mg/L	0.002				<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Phenol	mg/L	0.001	0.4			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenolics-Halogenated	2,4,5-Trichlorophenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2,4,6-Trichlorophenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2,4-Dichlorophenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2,6-Dichlorophenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2-Chlorophenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	4-Chloro-3-methylphenol	mg/L	0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Pentachlorophenol	mg/L	0.002	0.011			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Polychlorinated Biphenyls	Aroclor 1016	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Aroclor 1232	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Aroclor 1242	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Aroclor 1248	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Aroclor 1254	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Aroclor 1260	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Aroclor 1221	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	PCB (Sum of Total)	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Solvents	Methyl Ethyl Ketone	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
	2-Hexanone	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
	4-Methyl-2-pentanone	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
	Vinyl acetate	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
Other	Acidity (as CaCO3)	mg/L	1				-	-	-	-	-	-	-	-	-	-	-	-	29	13
	Benzo(a)pyrene (TEQs)	mg/L	0.000005				0.000006	<0.000005	0.000071	0.000013	0.000007	0.000033	0.000009	<0.000005	0.000041	0.000011	0.000019	<0.000005	<0.000005	<0.000005
	Hydrogen sulfide	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
	Methane	mg/L	0.01				4.11	4.04	11.4	8.12	7.22	1.94	2.49	5.45	4.16	5.89	8.1	10.5	9.35	1.45
	Methiocarb	mg/L	0.0002				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Total Petroleum Hydrocarbons	TPH C 6 - C 9 Fraction	mg/L	0.02	0.15			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	TPH C10 - C14 Fraction	mg/L	0.05				<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	TPH C15 - C28 Fraction	mg/L	0.1				<0.1	0.32	0.21	0.27	0.28	<0.1	<0.1	0.51	<0.1	0.11	<0.1	<0.1	0.24	<0.1
	TPH C29-C36 Fraction	mg/L	0.05				<0.05	0.06	0.07	0.07	0.08	<0.05	<0.05	0.18	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
	TPH+C10 - C36 (Sum of total)	mg/L	Calculated	0.6			<0.2	0.405	0.305	0.365	0.385	<0.2	<0.2	0.77	<0.2	0.16	<0.2	<0.2	0.315	<0.2
	TPH+C10 - C36 (Sum of total)	mg/L	0.05				<0.05	0.38	0.28	0.34	0.36	<0.05	<0.05	0.77	<0.05	0.11	<0.05	<0.05	0.29	<0.05
	TPH+C10 - C40 (Sum of total)	mg/L	0.1				<0.1	0.32	0.25	0.3	0.32	0.1	<0.1	0.85	0.1	0.15	<0.1	0.11	0.25	<0.1
	C6 - C10 Fraction	mg/L	0.02				<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	C6 - C10 Fraction minus BTEX (F1)	mg/L	0.02				<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	TRH >C10-C16 F2	mg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	TRH >C16-C34 F3	mg/L	0.1				<0.1	0.32	0.25	0.3	0.32	0.1	<0.1	0.6	0.1	0.15	<0.1	0.11	0.25	<0.1
	TRH >C34-C40 F4	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
Volatile Organic Compounds	1,1,1,2-Tetrachloroethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,1,2,2-Tetrachloroethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,1,1-Trichloroethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,1,2-Trichloroethane	mg/L	0.005	1.9			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2,3-Trichloropropane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2-Dibromo-3-chloropropane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2-Dibromoethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,1-Dichloroethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2-Dichloroethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,1-Dichloroethene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

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	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
Sample Location	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
Sample COC	09885-01	09885-02	Q09858-02	Q09858-03	Q09858-04	Q09858-06	Q09859-01	Q09859-02	Q09859-03	Q09860 - 01	Q09860 - 02	Q09860 - 03	Q6837-01	Q6837-02
Sampled Date	20/12/2012	20/12/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	13/11/2012	14/11/2012	14/11/2012	14/11/2012	13/12/2012	13/12/2012
Laboratory Ref	EP1210657	EP1210657	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209524	EP1209550	EP1209550	EP1209550	EP1210433	EP1210433
Stratigraphic Unit	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	Fill	SRA	Guildford

Chemical Group	Parameter	Unit	Detection limit	ANZECC 2000 Marine Water Slightly-Moderately Disturbed Ecosystems	Swan River Trust	DEC Groundwater Acidification	BH02-2003	SB035	SB017	SB019	SB020	SB001	SB033	SB004	SB015	SB031	SB024	SB006	BH04	BH09
	cis-1,2-Dichloroethene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	trans-1,2-dichloroethene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,2-Dichloropropane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,3-Dichloropropane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	2,2-Dichloropropane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	1,1-Dichloropropene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	cis-1,3-Dichloropropylene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	trans-1,3-dichloropropylene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	cis-1,4-Dichloro-2-butene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	trans-1,4-Dichloro-2-butene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Bromodichloromethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Bromoform	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Bromomethane	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
	Carbon disulfide	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Carbon tetrachloride	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Chlorodibromomethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Chloroethane	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
	Chloroform	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Chloromethane	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
	Dibromomethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Dichlorodifluoromethane	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
	Hexachlorobutadiene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Iodomethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Pentachloroethane	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Trichloroethene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Tetrachloroethene	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Trichlorofluoromethane	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
	Vinyl chloride	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

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APPENDIX E

Avian Fauna Survey and Database Search Results

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
CASUARIIFORMES												
Dromaiidae	**Emu**											
Dromaius novaehollandiae	Emu				x	x						
GALLIFORMES												
Megapodiidae	**Megapodes**											
Leipoa ocellata	Malleefowl	VU	S1					x				
Phasianidae	**Pheasants, Fowl & Allies**											
Coturnix pectoralis	Stubble Quail				x	x						
Coturnix ypsilophora	Brown Quail					x						
ANSERIFORMES												
Anatidae	**Ducks, Geese & Swans**											
Anas castanea	Chestnut Teal				x	x						
Anas gracilis	Grey Teal				x	x				x	x	
Anas platyrhynchos	Northern Mallard				x	x			x	x		x
Anas rhynchotis	Australasian Shoveler				x	x				x	x	x
Anas superciliosa	Pacific Black Duck				x	x			x	x	x	x
Aythya australis	Hardhead				x	x			x	x	x	x
Biziura lobata	Musk Duck				x	x			x	x	x	x
Chenonetta jubata	Maned Duck				x	x			x	x		x
Cygnus atratus	Black Swan				x	x			x	x	x	x
Malacorhynchus membranaceus	Pink-eared Duck				x	x				x	x	
Oxyura australis	Blue-billed Duck				x	x			x	x		x
Stictonetta naevosa	Freckled Duck				x	x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Tadorna tadornoides	Australian Shelduck				x	x				x	x	x
PODICIPEDIFORMES												
Podicipedidae	**Grebes**											
Podiceps cristatus	Great Crested Grebe				x				x	x	x	x
Poliocephalus poliocephalus	Hoary-headed Grebe				x				x		x	x
Tachybaptus novaehollandiae	Australasian Grebe				x	x			x	x		x
PELECANIFORMES												
Threskiornithidae	**Ibises, Spoonbills**											
Platalea flavipes	Yellow-billed Spoonbill				x	x				x	x	
Platalea regia	Royal Spoonbill					x						
Plegadis falcinellus	Glossy Ibis	Mi	S3			x						
Threskiornis moluccus	Australian White Ibis				x	x			x	x	x	x
Threskiornis spinicollis	Straw-necked Ibis				x	x			x	x	x	
Ardeidae	**Herons, Bitterns**											
Ardea garzetta	Little Egret					x				x	x	
Ardea alba	Great Egret	Mi	S3			x		x		x	x	x
Ardea Ibis	Eastern Cattle Egret	Mi	S3		x	x		x				
Ardea pacifica	White-necked Heron				x	x						
Botaurus poiciloptilus	Australasian Bittern	EN	S1		x			x				
Dupetor flavicollis	Black Bittern			P3	x							
Egretta novaehollandiae	White-faced Heron				x				x	x	x	x
Egretta sacra	Eastern Reef Egret	Mi	S3			x						
Ixobrychus dubius	Black-backed Bittern			P4	x	x						x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Nycticorax caledonicus	Nankeen Night Heron				x	x				x		x
Pelecanidae	**Pelicans**											
Pelecanus conspicillatus	Australian Pelican				x	x			x	x	x	x
SULIFORMES												
Phalacrocoracidae	**Cormorants, shags**											
Microcarbo melanoleucos	Little Pied Cormorant					x			x		x	x
Phalacrocorax carbo	Great Cormorant				x	x				x	x	x
Phalacrocorax fascescens	Black-faced Cormorant					x						
Phalacrocorax sulcirostris	Little Black Cormorant				x					x	x	x
Phalacrocorax varius	Australian Pied Cormorant				x	x				x	x	
Anhingidae	**Anhingas, darters**											
Anhinga novaehollandiae	Australasian Darter					x			x	x	x	x
ACCIPITRIFORMES												
Pandionidae	**Ospreys**											
Pandion cristatus	Eastern Osprey				x	x				x		
Accipitridae	**Kites, Hawks & Eagles**											
Accipiter cirrocephalus	Collared Sparrowhawk				x	x						
Accipiter fasciatus	Brown Goshawk				x	x						
Aquila audax	Wedge-tailed Eagle					x						
Circus approximans	Swamp Harrier				x	x						
Circus assimilis	Spotted Harrier					x						
Elanoides axillaris	Black-shouldered Kite				x	x				x		
Haliaeetus leucogaster	White-bellied Sea Eagle	Mi	S3			x		x		x		

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Haliastur sphenurus	Whistling Kite				x	x						
Hieraaetus morphnoides	Little Eagle				x	x				x		
Lophoictinia isura	Square-tailed Kite				x	x						
FALCONIFORMES												
Falconidae	**Caracaras, Falcons**											
Falco berigora	Brown Falcon				x	x						
Falco cenchroides	Nankeen Kestrel				x	x				x		
Falco hypoleucos	Grey Falcon		S1	VU	x							
Falco longipennis	Australian Hobby				x	x				x		x
Falco peregrinus	Peregrine Falcon		S4		x	x				x		
OTIDIFORMES												
Otididae	**Bustards**											
Ardeotis australis	Australian Bustard			P4	x							
GRUIFORMES												
Rallidae	**Rails, Crakes & Coots**											
Fulica atra	Eurasian Coot				x	x			x	x		x
Gallinula tenebrosa	Dusky Moorhen				x	x			x	x		x
Gallirallus philippensis	Buff-banded Rail				x	x				x		
Porphyrio porphyrio	Purple Swamphen				x				x	x		x
Porzana fluminea	Australian Crake				x	x						
Porzana pusilla	Baillon's Crake				x	x						
Porzana tabuensis	Spotless Crake				x	x				x		
Tribonyx ventralis	Black-tailed Native-hen				x	x				x		x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
CHARADRIIFORMES												
Turnicidae	**Buttonquail**											
Turnix varius	Painted Buttonquail				x	x						
Turnix velox	Little Buttonquail					x						
Burhinidae	**Stone-curlews**											
Burhinus grallarius	Bush Stone-curlew				x							
Haematopodidae	**Oystercatchers**											
Haematopus fuliginosus	Sooty Oystercatcher					x						
Haematopus longirostris	Pied Oystercatcher				x	x						
Recurvirostridae	**Stilts, Avocets**											
Cladorhynchus leucocephalus	Banded Stilt				x	x						
Himantopus leucocephalus	White-headed Stilt				x	x		x		x		
Recurvirostra novaehollandiae	Red-necked Avocet					x		x		x		
Charadriidae	**Plovers**											
Charadrius bicinctus	Double-banded Plover	Mi	S3					x				
Charadrius dubius	Little Ringed Plover	Mi	S3			x						
Charadrius leschenaultii	Greater Sand Plover	Mi	S1; S3	VU		x		x			x	
Charadrius mongolus	Lesser Sand Plover	Mi	S1; S3	VU		x		x			x	
Charadrius ruficapillus	Red-capped Plover				x	x		x		x	x	
Elseyornis melanops	Black-fronted Dotterel					x				x	x	
Erythrogonys cinctus	Red-kneed Dotterel				x	x						
Pluvialis fulva	Pacific Golden Plover	Mi	S3					x			x	
Pluvialis squatarola	Grey Plover	Mi	S3		x	x		x			x	

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Thinornis rubricollis	Hooded Dotterel			P4		x					x	
Vanellus tricolor	Banded Lapwing					x						
Rostratulidae	**Painted Snipes**											
Rostratula australis	Australian Painted Snipe	VU	S1	EN		x		x				
Scolopacidae	**Sandpipers, Snipes**											
Actitis hypoleucos	Common Sandpiper	Mi	S3		x	x		x		x	x	
Arenaria interpres	Ruddy Turnstone	Mi	S3			x		x			x	
Calidris acuminata	Sharp-tailed Sandpiper	Mi	S3		x	x		x		x	x	
Calidris alba	Sanderling	Mi	S3			x		x				
Calidris canutus	Red Knot	Mi	S1; S3	VU		x		x			x	
Calidris ferruginea	Curlew Sandpiper	Mi	S1; S3	VU	x	x		x			x	
Calidris melanotos	Pectoral Sandpiper	Mi	S3					x			x	
Calidris ruficollis	Red-necked Stint	Mi	S3		x	x		x		x	x	
Calidris tenuirostris	Great Knot	Mi	S1; S3	VU		x		x			x	
Limicola falcinellus	Broad-billed Sandpiper	Mi	S3								x	
Limosa lapponica	Bar-tailed Godwit	Mi	S1; S3	VU		x		x			x	
Limosa limosa	Black-tailed Godwit	Mi	S3			x		x			x	
Numenius arquata	Eurasian Curlew	Mi	S1; S3	VU	x							
Numenius minutus	Little Curlew	Mi	S3			x						
Numenius phaeopus	Whimbrel	Mi	S3			x		x			x	
Phalaropus lobatus	Red-necked Phalarope	Mi	S3					x				
Philomachus pugnax	Ruff	Mi	S3			x						
Tringa brevipes	Grey-tailed Tattler	Mi	S3			x		x			x	

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Tringa glareola	Wood Sandpiper	Mi	S3			x						
Tringa nebularia	Common Greenshank	Mi	S3		x	x		x		x	x	
Tringa stagnatilis	Marsh Sandpiper	Mi	S3			x		x			x	
Tringa totanus	Common Redshank	Mi	S3					x				
Xenus cinereus	Terek Sandpiper	Mi	S3			x		x			x	
Phalaropus lobatus	Red-necked Phalarope	Mi	S3					x				
Laridae	**Gulls, Terns & Skimmers**											
Chlidonias hybrida	Whiskered Tern					x						
Chroicocephalus novaehollandiae	Silver Gull				x	x			x	x	x	x
Gelochelidon nilotica	Gull-billed Tern					x						
Hydroprogne caspia	Caspian Tern	Mi	S3			x				x	x	x
Larus pacificus	Pacific Gull					x						
Onychoprion anaethetus	Bridled Tern	Mi	S3			x						
Sterna dougallii	Roseate Tern					x						
Sterna paradisaea	Arctic Tern					x						
Sternula nereis	Fairy Tern	VU			x	x		x			x	
Thalasseus bergii	Greater Crested Tern				x	x				x	x	
COLUMBIFORMES												
Columbidae	**Pigeons, Doves**											
Columba livia	Rock Dove				x	x			x	x		
Ocyphaps lophotes	Crested Pigeon					x						
Phaps chalcoptera	Common Bronzewing				x	x						
Spilopelia senegalensis	Laughing Dove				x	x			x	x		x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Streptopelia chinensis	Spotted Dove				x	x				x		x
PSITTACIFORMES												
Cacatuidae	**Cockatoos**											
Cacatua galerita	Sulfur-crested Cockatoo					x						
Cacatua pastinator	Western Corella				x	x						
Cacatua sanguinea	Little Corella				x	x			x	x		x
Cacatua tenuirostris	Long-billed Corella					x				x		
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S1		x	x		x		x		x
Calyptorhynchus baudinii	Baudin's Black Cockatoo	VU	S1		x	x						
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	EN	S1		x	x		x		x		
Eolophus roseicapilla	Galah					x				x		
Lophochroa leadbeateri	Major Mitchell's Cockatoo		S4		x							
Nymphicus hollandicus	Cockatiel				x	x						
Psittacidae	**Parrots**											
Barnardius zonarius	Australian Ringneck				x	x				x		
Glossopsitta porphyrocephala	Purple-crowned Lorikeet				x	x						
Melopsittacus undulatus	Budgerigar				x							
Neophema elegans	Elegant Parrot				x	x						
Platycercus icterotis	Western Rosella					x						
Polytelis anthopeplus	Regent Parrot				x	x						
Purpureicephalus spurius	Red-capped Parrot				x	x						
Trichoglossus moluccanus	Rainbow Lorikeet				x	x				x		x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
CUCULIFORMES												
Cuculidae	**Cuckoos**											
Cacomantis flabelliformis	Fan-tailed Cuckoo					x						
Cacomantis pallidus	Pallid Cuckoo					x						
Chrysococcyx basalis	Horsfield's Bronze Cuckoo					x						
Chrysococcyx lucidus	Shining Bronze Cuckoo					x						
STRIGIFORMES												
Tyto delicatula	Eastern Barn Owl				x	x						
Tyto novaehollandiae	Australian Masked Owl			P3	x							
Strigidae	**Owls**											
Ninox boobook	Southern Boobook				x	x				x		
Ninox connivens	Barking Owl					x						
CAPRIMULGIFORMES												
Podargidae	**Frogmouths**											
Podargus strigoides	Tawny Frogmouth					x						
Caprimulgidae	**Nightjars**											
Eurostopodus argus	Spotted Nightjar				x					x		
APODIFORMES												
Apodidae	**Swifts**											
Apus pacificus	Pacific Swift	Mi	S3		x	x		x				
CORACIIFORMES												
Alcedinidae	**Kingfishers**											
Dacelo novaeguineae	Laughing Kookaburra				x	x				x		

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Todiramphus sanctus	Sacred Kingfisher				x	x						
Meropidae	**Bee-eaters**											
Merops ornatus	Rainbow Bee-eater	Mi	S3		x	x		x		x		
PASSERIFORMES												
Climacteridae	**Australasian Treecreepers**											
Climacteris rufus	Rufous Treecreeper					x						
Maluridae	**Australasian Wrens**											
Malurus elegans	Red-winged Fairywren					x						
Malurus lamberti	Variegated Fairywren				x	x						
Malurus leucopterus	White-winged Fairywren					x						
Malurus pulcherrimus	Blue-breasted Fairywren					x						
Malurus splendens	Splendid Fairywren				x	x						
Stipiturus malachurus	Southern Emu-wren					x						
Meliphagidae	**Honeyeaters**											
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					x						
Acanthorhynchus superciliosus	Western Spinebill				x	x						
Anthochaera carunculata	Red Wattlebird				x	x			x			
Anthochaera lunulata	Western Wattlebird				x	x						
Epthianura albifrons	White-fronted Chat				x	x						
Epthianura tricolor	Crimson Chat					x						
Gliciphila melanops	Tawny-crowned Honeyeater				x	x						
Lichenostomus leucotis	White-eared Honeyeater					x						
Lichenostomus ornatus	Yellow-plumed Honeyeater				x	x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Lichenostomus virescens	Singing Honeyeater				x	x			x			x
Lichmera indistincta	Brown Honeyeater				x	x			x			x
Manorina flavigula	Yellow-throated Miner				x	x						
Melithreptus brevirostris	Brown-headed Honeyeater				x	x						
Melithreptus lunatus	White-naped Honeyeater				x	x						
Phylidonyris niger	White-cheeked Honeyeater				x	x						
Phylidonyris novaehollandiae	New Holland Honeyeater				x	x						x
Purnella albifrons	White-fronted Honeyeater					x						
Pardalotidae	**Pardalotes**											
Pardalotus punctatus	Spotted Pardalote				x	x						
Pardalotus striatus	Striated Pardalote				x	x						
Acanthizidae	**Australasian Warblers**											
Acanthiza apicalis	Inland Thornbill				x	x						
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				x	x						
Acanthiza inornata	Western Thornbill				x	x						
Calamanthus campestris	Rufous Fieldwren			P4		x						
Gerygone fusca	Western Gerygone				x	x						
Sericornis frontalis	White-browed Scrubwren					x						
Smicrornis brevirostris	Weebill				x	x						
Cracticidae	**Butcherbirds and Allies**											
Cracticus nigrogularis	Pied Butcherbird				x	x						
Cracticus torquatus	Grey Butcherbird				x	x						
Gymnorhina tibicen	Australian Magpie				x	x			x			x

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Strepera versicolor	Grey Currawong				x	x						
Artamidae	**Woodswallows**											
Artamus cinereus	Black-faced Woodswallow				x							
Artamus cyanopterus	Dusky Woodswallow					x						
Artamus personatus	Masked Woodswallow				x							
Campephagidae	**Cuckooshrikes**											
Coracina maxima	Ground Cuckoo-shrike				x							
Coracina novaehollandiae	Black-faced Cuckooshrike				x	x						x
Lalage tricolor	White-winged Triller				x							
Neosittidae	**Sittellas**											
Daphoenositta chrysoptera	Varied Sittella				x	x						
Pachycephalidae	**Whistlers and Allies**											
Colluricincla harmonica	Grey Shrikethrush				x							
Pachycephala pectoralis	Australian Golden Whistler				x							
Pachycephala rufiventris	Rufous Whistler				x							
Rhipiduridae	**Fantails**											
Rhipidura albiscapa	Grey Fantail				x	x						
Rhipidura leucophrys	Willie Wagtail				x	x			x			x
Monarchidae	**Monarchs**											
Grallina cyanoleuca	Magpie-lark				x	x			x			x
Myiagra inquieta	Restless Flycatcher					x						
Corvidae	**Crows, Jays**											
Corvus bennetti	Little Crow				x	x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Corvus coronoides	Australian Raven				x	x			x			x
Petroicidae	**Australasian Robins**											
Eopsaltria georgiana	White-breasted Robin					x						
Eopsaltria griseogularis	Western Yellow Robin				x	x						
Melanodryas cucullata	Hooded Robin				x	x						
Microeca fascinans	Jacky Winter					x						
Petroica boodang	Scarlet Robin				x	x						
Petroica goodenovii	Red-capped Robin					x						
Hirundinidae	**Swallows, Martins**											
Cheramoeca leucosterna	White-backed Swallow					x						
Hirundo neoxena	Welcome Swallow				x	x			x			x
Petrochelidon ariel	Fairy Martin					x						
Petrochelidon nigricans	Tree Martin				x	x						x
Acrocephalidae	**Reed Warblers and Allies**											
Acrocephalus australis	Australian Reed Warbler				x	x			x	x		x
Locustellidae	**Grassbirds and allies**											
Cincloramphus cruralis	Brown Songlark					x						
Cincloramphus mathewsi	Rufous Songlark				x	x						
Megalurus gramineus	Little Grassbird				x	x			x	x		x
Zosteropidae	**White-eyes**											
Zosterops lateralis	Silvereye				x	x			x			
Dicaeidae	**Flowerpeckers**											
Dicaeum hirundinaceum	Mistletoebird				x	x						

BIRDS Scientific Name	Common Name	Conservation Codes		DEC	A	B	C	D	E	F	G	Species Observed by ENV (Dec 2012)
		EPBC	WC									
Estrildidae	**Waxbills, Munias & Allies**											
Lonchura castaneothorax	Chestnut-breasted Mannikin					x						
Stagonopleura oculata	Red-eared Firetail					x						
Motacillidae	**Wagtails, Pipits**											
Anthus australis	Australian Pipit					x			x			

- EPBC- Environmental Protection and Biodiversity Conservation Act 1999
- WC - Wildlife Conservation Act 1950
- DEC - Department of Conservation Priority Code
- A - Listed in Naturemap (2012)
- B - Listed by Birdlife Australia (2012)
- C - Listed in the DEC threatened and Priority Fauna Database
- D - Listed by the SEWPAC Protected Matters Search Tool
- E - Recorded by Bamford Consulting Ecologists (2012)
- F - Recorded at Burswood Park Golf Course by Ornithological Technical Services (2012)
- G - Recorded at the Swan Estuary Marine Park, Shorebirds 2020 database (2012)

APPENDIX F

Construction Daily Inspection Checklist

Project Name: Crown Towers Development					**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?					
Are stationary engines fitted with drip tray or located in a secondary containment facility?					
Is there evidence of hydrocarbon spills?					

Project Name: Crown Towers Development					**Date:**
Inspector/s:					
Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions required/Comments**	**Actions input into register?**
Surface Water Management					
Are drainage ways free of litter?					
Is there any ponding or flooding?					
Is topsoil stockpiled 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?					
Noise and Vibration Monitoring					
Have any complaints been received? If yes have the following actions been undertaken? ▪ Monitoring is undertaken and reported within 7 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.					
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).					

Project Name:	Crown Towers Development			**Date:**	
Inspector/s:					
Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions required/Comments**	**Actions input into register?**
Is all unnecessary equipment being shut off when not in use?					
Vegetation Clearing					
No evidence of clearing/disturbance outside approved areas?					
Rehabilitation nursery (logs & grass trees) 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/hunting/or keeping native fauna on-site?					
Any contamination of retained lakes?					
Trenches created have bunds and upstream exit points to allow trapped fauna to escape?					
All pipelines under construction are capped each night to eliminate fauna being trapped?					
Trenches inspected for signs of fauna in them each morning prior to starting work?					
Any signs of or native animal's on-site/trapped fauna?					
Is wild care promotional signage on notice boards & updated?					

Project Name: Crown Towers Development				**Date:**	
Inspector/s:					
Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions required/Comments**	**Actions input into register?**
Dust Odour & Air Quality Management				(Daily)	
Off-site and on-site dust monitoring indicates that dust levels are within adopted performance criteria. Data recorded daily?					
Is construction traffic as per the site speed limit signage 10 km/hr?					
Are vehicles idling when not required?					
No vehicles venture off of designated tracks unless authorised?					
Are exposed ground surfaces watered down where possible?					
Is the water cart sufficient for the task?					
Are all roadways & cleared areas kept damp & at least every 3 hours?					
Have any Public comments been made?					
Are 1.8 m ring lock fences & breeze cloth in good condition/no gaps or holes?					
Are earthworks & clearing being conducted in appropriate stages to create buffer strips?					
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 in regards to traffic management?					
Any traffic safety incidents in regards to traffic management?					
Any damage to conservation areas in regards to traffic management?					

Project Name:	Crown Towers Development			**Date:**	
Inspector/s:					
Work Area:	**N/A**	**Acceptable (*tick*)**		**Actions required/Comments**	**Actions input into register?**
Are site vehicles adhering to site speed limits 10 km/hr?					
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?					

Inspection Comments:

Inspection Action Items

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APPENDIX G

Guideline Trigger Levels for Surface Water Monitoring

Table G1: Guideline Trigger Levels for Surface Water Monitoring

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Field Parameters	Oxidation Reduction Potential	mV	-						
	Temperature	°C	-						
	pH		-			6.5-8.5	8-8.4		6-9.0
	Conductivity	ms/cm	-						
	Dissolved oxygen	mg/L	-		90-110 (% saturation)				
Sample Quality Parameters	pH (Lab)	pH_Units	0.1	7.5-8.5	7.5-8.5	6.5-8.5	8-8.4		6-9.0
	Sodium (Filtered)	mg/L	0.5						
	Potassium (Filtered)	mg/L	0.1						
	Calcium (Filtered)	mg/L	0.2						
	Magnesium (Filtered)	mg/L	0.1						
	Chloride	mg/L	1					2500	
	Sulfate (as SO4)	mg/L	1					5000	
	Sulfate (as SO3)	mg/L	1						
	Bicarbonate Alkalinity as (HCO3)	mg/L	5						
	Carbonate Alkalinity (as CO3)	mg/L	1						
	Total Alkalinity (as CaCO3)	mg/L	5						
	Hardness (as CaCO3) (Filtered)	mg/L	5						
	Sum of Ions	mg/L	10						
	TFSS	mg/L	10						
	Anion-Cation Balance	%	-100						

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Heavy Metals	Arsenic	mg/L	0.001					0.07	0.1
	Arsenic (Filtered)	mg/L	0.001					0.07	0.1
	Boron	mg/L	0.005			0.37		40	0.5
	Boron (Filtered)	mg/L	0.005			0.37		40	0.5
	Cadmium	mg/L	0.0001			0.0002	0.0007	0.02	0.01
	Cadmium (Filtered)	mg/L	0.0001			0.0002	0.0007	0.02	0.01
	Chromium	mg/L	0.001				0.027(4)		0.1
	Chromium (Filtered)	mg/L	0.001				0.027(4)		0.1
	Copper	mg/L	0.001			0.0014	0.0013	20	0.2
	Copper (Filtered)	mg/L	0.001			0.0014	0.0013	20	0.2
	Lead	mg/L	0.001			0.0034	0.0044	0.1	2
	Lead (Filtered)	mg/L	0.001			0.0034	0.0044	0.1	2
	Manganese	mg/L	0.001			1.9		5	0.2
	Manganese (Filtered)	mg/L	0.001			1.9		5	0.2
	Mercury (filtered)	mg/L	0.00005			0.00006	0.0001	0.01	0.002
	Mercury	mg/L	0.0001			0.00006	0.0001	0.01	0.002
	Molybdenum	mg/L	0.001					0.5	0.01
	Molybdenum (Filtered)	mg/L	0.001					0.5	0.01
	Nickel	mg/L	0.001			0.011	0.007	0.2	0.2
	Nickel (Filtered)	mg/L	0.001			0.011	0.007	0.2	0.2
	Selenium	mg/L	0.002			0.005		0.1	0.02
	Selenium (Filtered)	mg/L	0.002			0.005		0.1	0.02
	Tin	mg/L	0.001						
	Tin (Filtered)	mg/L	0.001						
	Zinc	mg/L	0.001			0.008	0.015	30	2
	Zinc (Filtered)	mg/L	0.001			0.008	0.015	30	2

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Organochlorine Pesticides	a-BHC	mg/L	0.00005						
	Aldrin	mg/L	0.00001						
	Aldrin & Dieldrin (Sum of total)	mg/L						0.003	
	b-BHC	mg/L	0.00005						
	cis-Chlordane	mg/L	0.000002						
	gamma-Chlordane	mg/L	0.000002						
	d-BHC	mg/L	0.00005						
	DDD (1)	mg/L	0.00001						
	DDE (2)	mg/L	0.00001						
	DDT (3)	mg/L	0.000002			0.000006		0.2	
	DDT+DDE+DDD (Sum of total)	mg/L							
	Dieldrin	mg/L	0.000002						
	Endosulfan I	mg/L	0.000005						
	Endosulfan II	mg/L	0.000005						
	Endosulfan sulfate	mg/L	0.000005						
	Endrin	mg/L	0.000004			0.00001	0.000004		
	Endrin ketone	mg/L	0.00005						
	g-BHC	mg/L	0.00005					0.2	
	Heptachlor	mg/L	0.00001			0.00001			
	Heptachlor & heptachlor epoxide (Sum of total)	mg/l						0.003	
	Heptachlor epoxide	mg/L	0.00002						
	Methoxychlor	mg/L	0.0001						
	Hexachlorobenzene	mg/L	0.00001						

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water Use	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005						
	Bromophos-ethyl	mg/L	0.00005						
	Chlorpyriphos	mg/L	0.000009			0.00001	0.000009	0.01	
	Diazinon	mg/L	0.00001			0.00001		0.001	
	Dichlorvos	mg/L	0.0005						
	Ethion	mg/L	0.00005						
	Fenitrothion	mg/L	0.0002			0.0002		0.01	
	Malathion	mg/L	0.00005			0.00005			
	Methidathion	mg/L	0.00005						
	Parathion	mg/L	0.000004			0.000004		0.01	
PCBs	PCB 101	mg/L	0.0001						
	PCB 138	mg/L	0.0001						
	PCB 153	mg/L	0.0001						
	PCB 28	mg/L	0.0001						
	PCB 52	mg/L	0.0001						
	PCB 118	mg/L	0.0001						
	PCB 180	mg/L	0.0001						
Total Recoverable Hydrocarbons	TRH C_{10}-C_{14} Fraction	mg/L	0.05						
	TRH C_{15}-C_{28} Fraction	mg/L	0.2						
	TRH C_{29}-C_{36} Fraction	mg/L	0.2						
	TRH >C_{10}-C_{16} F2	mg/L	0.06						
	TRH >C_{16}-C_{34} F3	mg/L	0.5						
	TRH >C_{34}-C_{40} F4	mg/L	0.5						

APPENDIX H

Guideline Trigger Levels for Groundwater Monitoring

Table H1: Guideline Trigger Levels for Groundwater Monitoring

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
Sample Quality Parameters	pH (Lab)	pH Units	0.01	6.0-8.5	7.5-8.5	6.5-8.5	8.0-8.4		6.5-8.5		6-8.5
	Total Dissolved Solids @180°C	mg/L	10								
	Sodium (Filtered)	mg/L	0.5								
	Potassium (Filtered)	mg/L	0.1								
	Calcium (Filtered)	mg/L	0.2								
	Magnesium (Filtered)	mg/L	0.1								
	Chloride	mg/L	1					2500	250		
	Sulfate (as SO4)	mg/L	1					5000	250	500	
	Sulfide	mg/L	0.1								
	Bicarbonate Alkalinity as (HCO3)	mg/L	5								
	Carbonate Alkalinity (as CO3)	mg/L	1								
	Total Alkalinity (as CaCO3)	mg/L	1								
	Hardness (as CaCO3)	mg/L	5						200		

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	(Filtered)										
	Nitrate (as NO3-)	mg/L	0.05			0.7		500		50	-
	Nitrite (as NO2-)	mg/L	0.05					30		3	-
	Nitrogen (Total Oxidised)	mg/L	0.005		0.045						-
	Ammonia	mg/L	0.005		0.049	0.9	0.91	5	0.5		-
	Total Kjeldahl Nitrogen (as N)	mg/L	0.05								-
	Nitrogen (Inorganic)	mg/L	0.05								-
	Nitrogen (Total)	mg/L	0.05	>1.0	0.75						5
	Cyanide (total)	mg/L	0.004			0.007	0.004	0.8		0.08	-
	Reactive Phosphorus (as P)	mg/L	0.002		0.005						-
	Phosphorus	mg/L	0.01	>0.1	0.03	0.2					0.05
	Ionic Balance	%	-100								
	Sum of Ions (calc.)	mg/L	10								
	Thiocyanate	mg/L	0.1								

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Methane	mg/L	0.005								
Microbiological	Coliform	cfu/100 ml	1								-
	E. coli	cfu/100 ml	1								10(1)
Heavy Metals	Arsenic (Filtered)	mg/L	0.001					0.07		0.007	0.1
	Boron (Filtered)	mg/L	0.005			0.37		40		4	0.5
	Cadmium (Filtered)	mg/L	0.0001			0.0002	0.0055	0.02		0.002	0.01
	Chromium (Filtered)	mg/L	0.001								0.1
	Copper (Filtered)	mg/L	0.001			0.0014	0.0013	20	1	2	0.2
	Lead (Filtered)	mg/L	0.001			0.0034	0.0044	0.1		0.01	2
	Manganese (Filtered)	mg/L	0.001			1.9		5	0.1	0.5	0.2
	Mercury	mg/L	0.00005			0.00006	0.0001	0.01		0.001	0.002
	Molybdenum (Filtered)	mg/L	0.001					0.5		0.05	0.01
	Nickel (Filtered)	mg/L	0.001			0.011	0.07	0.2		0.02	0.2
	Selenium (Filtered)	mg/L	0.002			0.005		0.1		0.01	0.02

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Tin (Filtered)	mg/L	0.001								-
	Zinc (Filtered)	mg/L	0.001			0.008	0.015	30	3		2
MAH	1,2,4-trimethylbenzene	mg/L	0.0005								-
	1,3,5-Trimethylbenzene	mg/L	0.0005								-
	Benzene	mg/L	0.0005			0.95	0.5	0.01		0.001	-
	Ethylbenzene	mg/L	0.0005					0.003	0.003	0.3	-
	Isopropylbenzene	mg/L	0.0005								-
	n-Butylbenzene	mg/L	0.0005								-
	n-Propylbenzene	mg/L	0.0005								-
	p-Isopropyltoluene	mg/L	0.0005								-
	sec-Butylbenzene	mg/L	0.0005								-
	Styrene	mg/L	0.0005					0.004	0.004	0.03	-
	tert-Butylbenzene	mg/L	0.0005								-
	Toluene	mg/L	0.0005					0.025	0.025	0.8	-
	Xylenes (m & p)	mg/L	0.001			0.2 (2)		0.02	0.02	0.6	-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Xylene (o)	mg/L	0.0005			0.35		0.02	0.02	0.6	-
Organochlorine Pesticides	a-BHC	mg/L	0.00001								-
	Aldrin	mg/L	0.00001								-
	Aldrin & Dieldrin (Sum of total)	mg/L						0.003	0.0003	0.00001	-
	b-BHC	mg/L	0.00001								-
	Chlordane (Sum of total)	mg/L	0.00001			0.00003		0.01	0.001	0.00001	-
	cis-Chlordane	mg/L	0.000002								-
	gamma-Chlordane	mg/L	0.000002								-
	trans-Chlordane	mg/L	0.00001								-
	d-BHC	mg/L	0.00001								-
	DDD	mg/L	0.00001								-
	DDE	mg/L	0.00001								-
	DDT	mg/L	0.000002			0.00001		0.2	0.02	0.00006	-
	DDT+DDE+DDD (Sum of total)	mg/L	0.00001								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Dieldrin	mg/L	0.000002								-
	Endosulfan I	mg/L	0.000005								-
	Endosulfan II	mg/L	0.000005								-
	Endosulfan sulfate	mg/L	0.000005								-
	Endrin	mg/L	0.000004			0.00001	***0.000004***				-
	Endrin ketone	mg/L	0.00001								-
	g-BHC	mg/L	0.00001			0.0002		0.2	0.02	0.00005	-
	Heptachlor	mg/L	0.000005			0.00001					-
	Heptachlor & heptachlor epoxide (Sum of total)	mg/l						0.003	0.0003	0.00005	-
	Heptachlor epoxide	mg/L	0.00001								-
	Methoxychlor	mg/L	0.00001								-
Organophosphorous Pesticides	Azinphos-methyl	mg/L	0.00005			0.00002					-
	Bromophos-ethyl	mg/L	0.00005								-
	Chlorpyriphos	mg/L	0.000009			0.00001	0.000009	0.01	0.01		-
	Diazinon	mg/L	0.00001			0.00001		0.001	0.003	0.001	-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Dichlorvos	mg/L	0.0001								-
	Ethion	mg/L	0.00005								-
	Fenitrothion	mg/L	0.0002			0.0002		0.01	0.01		-
	Malathion	mg/L	0.00005			0.00005					-
	Methidathion	mg/L	0.00005								-
	Parathion	mg/L	0.000004			0.000004		0.01	0.01		-
Pesticides - Others	Carbaryl	mg/L	0.0005								-
Herbicides	Carbofuran	mg/L	0.0005			0.00006		0.005	0.01	0.005	-
	Atrazine	mg/L	0.0005			0.013		0.0001	0.04	0.0001	-
	Cyanazine	mg/L	0.0005								-
	Hexazinone	mg/L	0.001								-
	Metribuzin	mg/L	0.0005								-
	Prometryn	mg/L	0.0005								-
	Propazine	mg/L	0.0005								-
	Simazine	mg/L	0.0005			0.0032		0.0005	0.02	0.0005	-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Terbutryn	mg/L	0.0005								-
	Terbutylazine	mg/L	0.0005								-
Polychlorinated Biphenyls	PCB 101	mg/L	0.0001								-
	PCB 138	mg/L	0.0001								-
	PCB 153	mg/L	0.0001								-
	PCB 28	mg/L	0.0001								-
	PCB 52	mg/L	0.0001								-
	PCB 118	mg/L	0.0001								-
	PCB 180	mg/L	0.0001								-
PAH	Acenaphthene	mg/L	0.00001								-
	Acenaphthylene	mg/L	0.00001								-
	Anthracene	mg/L	0.00001								-
	Benz(a)anthracene	mg/L	0.00001								-
	Benzo(a)pyrene	mg/L	0.00001					0.0001		0.00001	-
	Benzo(b)&(k)fluoranthene	mg/L	0.00002								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Benzo(g,h,i)perylene	mg/L	0.00001								-
	Chrysene	mg/L	0.00001								-
	Dibenz(a,h)anthracene	mg/L	0.00001								-
	Fluoranthene	mg/L	0.00001								-
	Fluorene	mg/L	0.00001								-
	Indeno(1,2,3-c,d)pyrene	mg/L	0.00001								-
	Naphthalene	mg/L	0.00002			0.016	0.05				-
	Phenanthrene	mg/L	0.00001								-
	Pyrene	mg/L	0.00001								-
PAH - Others	1-Methylnaphthalene	mg/L	0.00001								
	2-Methylnaphthalene	mg/L	0.00001								
Halogenated Benzenes	1,2,3-Trichlorobenzene	mg/L	0.0005			0.003		0.005	0.005	0.003	-
	1,2,4-Trichlorobenzene	mg/L	0.0005			0.085	0.02	0.005	0.005	0.003	-
	1,2-Dichlorobenzene	mg/L	0.0005			0.16		0.001	0.001	1.5	-
	1,3-Dichlorobenzene	mg/L	0.0005			0.26		0.02	0.02		-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	1,4-Dichlorobenzene	mg/L	0.0003			0.06		0.003	0.003	0.04	-
	2-Chlorotoluene	mg/L	0.0005								-
	4-Chlorotoluene	mg/L	0.0005								-
	Bromobenzene	mg/L	0.0005								-
	Chlorobenzene	mg/L	0.0005					0.01	0.01	0.3	-
	Hexachlorobenzene	mg/L	0.00001								-
Phenolics	2,4-Dimethylphenol	mg/L	0.0001								-
	2,4-Dinitrophenol	mg/L	0.0001								-
	2-Methylphenol	mg/L	0.0001								-
	2-Nitrophenol	mg/L	0.00005								-
	3- & 4- Methylphenol	mg/L	0.0002								-
	3,4-Dimethylphenol	mg/L	0.0002								-
	4-Nitrophenol	mg/L	0.00005								-
	Phenol	mg/L	0.0001			0.32	0.4				-
Phenolics-Halogenated	2,3,4,6-Tetrachlorophenol	mg/L	0.00001			0.01					-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	2,3,5,6-Tetrachlorophenol	mg/L	0.00001								-
	2,4,5-Trichlorophenol	mg/L	0.00001								-
	2,4,6-Trichlorophenol	mg/L	0.00001			0.003		0.2	0.002	0.02	-
	2,4-Dichlorophenol	mg/L	0.00001			0.12		2	0.0003	0.2	-
	2,6-Dichlorophenol	mg/L	0.00001								-
	2,3,4,6 & 2,3,5,6-Tetrachlorophenol	mg/L	0.00002								-
	2-Chlorophenol	mg/L	0.0001			0.34		3	0.0001	0.3	-
	Pentachlorophenol	mg/L	0.00001			0.0036	0.011				-
Solvents	Methyl Ethyl Ketone	mg/L	0.01								-
	2-Hexanone	mg/L	0.005								-
	4-Methyl-2-pentanone	mg/L	0.005								-
	Acetone	mg/L	0.01								-
	Acrylonitrile	mg/L	0.0005								-
	Methyl-t-butyl ether	mg/L	0.0005					0.012	0.012		-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Vinyl acetate	mg/L	0.01								-
Total Recoverable Hydrocarbons	TRH C_6-C_9 Fraction	mg/L	0.02								-
	TRH C_{10}-C_{14}	mg/L	0.05								-
	TRH C_{15}-C_{28}	mg/L	0.1								-
	TRH C_{29}-C_{36}	mg/L	0.05								-
	TRH C_6-C_{10} minus BTEX (F1)	mg/L	0.02								-
	TRH $>C_{10}$-C_{16} F2	mg/L	0.06								-
	TRH $>C_{16}$-C_{34} F3	mg/L	0.5								-
	TRH $>C_{34}$-C_{40} F4	mg/L	0.5								-
Total Petroleum Hydrocarbons	TPH $>C_{16}$-C_{28} Aliphatic	ug/L	250								-
	TPH $>C_{16}$-C_{28} Aromatic	ug/L	250								-
	TPH $>C_{16}$-C_{35} Aliphatic (Sum)	ug/L	500								-
	TPH $>C_{28}$-C_{35} Aliphatic	ug/L	250								-
	TPH $>C_{28}$-C_{35} Aromatic	ug/L	250								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	TPH >C_9-C_{16} Aliphatic	ug/L	150								-
	TPH >C_9-C_{16} Aromatic	ug/L	150								-
	Aliphatic Hydrocarbons>C_{35}-C_{40}	mg/L	0.5								-
	TPH C_{16}-C_{35} Aromatic	mg/L	0.5								-
Volatile Organic Compounds	1,1,1,2-Tetrachloroethane	mg/L	0.0005								-
	1,1,2,2-Tetrachloroethane	mg/L	0.0005								-
	1,1,1-Trichloroethane	mg/L	0.0005								-
	1,1,2-Trichloroethane	mg/L	0.0005			6.5	1.9				-
	1,2,3-Trichloropropane	mg/L	0.0005								-
	1,2-Dibromo-3-chloropropane	mg/L	0.0005								-
	1,2-Dibromoethane	mg/L	0.0005								-
	1,1-Dichloroethane	mg/L	0.0005								-
	1,2-Dichloroethane	mg/L	0.0005					0.03		0.003	-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	1,1-Dichloroethene	mg/L	0.0005					0.3		0.03	-
	cis-1,2-Dichloroethene	mg/L	0.0005								-
	trans-1,2-dichloroethene	mg/L	0.0005								-
	1,2-Dichloropropane	mg/L	0.0005								-
	1,3-Dichloropropane	mg/L	0.0005								-
	2,2-Dichloropropane	mg/L	0.0005								-
	1,1-Dichloropropene	mg/L	0.0005								-
	cis-1,3-Dichloropropene	mg/L	0.0005								-
	trans-1,3-dichloropropene	mg/L	0.0005								-
	cis-1,4-Dichloro-2-butene	mg/L	0.001								-
	trans-1,4-Dichloro-2-butene	mg/L	0.001								-
	Allyl chloride	mg/L	0.0005								-
	Bromochloromethane	mg/L	0.0005								-
	Bromodichloromethane	mg/L	0.0005								-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Bromoform	ug/L	0.5								-
	Bromomethane	mg/L	0.01								-
	Carbon disulfide	mg/L	0.0005								-
	Carbon tetrachloride	mg/L	0.0005					0.03		0.003	-
	Chlorodibromomethane	mg/L	0.0005								-
	Chloroethane	mg/L	0.005								-
	Chloroform	mg/L	0.0005								-
	Chloromethane	mg/L	0.005								-
	Dibromomethane	ug/L	0.5								-
	Dichlorodifluoromethane	mg/L	0.005								-
	Dichloromethane	mg/L	0.005					0.04		0.004	-
	Hexachlorobutadiene	mg/L	0.001					0.007		0.0007	-
	Iodomethane	mg/L	0.005								-
	Trichloroethene	mg/L	0.0005								-
	Tetrachloroethene	mg/L	0.0005					0.5		0.05	-

Chem Group	Chem Name	Output Unit	EQL	Swan River Trust Interim Trigger Values*	ANZECC/ARMCANZ Estuaries in South-West Australia	ANZECC & ARMCANZ (2000) Freshwaters (95%)	ANZECC & ARMCANZ (2000) Marine Waters (95%)	DEC Domestic Non-potable Water use	DEC Drinking Water AV	DEC Drinking Water HV	ANZECC & ARMCANZ (2000) Long-term Irrigation Water Protection
	Trichlorofluoromethane	mg/L	0.001								-
	Vinyl chloride	mg/L	0.0003					0.003		0.0003	-

APPENDIX I

Project Glossary and Definitions

Project Glossary and Definitions

Term	Definition
µg/m³	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
DMAs	Decision Making Authorities
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	Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPP	Environmental Protection Policy
Golder	Golder Associates
IF	Influencing Factor
KPF	Kings Park Formation
Lead Contractor	Contractor engaged to undertake Construction Phase works
MP	Management Plan
NEPM	National Environmental Protection Measure
NPI	National Pollutant Inventory
OEMF	Operations Environmental Management Framework
OEMP	Operations Environmental Management Plan
OEPA	Office of the Environmental Protection Authority
OHS	Occupational Health and Safety
Operations Phase	The phase of the Project during which operations will be undertaken
PER	Public Environmental Review
PM_{10}	Particulate Matter 10 µm
$PM_{2.5}$	Particulate Matter 2.5 µm
ppm	Parts per million
Project	The Crown Towers Project
Project EMP	Crown Towers Environmental Management Plan
PSI	Preliminary Site Investigation

Term	Definition
RFP	Request for Proposal
RL	Reduced Levels
SCD	Sandy Channel Deposit
SEWPAC	Department of Sustainability, Environment, Water, Populations and Communities
SRA	Swan River Alluvium
	Swan River Trust
TSP	Total Suspended Particulates

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